ICIS 2022 ABSTRACT PROCEEDINGS

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Keynotes

K.01 – A Two-Brain Perspective on Human Sociality

Ruth Feldman, Center for Developmental Social Neuroscience at the Interdisciplinary Center

Scientists have called to move investigations into the social brain to naturalistic social exchanges and complement assessment of single-brain functioning with two-brain coordination. The talk will present our conceptual model on biobehavioral synchrony, which maintains that synchrony of brain and behavior emerges within the parent-infant bond during early sensitive periods and expands to include more complex, symbolic, and reciprocal components. We will begin by describing how synchrony is implemented in the parental brain and longitudinally shapes the child's affiliative brain through synchronous caregiving, charting the cross-generational arc of attachment. Studies on mother-child brain-to-brain synchrony will demonstrate how inter-brain synchrony is impacted by aspects of humans' co-presence, including chemosignals and technologically-assisted remote communication. Translational implications will be addressed by a synchrony-based intervention for post-partum depression and its effects on inter-brain coordination. The talk will conclude by contemplating how synchrony sustains the meaning component of human resilience and gives room to group participation and abstract commitments that transcend the life of the individual.

K.02 – The Effects of Early Psychosocial Deprivation on Brain and Behavioural Development

Charles Nelson, Harvard University

Experience is the engine that drives much of postnatal brain development. When children are deprived of key (i.e., experience-expected) experiences, particularly during critical periods of development, brain and behavioral development can be derailed. There is perhaps no more egregious form of deprivation than being raised in large, state-run institutions.

In my talk, I will introduce a project launched more than 20 years ago, based in Bucharest, Romania. In the Bucharest Early Intervention Project three groups of Romanian children are being studied: infants abandoned to institutions and who remain in institutional care; infants abandoned to institutions but then placed in high quality foster care; and infants who have never been institutionalized. These three groups have been studied through age 16, with a 21 year follow now underway. In my talk I will introduce the overall project, including its conceptual framework, its experimental design, the ethics involved in conducting this work and the nature of the intervention we deployed. I will then briefly summarize findings from several key domains, emphasizing not only intervention effects but how the timing of the intervention most contributes to long-term outcomes.

K.03 – Presidential Address: Understanding developmental cascades and experience: Diversity matters

Lisa Oakes, UC, Davis

Experience shapes development. Infants learn the language they hear, they become attached to the caregivers they experience, and they tune their perception to the faces they see. In this talk I discuss how a developmental cascades framework allows a mechanistic understanding of the role of experience in infant development. Because in developmental cascades achievements and changes at one point in time set the stage for achievements and changes at a later point in time, experience itself has a cascading effect on development. As a result, infants' lived experiences will change the shape of the cascade and we can only fully understand development by sampling development under a diversity of experiences. I will illustrate by describing infant visual attention development as a series of developmental cascades, and show how our understanding has been enriched by considering differences in development as a function of differences in lived experience.

K.04 – Presidential Address: The Mountain Stream of Infant Development

Catherine S. Tamis-LeMonda, New York University

As researchers, we share a passion for advancing science on infant learning and development. We also share the challenges that come with studying babies and figuring out which approaches might best address our specific questions. And all questions and approaches start with a theory. How we do science—our approach—depends on how we think about learning—our theoretical orientation. And so, I begin with theory: that learning is an active, dynamic, and socially-embedded process. I then draw on select studies of infant play and language interactions in social context to illustrate a dynamic-systems perspective. As infants navigate the spaces, places, and activities of everyday life, they generate rich perceptual and social inputs vital to learning. In turn, each new skill opens up new opportunities: Behaviors in the moment affect behaviors in other domains, elicit timely, multimodal inputs from caregivers, and cascade to word learning. I frame findings around questions core to the study of infants: How do we generate our research ideas? Where do we conduct our studies? How do we think about infant behavior? How can we best study the whole child? And how can researchers share their science to accelerate discovery about learning and development in the whole child?

Invited

I.01 – Sampling to Learn and Learning to Sample

Dima Amso, Columbia University, Columbia University

Visual attention both guides and is guided by learning and memory systems. A great deal of research has shown that what is attended is critical for what is learned from a complex environment in infancy. In this talk, I will focus instead on how learning and memory impact visual attention sampling. I will present data from spatial contextual cueing and reinforcement learning studies in infancy. I will end with the idea that a multiple memory systems approach offers a useful organizational structure for research on interactions between attention and memory.

I.02 – Prenatal Epigenetics and the Emergence of Developmental Trajectories

Frances Champagne, University of Texas at Austin

The prenatal period is defined by rapid neurodevelopmental change and there is converging evidence from longitudinal and lab-based studies for the causal role of prenatal exposures (stress, hormones, nutrition, toxins) in altering neurodevelopment prenatally with consequences for infant and childhood neurobehavioral outcomes. Epigenetic effects of prenatal exposures are increasingly evident and may be critical molecular mechanisms accounting for the short- and long-term impacts of the environment on health and development. The intergenerational impact of the environment may also involve the interplay between prenatal epigenetic factors and behavioral systems. This talk will explore evidence for the role of prenatal epigenetics in within and across-generation developmental effects and consider how postnatal maternal caregiving can serve to modulate the transmission of epigenetic effects. In particular, there will be a focus on maternal prenatal exposure to stress and endocrine dysregulation as well as paternal stress.

I.03 – A long and rewarding road: Lessons I have learned

Diane Poulin Dubois**,** Concordia University

One of the most important aspects of managing a career is making and learning from one's own mistakes and others'. Whoever believes that losers make mistakes but that successful scholars avoid those mistakes is wrong. One of the advantages that senior scholars have over junior scholars is that they have made more mistakes to learn from, even though they infrequently talk or write about it. This talk will be about the mistakes I have made at different points of my career and what I have learned from them. Topics range from grantsmanship, publishing, reviewing, collaborations, research conceptualization, and supervisory relationships. The goal is to help students, postdoctoral fellows, and junior scientists to benefit from the lessons I have learned over the years as a scientist and research supervisor.

I.04 – Developmental Variability and Developmental Cascades: Lessons from Infants with an Older Sibling with Autism

Jana Iverson, University of Pittsburgh

The onset of sitting and walking are among the most transformational events of infancy. In this talk, I will present findings from research designed to examine ways in which advances in these two motor skills afford infants foundational opportunities and experiences that benefit communicative and language development. More generally, these results reveal how the achievement of new motor skills exerts far-reaching, cascading effects on development that extend beyond the individual to impact the behavior of social partners and the broader communicative environment. Much of the data come from

longitudinal studies of an exceptionally interesting group of infants, those with an older sibling with autism. Some of these infants will themselves eventually receive an autism diagnosis, and many exhibit developmental delays, especially in language and communication. Finally, I will argue that improving our understanding of the links between early motor, communicative, and language development in a way that focuses on the constant, dynamic, and complex interplay between developing infants and their environments is critical for the development of effective intervention for infants and toddlers with or at risk for developmental delays.

I.05 – The evolution of developmental theories since Piaget

Philippe Rochat, Emory University

Piaget (1896-1980) paved the way to major discoveries regarding the origins and development of infant cognition. His theory framed much of the new ideas on early cognitive development that emerged in the 1970's, in the footsteps of the 1960's cognitive revolution. Here I want to re-trace major conceptual changes since Piaget and provide a meta-view on empirical findings that may have triggered the call for such changes. I will also try to make sense of ongoing theoretical debates on infant cognition by casting them within the perennial nature-nurture controversy. Looking at the rich history of ideas and research since Piaget, one is struck by the high confirmatory and conformity biases that shaped infant studies for the past 40 years.

I.06 – Towards a Cultural Understanding of How Infants Learn

Su-hua Wang, University of California, Santa Cruz

Through acting on objects and observing others do so, human infants are presented with a flux of examples in everyday life about how objects and people interact with one another. Extracting patterns and rules from observed physical and social events is a central task for young learners. When infants begin to explore on their own, things that were once out of reach can now be played with in various ways, providing a rich set of information about the world. Rapid learning in infancy and early childhood suggests powerful mechanisms at work for data organization and knowledge acquisition. My research has examined two of these mechanisms: statistical learning that allows infants to recognize patterns and explanation-based learning that ensures the causal coherence of the rule being learned. However, learning does not occur in a cultural vacuum. Our lived experience—what we see, hear and do—is not raw. Rather, it shapes and is shaped by cultural practices and contextual expectations. How do the proof-of-concept research findings connect to our understanding about cultural ways of learning and clarify the roles of culture and context in infant cognition? To tackle these questions, recent studies in my lab have focused on the lived experience of infants and young children from different cultural groups with everyday materials such as books, toys, and technology and compared the practices that they co-enact with caregivers around these materials.

In this talk, I present series of research that elucidates how infants represent and recognize patterns of dynamic events involving objects and human interaction, and discuss similarities and differences in how infants do so for physical events and for social events in which intentionality and empathy need to be

taken into account. Specifically, I present three sets of studies that demonstrate the effects of hands-on experiences and cultural contexts on early learning. The first line of work showed that active exploration, including playing with objects or making their own choices, sharpened infants' perception and understanding of physical and social events. The second line of work, with a cultural lens, showed that infants needed fewer examples to learn a new physical concept when provided with hands-on experiences in a sociocultural context as opposed to learning through observation only. Moreover, cross-cultural variation in parental guidance during the learning process pointed to diverse pathways for knowledge acquisition. The third line of work begins to address issues of how the context of an experience (or the framing of a task) affects the way babies and young children perceive and approach a problem at hand. Together, these findings provide empirical evidence to support the shift from a context-free model towards a cultural understanding of how infants learn.

I.07 – Presidential Symposium

Using machine learning in early language acquisition research: Examples from long-form audio-recordings

Alejandrina Cristia, CNRS

In 2022, we may not have hoverboards, but we have seen artificial intelligences beat humans at go, write in the style of Shakespeare, and generate novel continuations to incomplete spoken sentences. Feats like these have, in part, been due to the rise of self-supervision machine learning techniques, in which systems are trained with vast amounts of unlabeled data. In this talk, I argue that such techniques are useful to infant researchers working in under-described languages and cultures in two key ways: First, to create classifiers that describe and annotate the vast amounts of infant-centered data we can now easily collect; and second, to build systems that potentially learn like infants do. I draw from recent work using audiorecordings collected with wearables to illustrate these two avenues of work in the description of children's spoken language environment, while highlighting both opportunities and challenges, including saliently ethical and legal ones.

Cascading consequences of early bilingual exposure

Nuria Sebastian Galles, Pompeu Fabra University

Millions of infants in the world (perhaps most infants) learn language by exposure to more than one language. Infants growing up in multilingual environments face specific challenges. First, they must realize that there is more than one language in the environment, they must sort the two inputs and at some point they have to build separate representations for each language. Second, they must do it with reduced input to each language. Such fundamental differences do not hinder language learning (bilingualism does not result in pathological language delays), but it triggers specific cascading processing adaptations, some of them life-long ones.

The statistics of every day learning environments are made in the psychology of infants and their social partners

Linda Smith, Indiana University

Much of the data in the world is latent as it is unrealized without some direct physical action or event in the world. Thus, actions on the world, behavior, selects and creates the sensory properties of the input,

the frequency of specific categories of information and the temporal structure of the data for learning. This talk presents new evidence on how the statistics of parent-infant social interactions creates data streams that may optimize learning about objects and the words we use to talk about them.

Symposium

S.01: Capturing curiosity from the cradle: the early development of curiosity and active learning

S.01.01: Let me see that: Self-directed Exploration in Infants tested in the context of a new theoretical framework (Altmann)

Elena Altmann[1], Marina Bazhydai[1] Gert Westermann[1]
[1]Lancaster University

Infants explore the world to learn about it based on their intrinsically motivated curiosity. However, the cognitive mechanisms underlying such curiosity-driven exploratory behavior remain largely unknown. Here, we present a unifying theoretical framework and a novel experimental paradigm to shed some light on the issue. Our theoretical framework is based on the learning progress maximization driving engagement and disengagement as we incorporate the perspective of exploration-exploitation. We propose that curiosity is the positive arousal in anticipation of maximized learning progress. We suggest several parameters of individual differences such as a boredom-threshold, associated reward value and perseverance. We aim to unify various theories of curiosity while also incorporating research fields of boredom and exploration-exploitation to explain why infants, as well as adults, engage with something, under which circumstances they disengage, and why the experience of curiosity may subside during formal education. We designed a novel gaze-contingent eye-tracking paradigm to test this theory in infants where we aim to capture both the general mechanism and also individual differences in self-directed exploration. Here, 10-12-month-old infants are introduced to two novel stimulus categories (Fribbles species, TarrLab). Two identical "houses" are presented on a computer screen, and a new exemplar from either category is revealed when the infant fixates on the corresponding house. This design enables us to distinguish between exploration - switching from one category to the other - and exploitation - consecutively triggering exemplars from the same category. We will measure the number, speed, and sequence of trigger-events, the proportion of switch-decisions out of all triggers, as well as looking time. We hypothesise that infants will explore non-randomly and will differ in their exploration styles. The data collection is currently in progress, with the final sample of N=70 of 10-12-month-olds to be tested. Preliminary results (n=19, 47% female) indicate an early exploitative tendency in infants: a Bayes factor of 23.88 indicates strong evidence for an average switch-proportion below 50%. Furthermore, these preliminary results indicate extremely strong evidence (BF=802.5) for the hypothesis that infants focus their exploration on the category they trigger first. However, there does not seem to be a general species or side bias, as indicated by anecdotal (BF=2.1) and moderate (BF=4.1) evidence for the null hypothesis, respectively. Lastly, 4 clusters of exploration styles were found, overall suggesting a u-shaped relation between task engagement and greater exploration tendencies. A similar u-shaped relation is suggested for switches made across individual engagement, with higher switch-proportions at the beginning and towards the end of engagement. These preliminary results support our expectation of non-random exploration in young infants, but also of clear individual differences regarding how infants

choose to explore and learn about two novel categories. Analyses on the final sample using eye-tracking data will investigate whether switch-decisions can be predicted. This will help disentangle the predominant factors from our mechanistic framework reinforcing engagement but also triggering disengagement.

S.01.02: The role of infant curiosity and the social environment in infants? looking preference for physically impossible events (Lucca)

Kelsey Lucca[1], Vanessa Lazaro[2], Jinjing (Jenny) Wang[3]
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Infants are drawn to events that violate their expectations about the natural world: they look longer at events that are physically impossible, such as when a car passes through a wall (Baillargeon, 2004). This type of enhanced visual exploration shows stable individual differences in childhood (Perez & Feigenson, 2021). Do infants' visual preference for physically impossible events reflect an early form of curiosity? And if so, what factors contribute to individual differences in this early form of curiosity? The current study addresses this question by testing whether infants' curious tendencies in daily life and caregivers' curiosity-promoting behaviors predict their looking preferences for physically impossible events. We presented infants (N = 47, Mage = 16 months) with a series of three events that violated core object representations (e.g. a car passing through a wall) and closely matched possible events (e.g. a car stopping upon hitting a wall). See Figure 1. We measured the amount of time infants spent looking at the impossible event, controlling for their looking to the possible event, to compute infants' preference for looking at impossible events. Caregivers completed The Early Multidimensional Curiosity Scale (EMCS) that we designed to measure (1) infants' curiosity in everyday life (example question: "When something contradicts what your child knows about the world, how often does your child further explore, as if to figure out what happened?") and (2) caregivers' curiosity-promoting activities (example question: "When something happens that violates your child's expectations about the world, how often do you draw their attention to it?"). Infants' preference for looking at physically impossible compared to possible events was positively predicted by parental reports of infant curiosity (r = .29, p = .03), but not infants' temperament or vocabulary size (all p's > .05), suggesting that infants' visual preference for physically impossible events reflects an early form of curiosity. Additionally, infants' looking preference was positively predicted by parental engagement in curiosity-promoting activities (r = .32, p = .02), but not parents' own curiosity levels (p > .05), suggesting that parent-child interaction may play an important role in shaping early curiosity. These findings suggest that individual differences in infants' preference for physically impossible events may reflect an early form of curiosity, but not general cognitive functioning, temperament traits, or overall information-processing abilities. Importantly, we provide initial evidence for the unique role of parental input in shaping infants' curiosity. Curiosity-promoting behavior, such as how encouraging parents are of children's curious and exploratory behavior and parents' preference for curiosity-themed books, significantly predicts infants' looking preferences for the physically impossible events. In contrast, parents' own levels of curiosity do not contribute to individual differences in infants' looking preferences. The current work represents an important advance in identifying potential sources of individual differences in curiosity, right as those differences begin to emerge in the first few years of life.

S.01.03: Infants are active and adaptive ecological learners: Evidence from a novel gaze-contingent search task (Poli)

Francesco Poli[1], Andreas Domberg[2], Rogier Mars[3], Sabine Hunnius[1], Azzurra Ruggeri[4]
[1]Radboud University, [2]Max Planck Institute for Human Development, [3]University of Oxford, [4]Central European University

Evidence from a novel gaze-contingent search task: From early on, infants demonstrate simple forms of active learning: They tailor their attention depending on stimulus informativeness (Poli et al., 2020) and selectively attend and explore objects that violate their expectations (Perez & Feigenson, 2020). However, little is known about the early emergence of ecological learning (Ruggeri et al., 2019), that is, whether infants adapt their active-learning strategies to the statistical characteristics of the problem at hand. To this aim, we designed a novel gaze-contingent eye-tracking paradigm in which infants could engage in active information search by controlling a torchlight on the screen. Infants were presented with two within-subjects conditions, each including a training and a test phase. In the training phase, infants were presented with 8 events. In each event, they observed an animal jumping out of a treasure chest, and then moving upwards and disappearing at the top of the screen in one of four differently coloured areas (Figure 1). After a few seconds, the animal reappeared for a short time at the location where it had disappeared. In the Skewed condition, the animal appeared always in the same location. In the Uniform condition, the animal was in a differently coloured area every time, following a pseudo-randomized order. Across the training phase, the screen progressively turned darker to give infants the opportunity to learn how their gaze controlled the torchlight. At test, the screen was completely dark and infants could only hear the animal jumping out of the treasure chest. However, they had control over the torchlight and could search for the animal. In the Skewed condition, infants should focus their torchlight on the location where the animal appeared during training. In the Uniform condition, however, infants had no statistical information to support their prediction and should be more likely to search for additional cues to the animal's location, namely the location of the treasure chest, which remained always present on the screen. Pilot data indicates that infants between 12 and 36 months of age (N=10) show different gaze behaviour in the two conditions (Figure 2). In the Uniform condition, they spent more time searching in the correct target location that they successfully learned during training. In the skewed condition, they spent more time exploring, and crucially, they attended more to the informative cue. Notably, their performance was similar to adults (N=6) in its degree of adaptiveness. These preliminary results suggest that infants can actively adapt their information search depending on the probabilistic structure of the environment, and that they strategically look for additional information when they need to optimize their search. Thus, they provide initial evidence for active and ecological information-search during infancy. A final sample of infants (Mean-age = 18 months, N=50) is currently being tested.

S.01.04: Curiosity Enhances Incidental Object Encoding in 8-month-old Infants (Chen)

Xiaoyun Chen[1], Katherine Twomey[2], Gert Westermann[1]
[1]Lancater University, [2]University of Manchester

Recent research with adults indicates that curiosity induced by uncertainty enhances learning and memory outcomes, and that the resolution of curiosity has a special role in curiosity-driven learning. However, the role of curiosity-based learning in early development is unclear. Here we presented 8-month-old infants with a novel looking time procedure to explore: 1) whether uncertainty-induced curiosity enhances learning of incidental information; and 2) whether uncertainty-induced curiosity leads infants to seek uncertainty resolution over novelty. In Experiment 1, infants saw blurred images to

induce curiosity (Curiosity sequence) or a clear image (Non-curiosity sequence) followed by presentation of incidental objects. Despite looking equally to the incidental objects in both sequences, in a subsequent object recognition phase infants looked longer to incidental objects presented in the Non-Curiosity than in the Curiosity condition, indicating that curiosity induced by blurred pictures enhanced processing of the incidental object, leading to a novelty preference for the incidental object in the Non-Curiosity condition. In Experiment 2, a blurred picture of a novel toy was first presented, followed by its corresponding clear picture paired with a clear picture of a new novel toy side-by-side. Infants showed no preference for either image, providing no evidence for a drive to resolve uncertainty. Overall, the current studies suggest a developmental change in the function of curiosity, with a broad attention-enhancing effect in infancy.

S.02: Constructing joint attention: the microdynamics of how shared attention states are achieved and maintained

S.02.01: Proactive or reactive? Neural oscillatory insight into the leader-follower dynamics of early infant-caregiver interaction (Phillips)

E.A.M. Phillips[1], L. Goupil, I. M. Haresign, E. Bruce-Gardyne, F.A. Csolsim, M. Whitehorn, V. Leong, S.V.Wass

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We know infants' ability to engage in joint attention is fundamental to the development of language and social cognition (Donnellan et al., 2020). Yet, we understand little about the neural and cognitive mechanisms driving infant attention in shared interaction. A popular view has been that, by the end of the first year, infants achieve joint attention through intentional, proactive communication; using ostensive signals to direct and share the attention of a communicative partner (Tomasello, 2010). Here, we record EEG from infants during naturalistic play with their caregiver to investigate event-locked changes in neural activity before and after adult- vs. infant-led attention. It was hypothesised that, if infants proactively initiate joint attention, theta power, a neural marker of endogenously driven attention, would increase in the time before infant-led mutual attention; corresponding to an increase in infants' use of ostensive signals. Key to deliberately establishing joint attention is anticipating the partner's response to the initiation (Hamilton et al., 2021). Increased ostensive signalling was therefore hypothesised following infant-led attention, as well as increased alpha suppression; a pattern of neural activity associated with predictive processing in infancy (Monroy et al., 2019). Dual 32-channel EEG was recorded from infants and caregivers whilst they engaged in table-top-play with 3 toys. Gaze behaviour was coded offline and synchronised with the EEG signal. Thirty-seven dyads contributed data (mean infant age=11.12 months, SD=1.33). Infant-led attention included moments infants gazed towards objects with which the adult was not already engaged; sub-divided into looks to mutual attention, where the adult followed, and nonmutual attention. Adult-led mutual attention included all looks where infants followed adults' attention towards an object. To compare attention episodes, EEG power (1-16Hz) 2000ms before and after look onset was extracted via continuous Morlet wavelet convolution, and averaged over fronto-central electrodes. The probability time-series of infants looking to their partner or vocalising 5000ms before and after look onset was also extracted.

Our results indicated that infants were not predominantly proactive in creating episodes of mutual attention. Against hypotheses, theta activity (3-6Hz) did not increase in the 2000ms before infant-led looks to mutual attention, compared to adult-led looks, or infant-led looks to nonmutual attention: cluster-based permutation revealed no significant clusters at any frequency band (Fig. 1). Behavioural time-series analysis indicated no increase in infant looks to their partner or vocalisations before infant-led mutual attention.

Infants did, however, appear sensitive to their gaze being followed by the adult. After look onset, a significant positive cluster of time*frequency points at alpha frequencies (5-9Hz; p=0.003) was identified; indicating reduced alpha activity in the time after infant-led, compared to adult-led mutual attention (Fig. 2). There was little difference in infants' ostensive signalling post-look onset, and infant attention lasted longer during mutual attention, irrespective of whether the episode was adult- or infant-led (Fig. 2). Our findings suggest that infants do not actively control adults' attention - but that they are sensitive to when an adult responds to something they initiated. Behavioural contingency may therefore be a key mechanism through which infants learn to communicate intentionally.

S.02.02: Joint attention from the infant's point of view (Douglas)

Ian J. Douglas[1], Chen Yu

[1]University of Texas

The ability of parents and infants to enter into and maintain JA has been linked to numerous developmental outcomes, including later language, cognitive, and self-regulation abilities. Using head-mounted eye trackers, recent studies measured real-time attention in parent-infant interactions (e.g., Yu & Smith, 2016) with two new and "unexpected" findings: First, infants rarely look at their parent's face during toy play; Second, infants and parents successfully establish joint attention through not only following the other's gaze but also by following the other's hands. These findings, however, have come from studies in which parents and infants were seated (on the floor and in a highchair, respectively) and played on a tabletop with only three toys. The room was completely white, and each toy was only one color (Figure 1a). The simplified, tightly controlled environment raises two imminent questions that the present study aims to answer: 1) can those findings from "white-room" experiments also be observed in more naturalistic contexts? And 2) without face looks, is it possible for the two social partners to be aware of being in JA? To answer those questions, we collected data from 39 infants (15 to 25 months old) engaging in naturalistic "toy play" with their parents while wearing head-mounted eye trackers (Figure 1b). Each child-parent dyad could play freely with 24 objects in an unconstrained room. Eye tracking determined where children and parents looked, jointly attended, as well as who initiated and followed in JA. In Study 1, we quantified how often children looked at their parent's face. Results showed that the proportion of total play time that children spent looking at their parent's face is far less than that of parents (Figure 2a). Further analyses showed that when in the position of the follower, children looked to their parent's hands most often, while parents again relied on facial information at much higher rates (Figure 2b). In Study 2, we used a Convolutional Neural Network to examine whether a model can be trained to infer the parent's attentional state (and therefore whether the two were in JA) just from egocentric images from the infant's view alone, which included hardly any face looks. We found that the trained model can indeed classify individual egocentric images from the infant's view as "in JA" or "not JA", suggesting that social awareness of JA during toy play can be achieved without looking at the social partner's face. In summary, children are adept at following hand actions to infer

the attentional focus of their parents, and in general, attentional states can be inferred without sharing facial cues.

S.02.03: Constructing shared attention through sensorimotor coordination in infants with and without hearing loss (Monroy)

Claire Monroy[1], Chen Yu, Derek Houston

[1]University of Keele

Children with hearing loss generally achieve fewer moments of joint attention with caregivers (Lammertink et al., 2021). However, a growing body of research has revealed that shared attention can be achieved through multiple sensorimotor pathways (Yu & Smith, 2013). Recently, we have learned that deaf infants have different sensorimotor experiences than hearing infants, in the absence of auditory feedback (Fagan, 2019). In the current study, we focused on the sensorimotor coordination between deaf infants and their hearing parents to better understand the potential causes of differences in joint attention compared to hearing dyads. Specifically, we examined how well deaf and hearing infants coordinate their gaze and actions with caregivers while engaging in a goal-directed, interactive task. Twelve parent-infant dyads participated in our study: six deaf infants with cochlear implants (mean age = 19.0m, SD = 3.7) and six hearing infants (mean age = 19.2m, SD = 3.6). Dyads placed coins together into a piggy bank (Figure 1). The piggy bank was positioned such that infants had to coordinate their actions with their parent to achieve the goal. Both dyad members wore head-mounted eye-trackers, which recorded their eye movements and field of view. To examine sensorimotor coordination, we analyzed the temporal coupling between actions (the delay between parent passing a coin to their child and the child reaching for it), and infant anticipatory gaze to their parent's actions. Results revealed no differences between deaf and hearing dyads: across groups, infant and parent actions were tightly coupled in time (Figure 2). On average, infants initiated their reaches within 0.43s of their parent's movements (deaf = .51s, hearing = .35s, p = .35). Infants also reliably looked to the goal when parents inserted the coin (mean gaze latency = -98.61ms). Gaze latencies did not differ between groups (p = .27); however, deaf infants anticipated their parents' actions (mean latency = -208.33ms) while hearing infants were reactive (mean latency = 38.54ms). Preliminary findings therefore show no deficits in how deaf infants coordinate their eyes and hands with their parents' actions. In ongoing analyses, we are expanding this work in two crucial ways: we are examining additional behaviors like vocal cues or gestures that may reveal differences in how dyads are accomplishing this task despite similarities in overall success. Secondly, we will present data from deaf infants who have not yet received cochlear implants and are still exploring their world in silence

S.02.04: Infant Attention-Following in Laboratory and Home Settings (Tang)

Yueyan Tang[1], Gedeon Deak

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Previous studies on infant attention-following development have been conducted in both naturalistic and laboratory settings (Deak et al., 2017; Yu and Smith, 2013). Notably, the distribution of joint attention cues appears to differ between these settings. Deak et al. (2017) observed that during home dyadic play, North American mothers tended to employ a variety of behavioral cues to direct infants' attention, including a combination of verbal, gaze, and pointing or manual cues. It also has been

suggested that laboratory studies overestimate the importance of gaze cues in directing infants' attention (Deak et al., 2013; Morissette et al., 1995). More generally, infants might show different patterns of attention-following in different contexts. This study investigates whether individual differences and group-level trajectories in the development of attention-following are similar across different settings, and explores how scripted laboratory tasks differ from caregivers' natural patterns of attention-eliciting behaviors in unscripted interactions. Infants (N=43) from a Southern California city were videotaped monthly from 6 to 9 months of age in an unscripted attention-following task at home with their mother, and in a laboratory setting with an experimenter who produced scripted attention-directing cues (gaze, point, and gaze-plus-point). We first investigated the effects of context and age on infant attention following performance. Results showed a trajectory of gradually increasing attention-following with age in both settings (Figure 1). Results also suggested that infants followed more reliably at home, with greater longitudinal stability from 6 to 9 months. We then evaluated the consistency of infant attention-following between home and laboratory settings. Initial analyses revealed non-significant correlations between home and lab performance month-by-month, suggesting that infants showed distinct attention-following tendencies across contexts (Table 1). This suggests that infants' responses to joint-attention cues in a laboratory setting do not generalize to naturalistic settings. To further investigate the reasons behind the differences between settings, the effects of several behavioral and contextual variables were analyzed. Four variables were considered: cue duration (i.e., total seconds of adult cue production), cue strategy density (i.e., rate of adults looking at or touching the infant), and speech (i.e., addition of a verbal cue). Analyses revealed that neither cue duration nor cue strategy density predicted significant variance in home attention-following. Notably, the inclusion of verbal cues was near-ubiquitous at home but absent in the lab, suggesting a possible contribution to infants' attention-following in everyday settings (see Deák et al., 2008). Ongoing analysis will consider whether different speech content types within particular cues are differentially effective in eliciting infant attention-following. These results suggest that infants show different patterns of attention-following in different environments, and that parents' naturalistic cues are substantially different than the cue scripts used in many laboratory studies. We should be cautious in generalizing infant attention-following results from laboratory studies

S.03: Learning how to learn: Infants actively probe and manipulate their physical and social environments

S.03.01: Infants use speech-like vocalisations as a mechanism for arousal up-regulation across infant-caregiver dyads. (Wass)

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Living organisms are dynamical systems, that adaptively respond to external change in order to maintain constancy. Regulation is "the ongoing, dynamic, and adaptive modulation of internal state (emotion, cognition) or behavior, mediated by central and peripheral physiology" (Nigg, 2016). The aim of regulation is to maintain internal equilibrium (homeostasis) through allostasis (Cannon, 1929; McEwen & Wingfield, 2003). Impaired or atypical regulatory behaviours have been linked to multiple dimensions of psychopathology, including both internalising and externalising disorders, addiction, depression and others (Nigg, 2016). Maintaining internal equilibrium involves maintaining a balance between over-excitation and under-excitation. However, the majority of the concentrates on how children down-

regulate in response to externally induced over-arousal - often by administering a static, experimenter-controlled mild stressor to children in order to measure down regulatory behaviours in children. On this measure, even infants as young as 5 months show increases in down-regulatory behaviours such as gaze aversion during the time period following an experimenter-administered stressor. However, little previous work has examined how children self-regulate in actual real-world settings - and whether, and if so how, regulation involves up- as well as down-regulating arousal. We studied this in N=84 12-month-old infants. Using a still face paradigm, we measured traditional self-regulatory behaviours such as gaze aversion and self-soothing in the lab. Then, in the same infants, we took day-long recordings to examine how autonomic arousal (indexed from heart rate, heart rate variability and activity) and vocal behaviours spontaneously fluctuated at home. Consistent with expectations, children with superior self-regulation in the lab showed increased arousal stability across multiple time-scales at home. They also showed a slower rate of change of vocal affect and intensity in their vocalisations. In addition, however, when we examined how arousal stability (the likelihood of being in the same arousal state at time t+1) varied contingent on arousal levels at time t, we found that, over longer time-scales, infants with better self-regulation were more likely to upregulate arousal from lower arousal states (Figure 1). This pattern was not present in the low self-regulation group. We also examined how infants with superior self-regulation up-regulate arousal. We examined vocalisations, differentiating cries from speech-like vocalisations (Figure 2). All children were more likely to produce cries at extreme high arousal (Figure 2b). However, the high self-regulation group are also more likely to produce speech-like vocalisations at intermediate-to-high arousal, but the low self-regulation group are not (Figure 2c). We also show that speech-like vocalisations lead to sustained up regulation of arousal in both infant and caregiver. Overall, our results suggest that infants with better self-regulation are more likely to actively upregulate arousal from hypo-arousal states, and point to speech-like vocalisations as a mechanism for active arousal up-regulation via infant-caregiver interactions.

S.03.02: Infants' engagement in vocal turn-taking predicts their expectation for eliciting caregiver responses (Goldstein)

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Here we show how infants use their prelinguistic vocalizations (babbling) to probe the social environment for learning opportunities. We use mechanisms of curiosity-driven learning (CDL) to account for both vocal learning and social motivation. In CDL, learning progress (i.e. increases in prediction accuracy) is intrinsically rewarding. Studies of infant attention suggest bias towards information sources that maximize learning progress (Poli et. al, 2020). A learning progress account of social vocalizing predicts that infants will vocalize most in social contexts that are neither too unpredictable nor already well-understood. To test this idea, we assessed whether infants' expectations for eliciting responses from their caregivers is predicted by vocal turn-taking during naturalistic interaction. Results from human and non-human animals demonstrate that once associations between a behavior and its result are learned, removing the contingency between behavior and result causes distinct behavioral changes (e.g., McConnel & Miller 2014). After a contingency is removed, the rate of behavior temporarily increases and then immediately decreases. This pattern of increase followed by decrease is called an "extinction burst" because an extinction of an expected consequence elicits a burst of behavior (Lerman & Iwata, 1995). By 5 months, infants have learned that their prelinguistic

vocalizations result in contingent feedback from social partners, as measured by a vocal ex-tinction burst (VEB) (Goldstein, Schwade & Bornstein, 2008). Is the VEB related to infants' history of engagement in vocal turn-taking with caregivers? Fifty-four 5-month-old infants (M age = 5.32 months, SD = .24 months) participated in a still-face procedure consisting of three episodes. The Interaction-1 episode consisted of a 1-min natural interaction between infants and their caregivers. Next, during a 2-min Still Face episode, caregivers assumed a neutral and still face while looking silently at their infants' face. During the 1-min Interaction-2 episode, caregivers resumed naturalistic interaction with their infants. Audio-visual recordings of caregiver-infant dyads were used to code the number of infant non-cry vocalizations. Before the still-face procedure, dyads engaged in 15-minute free-play episodes. Parents were asked to play as they would at home. Parents' speech was transcribed from the free-play episodes. Conversational turns were operationalized as caregiver-infant vocalization pairs with less than 5 sec of intervening pause (Gilkerson et al., 2017). Turn-bouts were defined as successive caregiver-infant vocalization turns unbroken by more than 5 seconds of pause. We calculated the VEB as the difference between number of infant vocalizations per minute produced during Still Face and Interaction-1 episodes, following Goldstein et al. (2009). Infants showed a significant VEB (Figure 1). VEB magnitude positively correlated with three measures of dyadic vocal turn-taking during free-play (Figure 2A-C). To control for infant vocalization rate, we assessed whether infant volubility during free-play predicted VEB magnitude. Infant vocalizations per minute during free-play did not significantly correlate with infant VEB during the still-face procedure ($r(53)=.16$, $p=.22$). Thus, the extent to which infants monitor caregiver deviations from familiar levels of social contingency predicts their engagement in early vocal turn-taking with caregivers. Infants' expectations about the efficacy of their vocalizations represent a foundational step in communicative development.

S.03.03: An embodied solution of bottom-up and top-down attention control (Yu)

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Attentional control that emerges in late infancy predicts in children' current and future abilities in multiple cognitive domains, including executive function and self-regulation. Young infants' gaze is often pulled and held by external salience. After their first birthday, however, infants make considerable strides in internally controlling visual attention to enhance relevant and inhibit irrelevant sensory information. The present study aims at examining a new hypothesis that the emerging attentional control is actively developed through using the body to constrain and simplify attention selection. Toward this goal, we examined infant attention during toy play - a context that requires infants to continuously select, inhibit, monitor selected objects with moving bodies and moving things in the world. In Study 1, using head-mounted eye trackers, we measured 12-month-old infants' gaze when they played with a set of toys with their parents. In this context, previous studies show that the momentary visual size of objects in the infant's field of view robustly attract gaze. In the current study, we found that when infants directed gaze to an object, they simultaneously changed the spatial relation of their body to the attended object. As a result, the target's visual size is increased relative to distractors. By analyzing temporal sequences of infant attention and visual sizes of attended objects in the infant's egocentric view, we found that the onset, duration, and offset of the increased salience of target object was time-locked with the onset, duration and offset of infant gaze to the object. Thus, sustained attention by one-year-old infants includes an increase in the external salience of the target

that is created by the infants' own behavior. By doing so, infants employ an external and embodied solution to facilitate internal attentional control by using their body to externally control visual saliency of objects in view. In Study 2, we conducted a screen-viewing experiment to further examine whether only visual salience created by infants, but not any visual salience, can facilitate attention selection. To answer this question, 18-month-old infant observers were asked to view a set of egocentric visual scenes recorded from another group of infants during toy play. Visual properties of those visual scenes are similar to the ones created and perceived by infants in Study 1. We calculated visual salience maps of individual egocentric scenes which were not created by the infant observers in screen viewing but by the infants in toy play. A comparison of visual saliency maps with infant observers' fixation density maps shows no correlation between the two, suggesting that infant attention is not driven by visual salience in view when it is not self-generated. Taken together, the findings challenge characterizations of attention as a competition between bottom-up and top-down control and implicate instead a collaboration in which top-down goals drive behaviors that externally suppress distractors. We suggest that the active top-down control of attention through externally directed behavior may serve as the training ground for the development of internal control.

S.03.04: Individual Differences in the Maternal Context of Infant Sensorimotor Decoupling: A Longitudinal Study From 4 to 9 Months of Age (Ying)

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A Longitudinal Study From 4 to 9 Months of Age Mother-infant triadic interactions, wherein infants coordinate attention between a social partner and objects of shared focus (Striano & Reid, 2005), are believed to facilitate infants' social and praxis skills, including object-actions (Brandone et al., 2019), word meanings (Carpenter et al., 1998), social gaze (Striano & Reid, 2005), and social routines (Rochat et al., 2016). It is claimed that triadic engagement emerges around 9-12 months of age (Carpenter et al., 1998). However, infant sensorimotor decoupling, wherein infants look at one percept while manipulating another, or use each hand for different actions, is hypothesized to facilitate infants' transition to triadic interactions by allowing infants to smoothly shift attention between objects and social partners (de Barbaro et al., 2016). We explored how changes in sensorimotor decoupling might predict triadic skill development. De Barbaro et al. (2012) hypothesized that around 6 months infants are in a transitional period in sensorimotor decoupling development. Here we use a more bottom-up statistical method to classify infants as more or less mature at 6 months, and test whether this classification predicts other skills that might rely on sensorimotor decoupling. Moreover, we explore social contingencies between maternal behaviors and infant decoupling: i.e., whether infant decoupling is primed by maternal object-directed speech/action, and the converse: i.e., whether infant decoupling potentiates certain maternal behaviors. Mother-infant dyads (N=38) were recruited from the greater San Diego area and recorded in their homes during 5-6 minute toy play sessions. Infants' and mothers' object-handling, and infants' gaze fixations, were coded by randomly assigned trained coders. Infant Gaze-Hand (G-H) and Left Hand-Right Hand (H-H) decoupling rates were calculated, and High- and Low-decoupling groups were classified through k-means clustering of decoupling rates. Results showed that from 4 to 9 months infants increasingly decoupled their gaze and left and right hands, partly contingent on mothers' ongoing object manipulations. More specifically, individual differences in G-H decoupling emerged by month 4 and increased at 6 and 9 months, whereas, individual differences in infant H-H

decoupling were significant at 4 months but attenuated by 6 and 9 months. Additionally, infants decoupled gaze from handled objects more when mothers picked up a toy, and decoupled their hands from a handled object more when mothers dropped a toy. Moreover, mothers tend to change their manual action and engage in more joint object manipulation when infants decoupled hands than when they decoupled gaze and hands. This suggests that infants' increasing attention to multiple objects is related to caregiver actions in the moment. Notably, individual differences in infants' decoupling also were positively associated with laboratory attention-following performance, and with an "optimal rate" of maternal object-handling. These associations further suggest that sensorimotor decoupling and caregiver triadic behaviors predict the emergence of social attention skills. In sum, although triadic engagement becomes prevalent around 9-12 months of age (Vaughan et al., 2003), sensorimotor skills that might facilitate these interactions can be differentiated by 4 months. Thus, studies of triadic interactions should consider earlier individual differences in sensorimotor and attention-shifting abilities.

S.04: Applying rhythmic visual stimulation to uncover the neural mechanisms of early social learning

S.04.01: The Influence of Familiarity on Infant Face Individuation at 5 Months of Age (Peykarjou)

Stefanie Peykarjou[1], Miriam Langeloh[1], Max Planck[2], Bruno, Rossion[3], Sabina Pauen[1]

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Human adults are better at recognizing different views of a given face as belonging to the same person when that person is familiar rather than unfamiliar (Bruce, 1982; Bruce et al., 1999), but little is known regarding the developmental origins of this phenomenon. Behavioral and ERP research indicates that infants can recognize their mother and also unfamiliar strangers (e.g., de Haan & Nelson, 1997; Peykarjou, et al., 2016; Sai, 2005) when only a few images of each face are employed, and images are presented for at least 500 ms. However, the contribution of low-level factors to individuation in these studies remains unexplored. In a series of studies, we employed the Fast Periodic Visual Stimulation (FPVS; Rossion, 2015) approach to characterize 5-month-olds' face individuation. The FPVS EEG paradigm provides an implicit, objective, robust measure of visual categorization (de Heering & Rossion, 2015; Rossion, et al., 2015), requiring both discrimination between categories and generalization across exemplars. Here we tested face individuation in 5-month-old infants (overall N = 78, 35 females, 4 conditions between-subjects) across different levels of familiarity. Target faces were a) familiar (mother's face), b) familiarized in a live interaction phase prior to the experiment, c) familiarized in a 30-seconds picture familiarization phase, or d) not familiarized. In each trial, target faces were presented among four unfamiliar stranger faces in an oddball paradigm. Per facial identity, 12 different images varying in head orientation and facial expression were employed. All images were equalized for luminance and contrast. Images were presented at a high rate of 6 images per second (6 Hz) with the oddball appearing at every 5th position (1.2 Hz). We contrasted conditions where the target face appeared as oddball or as base stimulus. We tested whether significant activity ($Z > 1.64$, $p < .05$) at 1.2 Hz and harmonics (2.4 Hz, etc.) was elicited over the medial occipital cortex, reflecting selective responses to facial identity across views. Only in the mother standard condition, a significant response was observed at 1.2 Hz, but across all conditions, significant responses were elicited at harmonics of 1.2 Hz, indicating that infants individuated faces in all conditions. Individuation responses were stronger when the mother's rather than a familiarized stranger's face was immediately repeated at every

stimulation cycle, $F(1,38) = 4.399$, $p < .05$, $h^2 = .019$. There were no differences between individuation responses for faces familiarized in live interaction or a picture familiarization phase. Neither did individuation differ between conditions where the target face was presented at standard or oddball positions. Analysis of condition 'd' (not familiarized) is still under way. These data show that infants are able to recognize familiar and familiarized faces across different images, minimizing the contribution of low-level image characteristics to individuation, and at a high speed. Long-term familiarity enhanced individuation responses for the mother's face. Findings from the condition without any prior exposure to the face will further clarify the role of experience for infant face individuation.

S.04.02: Neural Sensitivity to Variations in Facial Cues to Trustworthiness in Six-Month-Old Infants (Silvestri)

Valentina Silvestri[1], Elisa Baccolo[1], Viola Macchi Cassia[1]

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Perception of trustworthiness - i.e. of other people's approachability - based on facial appearance has been extensively investigated in adults and children, who can easily distinguish between fine-grained variations in the intensity of facial cues to trustworthiness. However, the ontogenetic origins of this fundamental social skill are still debated (Over & Cook, 2018). Skills like regulating behavior according to other people's emotional facial expressions, and modulating avoidance/approach behaviour based on other people's conduct towards others, appear rather early in development, and become finer grained during the first year of life. Therefore, the questions of whether infants discriminate those facial cues that older children and adults perceive as signaling approach/avoidance, and what portion of visual information (i.e., featural/local vs. configural/global) they use when making this discrimination appear compelling. Only five studies have explored this question, finding evidence of behavioral and/or neural discrimination between neutral faces and faces at the positive/negative extremes of the trustworthiness continuum, but not between trustworthy and untrustworthy faces (Baccolo et al., 2020; Jessen & Grossmann, 2016, 2019a,b; Sakuta et al., 2018), thus leaving open the question of whether infants are indeed able to distinguish very trustworthy from very untrustworthy faces. In addition, almost all existing studies used computer-generated faces, which might fail to reflect infants' face processing expertise and limit the generalizability of the results. In this talk we will present two EEG studies using morphed images of realistic female faces associated with explicit judgments of high or low trustworthiness and the Fast Periodic Visual Stimulation (FPVS) paradigm, in which rapid stimulus presentation at a constant frequency evokes changes in voltage amplitudes of the brain's electrical activity at the same frequency. High- and low-trustworthy faces were presented as standard and oddball (i.e., deviant) stimuli. Oddball category (high/low trustworthiness) was varied within-subjects. Stimuli were presented at a fixed rate of 6 Hz (baseline) following an oddball paradigm, in which every 5th image, the deviant stimulus was introduced, creating a trial sequence containing changes in trustworthiness intensity at a frequency of 1.2 Hz (cf. Figure 1B). FPVS responses were analyzed at both frequencies of interest and their harmonics as a function of oddball type (high- vs. low-trustworthy). In Study 1 (N = 30), infants were presented with full-spectrum images. In Study 2 (N = 38), the visual spatial frequency (SF) content of the stimuli corresponding to featural (High-SF) vs. configural (Low-SF) information was manipulated using a spatial filtering approach similar to that used to test infants' emotion discrimination (Jessen & Grossmann, 2017) (cf. Figure 1A). Results showed that, irrespective of the SF content of the stimuli (Full-Spectrum, Low-SF, High-SF), the baseline response did not differ

between trustworthiness conditions. Oddball responses revealed that infants discriminated the change in trustworthiness intensity in all SF conditions when the oddball stimulus was high-trustworthy, while they succeeded when the oddball stimulus was low-trustworthy in the Low-SF condition only. Findings will be discussed for their implications for the understanding of the perceptual/neural mechanisms involved in early discrimination between positive- and negative-valenced faces.

S.04.03: Culture-specific Visual Processing in the Infant Brain (Köster)

Moritz Köster[1], Anna Bánki[2], Daiki, Yamasaki[3], Shoji Itakura[4], Stefanie, Hoehl[2]

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In Western cultures, the relative focus on the object versus the background of a visual scene is higher than in Eastern cultures (Masuda & Nisbett, 2001), a phenomenon coined context-sensitivity. Inter-individual differences in context-sensitivity increase in early to middle childhood across cultures (Imada et al., 2012) and are shaped by culture-specific parental attention guidance (Köster & Kärtner, 2018). Yet, the ontogenetic origins of cultural impacts on human cognition, and the underlying developmental mechanisms remain unknown. In the present cross-cultural electroencephalogram (EEG) study, we tested culture-specific visual perception of 12-month-old infants (N = 71) and assessed whether early cultural differences may be grounded in culture-specific pedagogical interactions with their caregivers. To measure context-sensitivity nonverbally, visual cortical processing of object versus background was assessed in the EEG of children by applying rhythmic visual stimulation with frequency tagging (Köster et al., 2017). This is, presenting object and background at different driving frequencies elicits separate evoked responses (steady-state visually evoked potentials [SSVEPs]) for each element (cf. Figure 2). Participants were mother-infant dyads from Vienna (urban Austria; a Western culture; N = 35) and Kyoto (urban Japan; an Eastern culture; N = 36). Infants were shown visual scenes depicting natural objects (e.g. animals, vehicles) in front of a natural background on a computer screen (cf. Figure 2A). Object and background were flickered at different stimulation frequencies (5.67 and 8.5 Hz, counterbalanced) while infants' visual cortical processing was measured with EEG (cf. Figure 2B,C,D). We applied a pre-post design with a training phase in between: in the pre- and post-phases, infants observed the images together with their mothers. During training, mothers were instructed to point out interesting elements of their choice to their infants on the images. We found that infants from Vienna showed a pronounced object SSVEP signal, in contrast to infants from Japan, showing an accentuated background signal across pre- and post-phases, $F(1,69) = 10.14$, $p = .002$, $p\eta^2 = .13$. The finding that culture-specific perceptual processes emerge in the first year already, may be explained by distinct social interaction experiences infants make in the two cultures: Mothers from Austria pointed out object elements of the scenes to their infants more often than mothers from Japan, who frequently pointed to the background of the scenes, $t(69) = 3.37$, $p = .001$, $d = .80$. Results suggest that culture shapes the human visual perceptual system from early infancy on, which is much earlier than presumed until to date. Additionally, our findings confirm that culture-specific parental attention guidance already emerges in early mother-infant interactions (Senzaki & Shimizu, 2020), which may lead to cultural differences in infants' visual perception.

S.04.04: How Communicative Cues During Joint Attention Promote Mutual Neural Processes of Infants and Caregivers (Bánki)

Anna Bánki[1], Moritz Köster[2], Radoslaw Martin Cichy[2], Stefanie Hoehl[1]

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Communicative cues such as eye contact have been shown to increase infants' brain activation in response to visual stimuli (Hoehl et al., 2014) and considered to promote shared attention in early development (Hoehl & Bertenthal, 2021; Siposova & Carpenter, 2019). In this study, we assessed whether communicative cues during joint attention between infant and caregiver enhance dyads' mutual neural processes. We propose that a higher degree of attention alignment will lead to more similar neuronal responses within the dyad. To investigate this, we used the method of rhythmic visual stimulation in a dual electroencephalography (EEG) paradigm measuring the brain activity of infant and caregiver simultaneously. Specifically, we assessed infants' and their mothers' brain responses (steady-state visually evoked potentials [SSVEPs]) and their associations to rhythmic visual stimuli. Mutual neural processes were quantified during two conditions: joint attention (JA) with communicative signals and mutual reference (eye contact, pointing, infant-directed speech) vs. joint watching (JW) without communication or mutual reference. Our sample consisted of 49 typically developing 11-13-month-old infants and their mothers. To track mutual visual processing, we presented images flickered at 4 Hz, depicting natural objects (i.e. animals and everyday objects) in front of a natural background (Cichy et al., 2016). Flickering images elicited SSVEPs at 4 Hz that could be recorded with EEG (Köster et al., 2017), allowing to assess dynamic changes in infants' and caregivers' shared attention. Between conditions, we manipulated communicative signals by instructing the mother to either establish mutual gaze with the infant and point to the images with a verbal comment upon stimulus onset, or simply watch the images together with the infant without communicative engagement. First, we predicted that communicative cues during JA should lead to increased attention and thus enhanced visual processing (higher SSVEP amplitudes) compared to JW, both in infants and mothers. Preliminary results (N = 23) revealed that infants showed increased visual processing during JA vs. JW ($\beta = .42$, $SE = .20$, $t(22) = 2.153$, $p = .043$). This suggests that communicative cues increase infants' attention during early interactions, which can be captured already on the neural level. In this presentation we will discuss further results on how communicative cues affect mothers' visual processing in such interactions; and whether they facilitate a greater alignment of attention in the dyad (higher amplitude correlations between SSVEPs of infants and mothers). Additionally, we will assess if communicative cues increase similarity between the activated object representations of infant and mother, by using representational similarity analysis (Cichy et al., 2014). This study is the first to apply rhythmic visual stimulation with SSVEP as a measure of joint attention during early social interactions. In contrast to focusing solely on infants' brain responses, this approach will enable new insights into how communicative cues during joint attention modulate both infants' and caregivers' brain activities and shape shared visual experience.

S.05: Atypical developmental cascades: Opportunities for learning and social interaction in infants with motor delays

S.05.01: Bidding on the go: Links between infant walking, social initiations, and caregiver responses in younger siblings of children with autism spectrum disorder (Schneider)

Joshua Schneider[1], Bianca Calabretta[1], Jana Iverson[1]

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The transition to walking has been linked to a shift in how infants initiate social interactions. As walkers, infants are efficient movers and take advantage of free hands for carrying. With extended arms and

showing gestures, walking infants produce "moving bids" by approaching caregivers and sharing objects. In turn, caregivers respond with language input that describes objects or directs infant play. This bidirectional process is built on a dance between infants' social actions and caregivers' responses. To date, however, these associations have only been documented in neurotypical infants when they first begin to walk.

Infants with an older sibling diagnosed with autism spectrum disorder (ASD), who are at elevated likelihood (EL) for ASD, may not engage in this social dance in the same way. For example, EL infants experience developmental differences in the component skills necessary to produce moving bids--they tend to walk later and produce fewer show gestures than their peers with a typical likelihood (TL) for ASD. Here we examined these behaviors in a sample of EL infants with diverse developmental outcomes and asked whether and how each component of a moving bid (carrying, approaching, producing a social bid) differentially elicited responses from caregivers.

Eighty-five 18-month-old infants (30 TL, 55 EL) were videorecorded during everyday activities with their caregivers at home for 45 minutes. EL infants were evaluated at 36 months and classified with an ASD diagnosis (EL-ASD, n=14), language delay without ASD (EL-LD, n=16), or no diagnosis (EL-ND, n=25). We identified all bouts of walking and for each bout, coded whether infants: (1) carried an object, (2) approached their caregiver, or (3) generated a social bid with a show gesture. Each bout was then categorized as an approach, approach and carry, or social bid. Finally, we coded whether caregivers provided a verbal response (i.e., a vocalization containing words) within 5 seconds of each infant action bout.

EL-ASD infants walked significantly less often than their TL peers ($p < .01$) but were just as likely to carry objects ($p > .05$). When infants walked, they were most likely to approach their caregivers and least likely to produce a social bid (Figure 1). And although social bids occupied the smallest share of bouts, they were the action type most likely to elicit a response from caregivers, followed by approaches without and with objects respectively (Figure 2). There were no differences between outcome groups for responses to social bids. However, and notably, EL-ASD infants were significantly more likely than all other groups to receive a response when they approached caregivers with or without objects in tow (ps $< .05$; Figure 2).

Taken together, these findings reveal striking interconnections between infant action and caregiver response. Social bids were most salient in eliciting language for all groups. However, caregivers of EL-ASD infants maximized opportunities to respond to their infants' social initiations, regardless of action type. Indeed, action creates interaction, and these data underscore the possibility that caregivers of EL-ASD infants display increased sensitivity to their infants' social actions.

S.05.02: The impact of age, motor ability, and learning to walk on Emotional Availability in children of different ages and motor abilities (Molinini)

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Objective: The quality of parent-child relationships generally improves when children begin walking. The age children walk and delays in gross motor development are possible confounders of the effect of walking on the relationship qualities. The aim of this analysis was to describe the quality of the relationship in response to the onset of walking in children of different ages and motor abilities

Methods: Participants included parent-child dyads with motor delays (MD; N=27) and typical motor development (TD; N=15) participating in a larger study. The quality of the interaction (Emotional Availability, EA) and gross motor skills (Gross Motor Function Measure-66, GMFM) were assessed at baseline, 3-, 6-, and 12-months post baseline. The pre- and post-walking visits were retrospectively identified by GMFM scores. A 5-minute parent-child interaction was scored with the EA Scale, 4th edition to quantify four adult (Sensitivity, Structuring, Non-Intrusiveness, and Non-Hostility) and two child (Responsiveness and Involvement) EA dimensions. Higher EA scores indicate more desirable EA. Mixed modeling with random effects compared EA at pre-walking, post-walking, and change between visits between motor groups. Multiple linear regression identified predictors of EA.

Results: Pre- and post-walking ages were different between groups (p's<.001); MD: pre-walking=14.4 months, SD 2.71, post-walking=18.82 months, SD 3.49; TD: pre-walking=10.00 months, SD 1.74, post-walking=14.83 months, SD 3.08. There was no difference in GMFM between groups at either visits (p's>.98).

TD scored higher than MD in Sensitivity and Structuring at both visits (p's<.04) and in Non-Intrusiveness and Non-Hostility at post-walking only (p's<.02). There were no group differences in child EA at either visit. From pre- to post-walking parents in the TD group increased Non-Intrusiveness scores (difference = 2.17, p=.04) and the MD group decreased Non-Hostility scores (difference = -1.39, p=.02).

There were differences in the predictive associations of age and GMFM based on motor group. Age predicted Sensitivity, Structuring, and Child Responsiveness at pre- and post-walking, and Non-Intrusiveness and Non-Hostility at post-walking in MD but not TD. Conversely, GMFM at pre-walking predicted all 4 adult EA dimensions and Child Responsiveness at pre-walking in TD but not MD. Older age for MD or higher GMFM scores at the pre-walking visit for TD was associated with lower EA scores at that visit. Change in Non-Intrusiveness was predicted by motor group but no other changes in EA were predicted by motor group, age or GMFM.

Conclusions: Dyads with MD generally had lower EA compared to TD. Parents were influenced and responded differently to the onset of walking. Parents of children with MD were influenced by age and demonstrated less non-hostile behaviors when children began walking. Whereas parents of children with TD were influenced by motor skills prior to the onset of walking and became less intrusive once their child was walking. Despite being skilled matched, having a motor delay and walking later may have altered parents perceptions of their child, leading to challenges in parent and child EA. To better understand the effect of walking on EA, future research should consider the impact of the dyad's past interaction experiences in addition to motor skill and age.

S.05.03: Prerequisites to joint attention: Role of sitting status, sitting skill, and motor delay (Kretch)

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Joint attention--two individuals simultaneously attending to the same object--is an important mechanism for infant learning. Joint attention can be achieved via two pathways: *gaze following*, following the partner's gaze to objects, and *hand following*, fixating objects in the partner's hands. Therefore, two prerequisites to joint attention are ability to view the partner's face and ability to contact objects. The onset of independent sitting has cascading effects on cognitive and language development, potentially due to increased joint attention opportunities. But before infants sit independently, they sit with adult support. We investigated how joint attention prerequisites--face viewing and object contact--differ between independent and supported sitting. We hypothesized that the demands of supporting infants' posture would limit both pathways: infants would more frequently face away from caregivers, and caregivers' hands would be less available to contact objects. We also examined whether these measures were associated with sitting skill, as support demands may decrease with increasing postural control. Because infants with motor delays are at risk for secondary cognitive and language delays, we examined both typically developing infants and infants with delayed sitting skills.

We tested 33 infants with typical development (TD; 5-7 months) and 128 infants with motor delay (MD; 7-16 months) with emerging sitting abilities. Approximately 50% of infants in each group could sit hands-free. Infants and caregivers were videotaped for five minutes of free play. *Sitting skill*was assessed using the Gross Motor Function Measure Sitting Scale. Portions of the free play task where infants sat, supported or unsupported, were scored for three outcomes: 1) orientation-- *face-to-face*, *side-by-side* (infant/caregiver at right angles), or *back-to-front* (infant facing away from caregiver); 2) i*nfant object contact*; and 3) *caregiver object contact*. *Sitting status*was classified as *sitter* for infants who spent time sitting unsupported and *non-sitter*for those who only sat supported. Summed durations for each outcome (proportions of sitting duration) were analyzed using beta regression. Initial models contained group, sitting status, and their interaction as predictors. Subsequent models added sitting skill and age; likelihood ratio tests examined whether these variables significantly improved the models.

Sitters spent more time face-to-face (B=.48, p=.03) and side-by-side (B=.74, p=.002), and less time back-to-front (B=-1.26, p<.001), than non-sitters (Figure 1). There were no group effects. Sitters contacted objects more than non-sitters (B=.41, p=.046) and TD infants contacted objects more than MD infants (B=.82, p=.03, Figure 2). Surprisingly, caregiver toy contact did not differ by sitting status or group. Additional coding revealed that caregivers infrequently supported infants with both hands (M=32%); instead, they used one (M=40%) or no (M=28%) hands, freeing hands to handle objects. Adding sitting skill or age did not improve the models.

Results suggest that independent sitting affects some joint attention prerequisites (face viewing, infant object contact), but not others (caregiver object contact). This represents a discontinuous change with sitting onset, rather than a gradual shift with increasing sitting ability. These effects persist regardless of age of sitting development, indicating that pre-sitting children with motor delays may have reduced joint attention opportunities.

S.05.04: Infant predictors of adaptive functioning in Down Syndrome (Daunhauer)

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Adaptive functioning refers to behaviors people engage in every day including self-care skills, academic skills and vocational skills. While research has documented that individuals with Down syndrome (DS) have challenges in adaptive functioning, little is known about how these abilities emerge or what developmental trajectory they follow. Obtaining this information has the potential to innovate targeted, early intervention for this population. Our aims for this study are to (1) characterize the adaptive functioning profile in infants and toddlers with DS and (2) examine potential infant predictors of adaptive behavior. Infants with DS who were 4 to 16 months of age participated in a brief longitudinal study. Time 1 (M chronological age [CA]= 8.92 months, SD = 3.59; M developmental age [DA]= 6.55 months, SD= 2.68) measures included the Bayley Scales of Development, 3rd edition (BSID-3), exploratory play (mean frequency of efficient grasping, mean latency to contact objects, and duration of manual exploration), and participant characteristics (prematurity in weeks, congenital heart defects, caregiver education, mean hours/week early intervention services, duration of early intervention services. At Time 2(approximately 6 months later; CA M= 15.55 months, SD= 3.79), primary caregivers completed the Comprehensive Interview Form of the Vineland Adaptive Behavior Scales 2 (VABS-2), which was used to evaluate adaptive skills in Socialization, Daily Living Skills, Communication, and Motor Skills.

A one-way repeated-measures MANOVA using mean standard VABS-2 scores indicated that significant differences existed across domains of adaptive functioning λ = .24, F (3, 51) = 54.98 p < .001, η²_{partial} =.76. Post-hoc pairwise t-tests with Bonferroni corrections indicated that participants demonstrated significantly more competent Socialization skills (M= 85.30, SD = 7.41) compared to performance on the domains of Daily Living Skills (M= 80.41, SD = 11.26), Communication (M= 78.15, SD = 10.35), and Motor Skills (M= 68.98, SD = 9.35). Results also indicated that participants had significantly more challenges in Motor Skills than in any other domain. We also considered infant predictors of toddler adaptive functioning by first examining bivariate correlations of possible predictors. The Socialization model demonstrated that language (p=.009) and prematurity (p = .023) significantly contributed to this model (F (3, 39) =4.44, p = .009, R²_{adj} = .20. The Communication regression model demonstrated that language (p < .001), efficient grasping (p=.044), and prematurity (p=.021) significantly contributed to this model (F (4, 38) =9.17, p < .001, R²_{adj} = .44). The Motor Skills model indicated that BSID-3 motor abilities (p=.011) and efficient grasping (p=.022) contributed significantly to the model (F (2, 45) =24.41, p < .001, R²_{adj} = .50). Latent class analyses are planned that will explore the heterogeneity of adaptive outcomes in DS.

Overall, our results indicate that older infants with DS demonstrated significant challenges in adaptive behavior that included a group profile of relative proficiencies in social abilities and relative difficulties in motor abilities. This study adds to the field by identifying infant characteristics including prematurity, early language abilities, and frequency of early grasping that contribute to a developmental cascade resulting in lower levels of adaptive functioning.

S.06: Developmental pathways of anxiety: maternal care shapes early neural and behavioral indices of infant approach and withdrawal

S.06.01: EEG Correlates of Anxiety Risk in the First Two Years of Life are associated with Mother-Infant Affective Concordance at 8 Months (Perez-Edgar)

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Caregiver-infant interactions are a central scaffold for cognitive, social, and emotional development. In typical development, attunement between caregiver and child may act as a conduit for the intergenerational transmission of traits and behaviors. In the case of anxiety, parental anxiety is associated with an elevated risk for child anxiety. Distinct parenting behaviors marked by over-protectiveness and intrusiveness can potentiate risk, mediated by the extent to which children observe and internalize parental behaviors, which may be captured by parent-child affective concordance. We investigated mother-infant behavioral affective concordance at 8mos and infant resting EEG longitudinally to examine relations with delta-beta coupling and alpha asymmetry over time. Delta-beta coupling captures the coordinated activity between subcortical and cortical brain systems involved in emotion regulation. Over-coupling is linked to a rigid behavioral phenotype and increased anxiety risk. Alpha asymmetry captures underlying motivations to withdraw (increased right asymmetry) and approach (increased left asymmetry) and is also associated with anxiety (right asymmetry). Families were drawn from a multisite longitudinal study examining infant temperament and attention in a diverse community sample. Mother-infant pairs engaged in 5-min interactions at 8mos. Affect for mother and infant was coded independently, and then synced for concordance. EEG measures were derived from 4 minutes of rest recorded at 8, 12, 18, and 24mos. Asymmetry was derived from relative alpha power in frontal sites, with delta-beta coupling derived from time series modeling at central sites. From the larger sample (N = 357), coding is complete for the first 100 mother-child dyads. When incorporating neural data, coded concordance and EEG are both currently available for infants at 8 (N=94), 12 (N=81), and 18mos (N=89). Multilevel models captured mother-infant concordance over the course of the 5-min interaction at 8mos. Growth models for the neural variables (from 8 to 18 months) were used to extract the growth slope, separately, for frontal asymmetry and central delta-beta coupling. Slopes were then added to the multilevel model capturing concordance to examine the extent to which average and time-dependent mother-infant concordance at 8mos predicted developmental trajectories of EEG correlates. Any interaction between mother affect-child affect concordance and growth slope can be interpreted as concordance predicting change in neural variables over time. Average affective concordance was significant and positive across the sample (B=0.42, p=.001). Concurrently, mother-infant affective concordance was weaker for infants with heightened Delta-Beta coupling at Central regions (B=-1.04, p=.041). Affective concordance was weaker for infants with right asymmetry. Mother-infant dyads characterized by increases in affective concordance had infants with increasing trajectories of Central region delta-beta coupling from 8-18mos. Region of significance analyses indicated that mother-infant affective concordance that became weaker and decoupled predicted a linear decrease in frontal alpha asymmetry, suggesting a developmental shift towards right asymmetry. Dyads with increases in affective concordance had a developmental shift towards left asymmetry. Individual differences in mother-child interactions may influence broad patterns of neural development. These patterns, in turn, may lay the developmental foundation for early psychopathology risk and later emergence of anxiety-specific symptoms.

S.06.02: Maternal caregiving moderates early temperamental risk for later emergence of Behavioral Inhibition across the first year of life (Frenkel)

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Individual differences in infants' approach and withdrawal tendencies greatly determine social functioning. Persistent generalized tendencies for social withdrawal, characterized in infancy by distinct patterns of neural activation and the observable phenotype of Behavioral Inhibition (BI) - form a prominent risk factor in the pathogenesis of clinical social anxiety. Individual differences in temperamental negative reactivity (NR) assessed within the first months of life, are predictive of later BI emerging toward the end of the first year. This rapidly evolving pathway of risk across the first year of life, often culminates in diagnosis of clincal social anxiety by early childhood. Maternal caregiving plays a key role in shaping infant's early approach and withdrawal tendencies. Nevertheless, studies rarely examine whether caregiver factors moderate NR-related risk across the first year of life, and prior to the emergence of infant BI. In the current longitudinal study infants (N=157) were assessed twice across the first year of life. Temperamental NR was observed at 4-months. At 10-months, infant 'resting' EEG yielded neural indices of persistent infant withdrawal, and BI was observed within the laboratory. Finally, early maternal caregiving was assessed at 4-months. We specifically examined three maternal constructs known to promote children's regulation abilities, yet surprisingly understudied in the development of BI: mother-infant interactions were coded for microanalytic measures of maternal contingent responsiveness, and global measures of infant-led caregiving. Lastly, maternal mentalization abilities (mind-mindedness; MM) were coded from a brief interview. Analyses examined whether early maternal caregiving moderates predictive links between 4-month infant NR and 10 month behavioral and neural indices of BI. Results revealed infant temperamental NR at 4-months interacted with maternal contingent responsiveness to shape patterns of infant EEG at 10-months ($B = 0.51$; $p < 0.001$). High NR associated with neural indices of social withdrawal (i.e. frontal right alpha asymmetry), but only for infants who experienced low levels of maternal contingent responsiveness ($B = -0.09$; $p < 0.001$). In turn, EEG patterns predicted increased BI observed concurrently ($B = -0.38$; $SE = 0.14$; $p = 0.009$). In contrast, high NR infants who experienced high levels of maternal contingent responsiveness at 4-months did not go on to exhibit right alpha asymmetry nor the associated observed BI. Similarly, infant-led caregiving moderated NR-related risk for infant BI when infant-led care was high, but not when infant led care was low (p=ns, $\beta = .54$, $p < .001$((see Figure 1). Moreover, Maternal MM moderated NR-related risk above and beyond the observed effects of infant-led care. Associations was found between NR and subsequent BI only at low but not high levels of maternal MM ($\beta = .72$, $p < .001$, p=ns) (see Figure 2). In conclusion, findings shed light on particular aspects of maternal giving that effectively moderate NR-related risk for subsequent BI and underlying neural activity. Given the well-established stability and risk of BI, identification of early protective caregiver factors that operate within the first year of life has pivotal clinical value. Our findings inform early preventive interventions targeted at parents of infants displaying NR-related risk.

S.06.03: The Moderating Role of Infant Temperament on the Relation Between Maternal Personality and Child Social Anxiety (Zeytinoglu)

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Social anxiety is amongst the most prevalent early emerging childhood mental health problems (Beesdo et al., 2009). Understanding the developmental pathways to social anxiety is critical for improving its prevention. Previous work suggested that maternal personality characteristics such as extraversion and shyness may play a role in the development of children's social anxiety by shaping children's social learning experiences (MacGowan & Schmidt, 2020; Zeytinoglu et al., 2021). Specifically, more extraverted and less shy mothers may prevent the development of children's social anxiety by modeling positive social behaviors, conveying positive information regarding social situations, and providing rich opportunities for their children to socialize with others (Fisak & Grills-Taquechel, 2007). However, children with different temperaments may be differentially impacted by these parenting characteristics and associated parenting behaviors. Here, we examine whether infant temperaments, behavioral inhibition and exuberance, moderate the impact of mothers' extraversion and shyness on children's later social anxiety. 291 infants (54% female) and their mothers were recruited based on infant temperament for a longitudinal study examining the role of temperament in socioemotional development. Infant behavioral inhibition (ages 2/3) and exuberance (age 3) were observed in the laboratory. Mothers reported on their own extraversion via NEO-FFI (Costa & McCrae, 1989) and shyness via Revised Cheek & Buss Scale (Cheek & Buss, 1981) when their child was 4 years old. Children's social anxiety was assessed via child and parent reports at ages 9, 12, and 15 using SCARED (Birmaher et al., 1999). Child and parent ratings were standardized and averaged to create an overall social anxiety composite. Moderation analyses revealed that both behavioral inhibition and exuberance moderated the impact of mothers' personality traits, extraversion and shyness, on children's later social anxiety. Specifically, higher levels of maternal extraversion related to lower levels of child social anxiety among toddlers low in behavioral inhibition and high in exuberance, but not among those with high behavioral inhibition and low exuberance (see Fig. 1). On the other hand, higher maternal shyness was related to higher child social anxiety among toddlers low in behavioral inhibition and high in exuberance, but not among those high in behavioral inhibition and low in exuberance (see Fig. 2). Our findings suggest that the influence of maternal personality on children's later social anxiety depends on infants' temperament. Higher maternal extraversion and lower maternal shyness predicted lower social anxiety among infants with low behavioral inhibition and high exuberance, but not among those with high behavioral inhibition and low exuberance. These findings suggest that infants with lower behavioral inhibition and higher exuberance are likely more sensitive to the mothers' personality characteristics (i.e., extraversion, shyness) and the social experiences associated with them. Thus, the socialization behaviors associated with these maternal characteristics may be especially important in preventing the development of social anxiety in infants with low behavioral inhibition and high exuberance. These findings highlight the importance of considering both child and maternal characteristics in understanding the developmental trajectory of social anxiety, as well as the importance of identifying prevention strategies suitable for children with different temperaments.

S.07: Insights into the early development of the COVID-19 generation

S.07.01: Characterizing Stress Networks During Pregnancy (Hendrix)

Cassandra L. Hendrix, Denise Werchan, Natalie H. Brito, Moriah E. Thomason

Stress does not occur within a vacuum, but is instead the product of cumulative, competing, and interactive exposures that accrue across an individual's lifetime. Yet many analyses consider very few, or

only one, exposure as a predictor of maternal and infant health outcomes. In a longitudinal sample of pregnant individuals (n=522), we employ a combination of factor, network, and latent profile analyses (LPA) to characterize the co-occurrence of adverse exposures among pregnant people living in New York City during the COVID-19 pandemic. The COPE Survey was completed online between May 2020 and October 2021 by all participants and a subset of these individuals subsequently completed the Infant Behavior Questionnaire - Very Short Form when infants were 6 months old (n=99; see Table 1). First, an exploratory factor analysis with varimax rotation was used to guide the creation of 5 stress factors that captured different aspects of adverse experiences during the COVID-19 pandemic: concern about scarcity, fear of illness, financial and employment disruption, perceived stress/mental health, and quarantine induced life disruption. These factors were confirmed to be good fit via confirmatory factor analysis. Next, we conducted a network analysis based on partial correlations between these 5 factors (see Figure 1A). Perceived stress/mental health yielded the greatest influence on other adversity factors (degree=6, betweenness centrality=0.9, eigenvector centrality=0.64, degree centrality=1.5), suggesting that interventions targeted at improving pregnant individuals' mental health may be especially influential in disrupting the spread of adversity within their lives. LPA analyses revealed significant subgroups within the sample reflecting differential adversity exposures during pregnancy, with 4 profiles as the best fitting model (Figure 1b). Mixture modelling (D3STEP) was used to examine prenatal adversity profile as a predictor of infant outcomes. There were no differences in infant surgency ($X^2=4.48$, $p=0.21$) or negative emotionality ($X^2=3.66$, $p=0.30$) based on prenatal adversity profiles. However, infants whose mothers experienced the highest levels of concern about scarcity and high levels of other adversities during pregnancy (class 4) were described as having significantly lower effortful control compared to infants belonging to the two profiles characterized by low scarcity concern (class 4 vs class 1: $X^2=18.36$, $p<0.001$; class 4 vs class 2: $X^2=5.61$, $p=0.02$). Interestingly, in a hierarchical linear regression examining prenatal adversity factors as individual predictors after controlling for covariates, none of the factors were individually associated with infant effortful control ($p's>0.35$). Collectively, these results highlight the importance of examining the co-occurrence of stressors in addition to examining individual exposures during pregnancy.

S.07.02: Molecular alterations underlying associations between perinatal infection and infant neurobehavioral development (Macêdo)

Letícia Régia Lima Cavalcante, Deniele Bezerra Los, Marylane da Silva Viana, Renata Castro Kehdi, Natália Gindri Fiorenza, Cristiana Libardi Miranda Furtado, Francisco Herlânio Costa Carvalho, Fabio Miyajima, Danielle S. Macedo

Several studies have demonstrated that the exposition of viral antigens in pregnancy may lead to negative consequences in key processes of neurodevelopment. This study aims to investigate the behavioral and molecular consequences of offspring exposition to SARS-CoV-2 during pregnancy and possible predictors of their susceptibility for neurodevelopmental disorders based on the analysis of samples collected during delivery. The study is being conducted in a Maternity Hospital from the Federal University of Ceara, located in Fortaleza, State of Ceara, Brazil. To date, we have 74 patients recruited for the study, 39 for the COVID-19 group, 26 for the flu-like syndrome group, and 9 for the control group. Most patients included in the COVID-19 and flu-like groups were recruited from January to July 2021, during the second wave in Brazil. The viral sequencing revealed that mothers were infected with gamma variant, also known as lineage P.1. Regarding the mothers' symptoms, there was a higher incidence of chills [covid-19=38.9%- flu-like=12.5% ($p=0.040$*)] and olfactory disorders [covid-19: 44.4%

- flu-like: 16.7% (p=0.029*)] in the covid-19 group compared with the flu-like group. Although there was no statistical difference, it was observed that 50% of the patients in the COVID-19 group showed signs of worsening of the flu-like syndrome, while in the flu-like syndrome group, only 29.2% of the patients showed some sign of worsening. The mothers were also asked to answer the COVID-19 and Perinatal Experiences Study Surveys (COPE survey). The control group reported more support through the social network (100%) than the Covid-19 group (50%), which also experienced more feelings of distress (50%). Regarding the pregnancy outcome, we observed that the gestational age was higher in the control group (39.84 ± 0.69 weeks) as compared with the flu-like syndrome group [38.07 ± 2.17 weeks (p=0. 0458*)] and to the covid-19 group [37.34 ± 2.71 weeks (p=0.0017*)], suggesting anticipation of childbirth due to the viral infection, whether by SARS-CoV-2 or other viruses. However, there was no difference regarding the newborns' (NB) anthropometric parameters at birth (weight, height, head circumference (HC), and chest circumference (CC)). As for the follow-up, 29.6% of the NBs from the COVID-19 group were transferred to intensive care units and 29.6% required non-invasive respiratory support, while these percentages for the flu-like group were 16.7% and 16.7%, although the differences were not statistically significant. To understand the effects of intrauterine SARS-CoV-2 exposure on neurodevelopment, our next step is to perform epigenetics' studies on the placenta and umbilical cord blood and periodical (every six months until two years old) assessments of developmental alterations in the babies, along with a collection of biospecimens for determination of possible molecular alterations.

S.07.03: What is it like to be born at times of COVID-19? Unveiling the effects of a global pandemic on infant development (Vacaru)

Stefania V. Vacaru, Sofia W. Scatolin, Nina Bruinhof, Pamela D. Browne, Marielle Cloin, Hedwig, van Bakel, Marion van den Heuvel, Roseriet Beijers, Carolina de Weerth

The COVID-19 outbreak abruptly changed the life of many young parents worldwide. In turn, these changes may be associated to offspring development. Initial findings from our study of parents in the perinatal period, showed that COVID-19 related changes may be a reason for concern, as we found elevated mental health problems in the prenatal (Vacaru et al., 2021) and in the postnatal period, with the latter associated to insensitive parenting practices (van den Heuvel et al., submitted). In the present study, we sought (1) to unveil whether psychological and physiological stress (i.e. cortisol hormone) in the prenatal period is linked to infant development (i.e. difficult temperament). Additionally, changes to parents' lives during the first COVID-19 lockdown, such as remote working, may have actually provided parents with the opportunity to spend longer time at home post-birth and hence engage in more breastfeeding and room-sharing (i.e. follow WHO recommendations better). Hence, our second aim was (2) to elucidate whether COVID-19 related changes to parents' lives were associated with basic infant caregiving practices (i.e. breastfeeding, room-sharing). To answer these quests, we set up a large Dutch longitudinal study following parents from pregnancy (N=1419; recruited in April-May 2020, first COVID-19 lockdown in The Netherlands) until their offspring was 6 months old (N=1230), with the aim of following parental experiences and infant development. We assessed mothers' demographic data, COVID-19 related worries and infants' general health outcomes, infant breastfeeding and room-sharing practices, and temperament in the first six months of the infant's life. For a subsample of women (N=100), we collected physiological measures (e.g. hair cortisol) during a home visit as an index of prolonged physiological stress. With respect to physiological stress, we found that in high SES mothers only, COVID-19 worries concerning work predicted elevated hair cortisol concentrations during pregnancy (b=.06, SE=.03, p<.05). However, hair cortisol concentrations were not associated of infant

difficult temperament. As for infant practices, we found that (exclusive) breastfeeding and room-sharing practices did not decrease compared to pre-pandemic reports in The Netherlands. Interestingly, we found that when mothers were at home for longer (either unemployed or working from home) infants room-shared longer with their parents (r=.170, p<.05). In addition, when partners were at home for longer, infants were exclusively breastfed longer (r=.110, p<.05). Our results showed that women with higher SES showed chronically heightened cortisol concentrations during pregnancy when they had higher work-related worries. This may suggest that the first COVID-19 lockdown may have more strongly impacted women that held more qualified jobs, possibly due to structural changes that challenged their job performance (i.e. working in isolation, increased responsibilities, remote managerial tasks). Our findings also suggest that actually being able to spend more time at home post-birth as a result of the lockdowns and restrictions, may have had positive effects on parental compliance with WHO infant caregiving recommendations concerning exclusive breastfeeding and room-sharing.

S.07.04: Risk for developmental delay among babies born during the pandemic (Giesbrecht)

Gerald F. Giesbrecht, Catherine Lebel, Suzanne Tough, Sheila McDonald, Lianne Tomfohr-Madsen

The COVID-19 pandemic has led to concerns about potential increases in developmental delay among infants born during the pandemic (Roseboom et al., 2021). We compared developmental screening of 1-year old infants born during the pandemic to pre-pandemic infants to determine whether risk for developmental delay was elevated. The University of Calgary (Alberta, Canada) Research Ethics Board approved the study and informed consent was obtained prior to data collection. The Pregnancy During the COVID-19 Pandemic (PdP) study recruited pregnant individuals ≥17 years and ≤35 weeks gestation at enrollment, living in Canada, and able to read and write in English or French (Giesbrecht et al., 2021). At infant 1-year of age (adjusted for prematurity), mothers completed the Ages and Stages Questionnaire (ASQ-3; Squires et al., 2009). Infants who were multiples (n = 38) or had confirmed COVID-19 infection (n = 18) were excluded from analysis. Mean scores and odds ratios for scoring 1 or 2 SD below the mean (indicating moderate or high risk, respectively, for developmental delay) were compared to several Canadian pre-pandemic cohorts: the All Our Families (AOF) study (n = 1275) and the Impact of Maternal and Paternal Postpartum Depression: Assessing Concurrent Depression in the Family (IMPACT) study (n = 2903). Data were available from 1623 PdP participants. Sociodemographic characteristics of the PdP cohort are comparable to the pre-pandemic cohorts, with the exception that PdP had somewhat higher income and fewer racialized individuals. PdP infants had lower mean scores on all domains, except Problem Solving (see Table 1). Using the ASQ-3 normative tables to determine the proportion of infants scoring 1 SD or 2 SD below the mean, we found that PdP infants had significantly higher risk for developmental delay (see Table 2). Specifically, the odds ratio for scoring 1 SD below the mean were 1.6, 1.2, and 1.3 for Communication, Gross Motor, and Personal-Social, respectively. The odds ratio for scoring 2 SD below the mean were 2.5 and 1.5 for Communication and Personal-Social, respectively. Risk for developmental delay in the Communication and Personal-Social domains was elevated in infants born during the COVID-19 pandemic relative to a comparable pre-pandemic cohort. These differences may reflect reduced opportunities for social interactions among pandemic-born infants, resulting from restrictions aimed at reducing the spread of COVID-19. Despite the increased risk for developmental delay, the percentage of infants below the cut-off was small, suggesting that development of most infants born during the pandemic is comparable to that of pre-pandemic infants. Families and clinicians should be reassured that, based on this standardized screening tool, most infants continue to do well despite challenges experienced by families and healthcare systems during the pandemic. Still, the

findings suggest that additional monitoring and increased referral for assessment may be needed among pandemic-born infants to ensure optimal development, especially because developmental concerns may emerge over time. Careful monitoring and appropriate early referral for assessment are needed, especially among infants with sociodemographic disadvantages, which are known to threaten early childhood development.

S.08: Getting the most out of Infant EEG data – State of the art techniques and meta-scientific perspectives

S.08.01: Consistency and reporting in preprocessing and analysis of infant ERP data - A systematic review (Paul)

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In order to meaningfully interpret event-related potential (ERP) data, the data have to undergo a complex preprocessing and analysis pipeline. In order to set up this pipeline, ERP researchers have to make a myriad of decisions, introducing a great deal of analytic flexibility. Recent studies have examined this flexibility, its consequences and ways to reduce it in the adult ERP literature (e.g., ?o?kić, et al., 2020; Sandre et al., 2020). However, these problems also apply to infants' and children's ERP data, which has received little attention with regard to analytic flexibility so far, despite the unique challenges infant ERP researchers face regarding data collection, which need to be addressed during preprocessing. To address this problem, we conducted a systematic review to assess common practices in infant ERP preprocessing and analysis steps. To keep the studies comparable, we focused on papers investigating the well-studied N400 component in one of its most common applications, word learning, in pre-school children (0-5 years). We identified 31 papers using a PubMed literature search. We analyzed 47 practices of these studies, including properties of preprocessing steps such as filtering, rereferencing, artifact rejection and correction methods, and statistical analysis. For each of these practices, we investigated the consistency with which the practice was implemented and how well it was reported. We found that each study used a unique preprocessing and analysis pipeline, indicating very little consistency overall. Individual practices differed greatly with regard to how consistently they were used and reported, with some practices being reported perfectly according to commonly accepted reporting guidelines, and others not at all. In addition, we show what effect different preprocessing decisions have on the ERP data. Based on these findings, we will discuss what infant ERP researchers can do to increase reporting and consistency in the implementations of analysis steps. We will particularly highlight how to deal with the unique challenges of infant ERP data. We hope to raise awareness that (1) infant ERP studies can only be reproducible when preprocessing and analysis steps are consistently reported, (2) the many decisions researchers have to make during preprocessing and analysis of infant ERP data can influence the results, and (3) we should strive towards standardized preprocessing and analysis pipelines to make results more comparable.

S.08.02: Facilitating good scientific practice with standardized EEG/ERP processing through HAPPE 2.0 software (Gabard-Durnam)

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Introduction: Infant electroencephalography research is experiencing a renaissance of innovation leveraging recent technological and computational advances. These rapidly changing research trends necessitate moments of reflection on how such new tools, measures, and methods reinforce or necessitate alignment with good scientific practice. In this talk I focus on how one such area of innovation, namely standardized, automated preprocessing of EEG and ERP data, can help us align with good scientific practice principles. Specifically, I present HAPPE 2.0 software as a flexible and state-of-the-art approach to align infant EEG/ERP research with good scientific practice in three key ways: 1) by facilitating replication and comparisons between researchers and datasets, 2) by improving artifact correction and rejection in infant EEG/ERP data to improve neural data retention, and 3) by providing empirical data quality metrics to improve the robustness of data analysis and reporting. Study populations: We aimed to provide a generalizable preprocessing solution by validating software methods across populations, ages, and EEG systems. Thus, software validation and analyses are presented using data from typically-developing infants and infants who experienced early-life hospitalization and general anesthesia in the USA (n = 24) with high-density ERP recordings at 4- and 10-months of age, infants and children at low- or high-risk for Autism Spectrum Disorder in the USA (n = 30) with high-density EEG recordings from ages 3 months to 3 years, and infants and children who experienced early orphanage care with or without randomization to foster care and community comparison children in Romania as part of the Bucharest Early Intervention Project (n = 30) with low-density EEG recordings from ages 6 to 30 months. Methods: We validated HAPPE 2.0's preprocessing methods using three complementary approaches. 1) Clean vs. artifact approach: We selected two 30-second segments within each participant's EEG file, one that was heavily artifact-laden and one clean segment. We tested whether artifact was effectively removed via different preprocessing methods by comparing post-processed segments within individuals. 2) Artifact addition approach-real EEG: We used known artifact signals and added them to the clean 30-second segments from the first approach to optimize real EEG signal recovery via preprocessing. 3) Artifact addition approach-simulated EEG: We generated synthetic EEG and ERP data with real artifact added to it in order to have a "ground truth" signal that we could attempt to recover via different processing methods. Results: We illustrate how HAPPE 2.0's parameter settings facilitate replication efforts. We further demonstrate that across approaches and datasets, wavelet-thresholding preprocessing approaches retain significantly more neural and simulated data and significantly less artifact than other approaches (e.g. 4-month ERP data: $F(6) = 5.426$, $p = 4.8*10\text{-}5$, $\eta_p^2 = 0.198$). Moreover, we demonstrate how HAPPE 2.0 generates data quality metrics that can be used as dependent measures and covariates to improve robustness of analyses and manuscript reporting practices. In these ways, we hope HAPPE 2.0 will help facilitate good scientific practice for infant EEG/ERP studies moving forward.

S.08.03: Using BIDS, cluster-based permutation tests, and effect sizes to facilitate reproducibility in infant EEG research (Meyer)

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Electroencephalography (EEG) is one of the most commonly used methods to measure brain activity of infants and toddlers in developmental psychology research. This infant-friendly technique allows for high temporal precision and has led to many valuable insights in cognitive, social, and clinical aspects of early development (Bell and Cuevas, 2012; Bosl et al., 2011; Braithwaite et al., 2020; de Haan, 2013;

Endedijk et al., 2017; Friederici, 2005; Marshall et al., 2004). Yet, inherent challenges of EEG data collection with infants such as their limited attention span leading to short recording times, limited tolerance for wearing the EEG cap, as well as limits in data quality due to large movement artifacts make infant EEG costly to acquire. As research community, we can more optimally use these valuable resources by sharing infant EEG data and analysis scripts, as well as properly applying and reporting statistical methods to infant EEG data. This is crucial to assess the scientific evidence presented in publications and to define follow-up research in a precise and reliable manner. To contribute to more reproducible infant EEG research, we will highlight three methods as illustrated in Figure 1. These methods address 1) organizing and sharing infant EEG data with the Brain Imaging Data Structure (BIDS) format, 2) analyzing infant EEG data by means of cluster-based permutation testing and 3) reporting effect sizes of (cluster-based permutation) results. Organizing infant EEG data. In this talk we will first discuss how BIDS provides a comprehensible manner to organize and share infant EEG data with the scientific community, in line with FAIR data principles (Findability, Accessibility, Interoperability, Reusability; Wilkinson et al., 2016). Analyzing infant EEG data. Second, we will give a tutorial-like description on using cluster-based permutation testing. This versatile test statistic solves the omnipresent multiple comparison problem in EEG and thereby can substantially decrease the risk of reporting false discoveries. Reporting infant EEG data. Finally, we will describe how to quantify effect sizes, in particular of cluster-based permutation results. Reporting effect sizes helps to inform about a finding's impact and robustness, serving as foundation for follow-up research. Infant EEG data and analysis scripts on which the examples in this talk are based will be openly accessible (https://doi.org/10.34973/gvr3-6g88; https://doi.org/10.34973/g4we-5v66). In a nutshell, in this talk we will describe three state-of-the-art methods for developmental EEG data with a focus on fostering reproducible science.

S.09: Implications of maternal sleep for maternal affect, cognition, neural processing, and parenting behavior during infancy

S.09.01: Maternal sleep and parenting quality during 1 to 24 months: The moderating role of coparenting quality (Bai)

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Linkages between sleep and individuals' daily functioning are well-established. However, only recently have research provided evidence that short sleep duration and poor sleep quality can compromise parents' sensitive parenting with young children (Bai et al., 2020; McQuillan et al., 2019). Very little is known, however, about whether the impact of poor sleep on parenting is further dependent on other aspects of mothers' social-ecological niche. Drawing on Feinberg's (2003) ecological model of coparenting, we hypothesized that coparenting quality may potentially serve as a buffer against the untoward effects of insufficient sleep on mothers' capacity for parenting. Both sleep quantity and quality indicators were included to enable a fuller understanding of any interaction effects of maternal sleep and coparenting on parenting quality.

Mothers with infants (N = 167, 47% male) were recruited to participate in an NIH-funded study focusing on parenting, sleep, and infant development. Maternal sleep across 7 consecutive days was assessed using AW-64 actiwatches (Philips/Respironics, Inc.) when infants were at 1, 3, 6, 9, 12, 18, and 24

months. Average sleep fragmentation (Percentage of inactive sleep time across the designated sleep period) and wake minutes after sleep onset (WASO; total awake minutes from sleep onset to sleep offset) across 7 days were calculated on each occasion as indicators of sleep quality; average total sleep time (TST; elapsed time from fall asleep time to wake time subtracted by WASO) was calculated as the sleep quantity indicator. On each occasion, mothers reported their coparenting quality via the Coparenting Relationship Scale (Feinberg et al., 2012), with higher scores indicating better coparenting quality. Maternal emotional availability (EA) was scored from video recordings during one night of infant bedtime using the Emotional Availability Scales (Biringen et al., 1998) on each occasion. EA coders were blind to other information in the study and highly reliable in their scoring.

Multilevel modeling was conducted to examine interaction effects of coparenting and sleep on EA at the between- and within-person level, by person-mean centering sleep variables and coparenting. Models were run for each sleep variable separately. Table 1 suggested that after controlling for covariates, shorter TST and poorer coparenting quality were independently predictive of lower maternal EA than others at the between-person level. Additionally, we found that sleep fragmentation and coparenting interacted to predict EA, such that higher fragmentation was associated with lower EA only for mothers with lower coparenting quality but not for mothers with higher coparenting quality (Figure 1). An identical interaction between WASO and coparenting was also found in predicting EA at the between-person level. No effect of maternal sleep and coparenting was found at the within-person level.

These results demonstrate that better coparenting relationships can buffer adverse effects of poor sleep quality on parenting quality with infants at bedtime. Potential mechanisms of this moderation could be that mothers with high coparenting relationships had higher self-efficacy and/or mental health. Further analyses will be conducted to examine those mechanisms. Findings imply that interventions may wish to incorporate parent sleep and coparenting relationships into parenting intervention protocols.

S.09.02: Mothers' disrupted sleep undermines maternal sensitivity in the early postpartum (Leerkes)

Esther M. Leerkes[1], Shourya Negi[1], Cheryl Buehler[1], Lenka H. Shriver[1], Laurie Wideman[1]

[1]UNC Greensboro

Sleep has been recognized as a predictor of parenting quality (e.g., Bai et al., 2020), but research in this area is scant. Our goals are to determine the extent to which maternal sleep disturbances (i.e., frequency of night wakings) predicts maternal sensitivity as a main effect and/or by moderating the extent to which mothers' social cognition about infant crying (i.e., cry processing) predicts sensitivity. Prior research demonstrated that mothers who engaged in higher infant-oriented cry processing and lower negative/mother-oriented cry processing are more sensitive toward their infants (Leerkes et al., 2014, 2016). We reasoned that disrupted sleep would undermine mothers' sensitivity in part by diminishing their ability to engage in and act on optimal social-information processing in the moment; thus, amplifying the negative association between mother-oriented cry processing and sensitivity and attenuating the positive association between infant-orienting crying processing and sensitivity.

Participants were 176 mothers (64% non-white, 45% first-time mothers) and their 2-month-old infants. Expectant mothers reported demographics, emotional risk (depression, trait anger, emotion regulation difficulties, neuroticism, agreeableness-reversed; α =.85), and emotional and cognitive responses to videoclips of 4 crying infants. The latter yielded two factors: infant oriented cry processing (i.e., high

empathy, accuracy identifying infant emotions, positive cry beliefs, adaptive causal attributions; α = .72) and mother-oriented cry processing (i.e., high anger, anxiety, negative causal attributions, and cry beliefs; α = .78). Mothers reported depressive symptoms and rated sleep quality using the Pittsburgh Sleep Quality Index (PSQ) at 2 months postpartum, and maternal sensitivity and infant negative affect were rated during multiple tasks and then averaged across tasks. Data were analyzed using multiple regression (Table 1).

S.09.03: Maternal sleep quality and caregiving feelings in the postpartum period (Tikotzky)

Liat Tikotzky[1], Dar Ran Peled[1], Avel Horwitz[1], Omer Finelstein[1], Gal Meiri[1]

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Introduction: A healthy parent-infant relationship is crucial for infant and child cognitive, social, and emotional development. Thus, identifying factors that promote positive parent-infant relationship is important to minimize risk for negative developmental outcomes. Recent research suggests that disturbed maternal sleep is associated with compromised mother-infant relationship. However, previous work was mainly based on cross-sectional designs and self-reported measures. The present study aimed to assess the links between maternal objective and subjective sleep and maternal feelings toward her infant, using both a diary-study design and a macro-longitudinal design.

Hypotheses: We hypothesized that maternal lower sleep quality would predict more negative maternal caregiving feelings (e.g., lower patience to be with the infant) on both a between-person and a within-person level. Furthermore, we hypothesized that the links between maternal sleep and her caregiving-feelings would be moderated by infant-related variables (temperament) and environmental variables (social support).

Methods: The sample included 151 married women, who were recruited during pregnancy through prenatal courses and announcements on internet forums. All participants signed informed consent before the first assessment. The data presented here were collected at 4 and 8 months postpartum. Maternal sleep was monitored at home for seven weeknights using actigraphy (an objective sleep assessment method) and sleep diaries. Mothers completed the sleep diaries in the morning, and then reported on their feelings toward the infant that same evening (i.e., patience to care for the baby; desire to be with the baby; anger toward the baby). Questionnaires were used to assess mother-infant bonding, maternal depressive symptoms, socio-demographic measures, and feeding method.

Results: Multilevel modeling were used to analyze the data. The diary study revealed that maternal sleep was associated with maternal caregiving feeling, both at the between- and within- person levels after controlling for depressive symptoms and feeding method. For example, the between-person effect of actigraphic sleep percent was positively associated with maternal patience for the infant; lower maternal sleep percent was associated with less patience to be with the infant ($\beta = .22$, $p < .001$) (Figure 1). Moreover, the within-person lagged effect of sleep percent was positively associated with maternal patience; when a mother had lower actigraphic sleep percent than her average on a given night, she reported a lower level of patience for her infant the following day ($\beta = .11$, $p < .001$) (Figure 2). Moderation analyses based on the macro-longitudinal design demonstrated that the links between maternal sleep and her feelings toward the infant were moderated by infant temperament and social support at both assessment points. For instance, higher variability (i.e., lower stability) in sleep percent

was associated with lower acceptance-tolerance toward the infant at 4 months, but only for mothers with low social support (β = -.33, p = .05).

Overall, the findings demonstrate that maternal objective and subjective sleep quality is significantly linked with maternal caregiving feeling at different time points during the postpartum period. Improving maternal sleep quality might be an important target for future interventions which may help mothers to feel more positively toward their infant.

S.09.04: Expectant mothers' sleep and multi-level responding to infant emotional cues (Patrick)

Madeline Patrick[1], Ashley M. Groh[1]

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Poorer maternal sleep is associated with insensitive caregiving (King et al., 2020; Bai et al, 2019; White et al., 2015). However, less is known about mechanisms by which sleep undermines caregiving behavior. Sleep disturbance is associated with maladaptive functioning across domains, including cognitive functioning, arousal level, affect regulation, and mood (Krause et al., 2017). Maladaptive functioning in these domains is linked to less sensitive caregiving (Leerkes et al., 2015). Thus, lower quality sleep may disrupt maternal responding to infant cues important to organizing caregiving behavior. Indeed, evidence from nulliparous young women provides preliminary support for this hypothesis (Leerkes et al., 2021). Extending this work, we examined expectant mothers' sleep quality during the third trimester of pregnancy in relation to their multi-level neural, cognitive, and emotional responding to infant emotional cues implicated in sensitive parenting. Late pregnancy is an important time to examine the significance of sleep given documented increases in sleep disturbance during the third trimester of pregnancy (Facco et al., 2010) and the significance of prenatal infant cue processing for caregiving behavior (Dudek et al., 2020; Leerkes, 2010).

Expectant mothers (expected N = 70; current n = 36) in the third trimester of pregnancy completed the General Sleep Disturbance Scale (Lee et al., 1991) yielding an overall index of sleep disturbance. Expectant mothers reported their self-oriented (minimization, directive control, spoiling) and infant-oriented (attachment/comfort, crying as communication) beliefs about infant crying via the Infant Crying Questionnaire (Haltigan et al., 2012). Participants listened to an audio recording of infant crying, then reported their positive and negative emotions and negative/internal causal attributions (e.g., spoiled, difficult temperament) about why the infant was crying. Finally, mothers completed an infant emotion categorization task where they identified infant emotions (happy, distress, neutral) while brain wave activity was monitored. The P300--indexing allocation of attentional resources to the processing of infant cues--was extracted for analyses.

Preliminary findings indicated greater reported sleep disturbance in the third trimester is associated with fewer infant oriented beliefs about crying (r = -.10), greater decreases in positive feelings in response to infant crying (r = -.10), and more negative attributions about infant crying (r = .21). Greater sleep disturbance was also associated with neural responding suggestive of a negativity bias in neurocognitive processing of infant emotional cues, including a shorter P300 latency to infant distress versus happy facial expressions (r = .27), longer P300 latency to infant happy versus neutral facial expressions (r = -.15), heightened P300 amplitude to distress versus happy facial expressions (r = .10), and smaller P300 amplitude to infant happy versus neutral facial expressions (r = -.13).

Findings indicate that sleep disturbance in the third trimester of pregnancy has broad significance for expectant mothers' responding to infant emotional cues, undermining emotional, cognitive, and neural responding to infant distress, highlighting potential mechanisms by which poorer sleep may ultimately undermine parenting behavior.

Higher maternal emotional risk and infant distress predicted lower maternal sensitivity. Over and above these covariates, higher mother-oriented cry processing and sleep disturbances predicted lower maternal sensitivity. Sleep disturbances also moderated both (a) mother-oriented and (b) infant oriented cry processing in the prediction of maternal sensitivity, albeit marginally for the latter. Mother-oriented cry processing was only significantly associated with lower maternal sensitivity among mothers with higher sleep disturbances, consistent with the view that poor sleep would amplify the likelihood of mothers acting on their negative cry processing (Figure 1, Panel A). Infant-oriented cry processing was only associated with higher maternal sensitivity among mothers with higher sleep disturbances suggesting infant-oriented cry processing promotes higher sensitivity in the context of disrupted sleep but makes no difference among mothers whose sleep was less disrupted (Figure 1, Panel B). No other scales on the PSQ demonstrated main or interactive effects in relation to sensitivity.

These results demonstrate the number of times mothers are awakened at night undermines the quality of their parenting in the early postpartum, both as a main effect and in conjunction with other maternal characteristics. Given most mothers' sleep is disrupted in the early post-partum months, efforts to help mothers cope with and accommodate for sleep loss at night are important to promote optimal parenting.

S.10: Real-time dynamics of infant physiological regulation

S.10.01: Testing Porges' Polyvagal Theory: Evidence for real-time RSA changes within unprompted infant distress (Madden-Rusnak)

Anna Madden-Rusnak[1], Meg Micheletti[1], Kaya de Barbaro[1]

[1]The University of Texas

Porges' foundational Polyvagal Theory of parasympathetic regulation (1991) states that activity of the vagus nerve modulates moment-by-moment changes in adaptive behavior during stress. Numerous studies have supported aspects of this theory, finding that engagement of the "vagal brake" during stressful lab tasks, measured as decreased respiratory sinus arrhythmia (RSA), predicts better infant behavioral regulation (see review: Sacrey et al, 2020). However, most prior work examines these hypotheses at a low temporal resolution, averaging RSA across tasks often upwards of 1-2 minutes. Thus, it's unknown whether vagal modulation truly functions to regulate behavior at immediate timescales. Only recently have reliable methods been published for calculating RSA dynamically and at a significantly higher resolution (Abney et al., 2021). Thus, our first aim was to test hypotheses of the Polyvagal Theory using high-resolution real-time patterns of RSA. Additionally, given that nearly all research on this topic has utilized structured tasks (e.g., still-face, arm restraint, etc.) to induce infant stress, the second aim was to test for these dynamics within naturally occuring, unprompted instances of infant distress (crying) and distress resolution.

Current Study. Infants (n= 38, age: 1-10mo, 22 females) and their mothers were video-recorded while wearing a chest-mounted ECG sensor in their home for 90 minutes. All spontaneous infant cry events

were annotated. A 15-second moving window technique was used to create a 5Hz timeseries of RSA (Abney, et al., 2021).

Event-related analyses compared time-locked dynamic RSA change in the 30-120 seconds prior to and following onset and offset of cries. We calculated RSA change by subtracting the RSA value in the sample prior to cry onset or offset from the RSA timeseries. As cry duration was variable, we included data up to 76.6 seconds (75th percentile) for cry onset comparisons. To determine if RSA changes differed significantly from chance, we used a bootstrapping technique to create 95% confidence intervals from 1000 randomly shuffled RSA values. To investigate possible differences between infants reported as good vs. poor regulators, we used a median cutoff on the Effortful Control (EF) sub-scale of the Infant Behavior Questionnaire-RF-VSF (Gartstein & Rothbart, 2013).

Results & Discussion. Averaging across all cry events and infants, continuous RSA significantly decreased between 36.6-76.6 seconds following distress onset, with RSA never rising above the lower CI for over 3.0 consecutive seconds within this range ($p < 0.05$; Figure 1A). RSA did not show the expected increase following distress offset (Figure 1B). Infants reported to have higher EF showed the expected decrease in RSA during cries and increase in RSA following cry resolutions, while infants low in EF showed neither pattern (Figures 2A, 2B).

Results provide the first empirical evidence confirming Porges' Polyvagal Theory in spontaneous and naturalistic episodes of infant distress. That RSA dynamically decreases following cry onset suggests that the vagal brake does in fact adaptively modulate nervous activity in tandem with behavior during stress, and furthermore, that high/low regulation groups differ suggest that these adaptive patterns are aligned with individual differences of caregiver reported temperament.

S.10.02: Mother-infant eye contact marks changes in physiological regulation and synchrony (Abney)

Drew, Abney[1], Elizabeth DaSilva[2], BennettBertenthal[2]

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In early infancy, the ability to regulate emotions develops rapidly in response to synchronous mother-infant interactions. Critically, emotion regulation involves a dynamic process characterized by moment-to-moment coordination of mothers' and infants' affect. One important index of this coordination is Mutual Gaze (MG) during which the infant and mother share attention and co-regulate their behavioral and physiological responses. The goal of the current study was to systematically assess the relation between mother-infant mutual gaze and their physiological responses.

Mothers and their 4- to 6-month-old infants (n= 114) participated in the study. Dyads were tested in the standard face-to-face-still-face paradigm. Behavioral and physiological measures (using ECG) were recorded and coded during each of the three phases of the paradigm (play, still-face, reunion). MG was measured as frames (200ms) when the infant and mother were both directing their gaze towards their partner's face. To compute a time series of parasympathetic dynamics for infant and mother, respiratory sinus arrythmia (RSA) was computed using a sliding window method (Abney, DaSilva, Lewis, & Bertenthal, 2021) which provided an RSA time series at 5hz (using a 15-second moving window). RSA synchrony was computed by submitting detrended RSA time series of infants and mothers to cross-correlation and indexing the lag-0 cross correlation coefficient.

Because this study is focused on dyadic repair of affective communication, we limit our analyses to the Reunion phase. Each dyad had about 10 (M=9.81, SD=4.67) MG bouts with an average duration of 4.85s (SD=6.76s). To test if there was a relationship between RSA levels, MG, and synchrony, for each MG bout, we extracted the average RSA during the bout, the phase-level RSA synchrony estimate, and the average RSA during a randomly-sampled bout of identical duration used as a control. We used linear mixed effects models with average RSA during the MG bout as the dependent variable, phase-level synchrony estimates as the fixed effects, and a maximal random effects structure. For infants, we observed a positive relationship between phase-level synchrony and average RSA during MG, B=0.36, p=.007. For the mother, we observed a negative relationship between phase-level synchrony and average RSA during MG, B=-0.37, p=.007. Importantly, we did not observe any significant relationships between average RSA during MG bouts and phase-level synchrony from matched randomly-sampled bouts, ps>.891. Figure 1 provides the first look at how dynamic changes in infants and mothers RSA and RSA synchrony is associated with the onset of MG bouts. Specifically, both infants' and mothers' RSA begin to increase within seconds preceding of the onset of MG bouts, and even more importantly, RSA synchrony begins to increase in a positive direction within seconds preceding and peaks at the onset of MG bouts.

These results provide new evidence that parasympathetic nervous system responses in early infancy are associated with both changes in physiological synchrony between infants and mothers as well as in-the-moment behaviors such as MG. Moreover, these results provide preliminary evidence that eye contact and shared attention are anticipated by the functioning of the autonomic nervous system.

S.10.03: Examining the Dynamics and Real-Time Effects of Mother-Infant Heart Rate Synchrony Across Episodes of Naturalistic Infant Distress (Micheletti)

Megan Micheletti[1], Anna Madden-Rusnak[1], Kaya de Barbaro[1]

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Mother-infant physiological synchrony is broadly thought to benefit child development by providing a scaffold for infants to develop their self-regulation, with benefits unfolding on timescales ranging from minutes to years. More recently, a competing theory has emerged: that in some contexts, an asynchronous physiological response is more beneficial for scaffolding real-time infant emotion regulation. Specifically, during periods of heightened infant arousal, like infant distress, a mother increasing her arousal synchronously with her infant may further exacerbate her infant's distress. Here, we provide the first evaluation of mother-infant physiological synchrony across episodes of everyday infant distress to evaluate the role of synchrony vs. asynchrony in fostering real-time emotion regulation. The objectives of this study were to: 1) determine if mother-infant physiological synchrony is more likely to occur during periods of infant distress vs. non-distress, and 2) examine whether the degree of mother-infant physiological synchrony achieved during infant distress predicts real-time emotion regulation, i.e. time to distress resolution.

41 infants (M=4.4, SD= 2.6 months) and their mothers were videotaped in their homes continuously for 90 minutes. Spontaneous episodes of infant distress (including fusses and cries) were coded by trained research assistants. Mother and infant heart rate were measured by chest-worn Movisens ECG sensors. Interbeat-intervals (IBIs) were extracted offline using ARTiiFACT and interpolated at 2 Hz.

To quantify physiological synchrony, we conducted cross-recurrence quantification analysis (CRQA) as it is well-suited for time-series that are non-stationary or have complicated dynamics, such as IBI data. We conducted analyses in R using 'crqa' (Wallot & Leonardi, 2018) and optimized parameters to a radius of .12 for all diagonal cross recurrence plots (DCRP). To measure degree of synchrony achieved during the distress episode, we used DCRP to calculate percent recurrence at lag-0, indicating the percentage of recurrence between mother's and infant's time series at the same point in time. Given our nested data (multiple distress episodes per dyad), we ran linear mixed effects models with the dyad as the random effect. We also created shuffled IBI time series from non-distress data for mother and infant to evaluate physiological synchrony in distress vs. non-distress episodes using a paired t-test at the level of individual distress episodes.

Physiological synchrony did not systematically vary across periods of distress vs. non-distress (t=0.02, p=.981, Fig 1). Within dyads, the degree of mother-infant physiological synchrony achieved during a distress episode did not predict time to distress resolution (B=-10.6, p=.751). Across all distress episodes, younger infants had significantly longer bouts of distress (B=-2.2, p=.008), but infant age did not predict physiological synchrony during the distress episode (B=0.1, p=.766, Fig 2).

Results show that synchrony (or asynchrony) between mother and infant heart rates during spontaneous infant distress at home is not an indicator of real-time infant emotion regulation, particularly at this short temporal scale. We contribute to a growing body of research emphasizing the contexts, timescales, and dynamics of physiological synchrony that matter for scaffolding infant self-regulation.

S.10.04: Moment-by-Moment RSA Synchrony Between Mothers and Infants at Multiple Levels & the Influence of Context (Stallworthy)

Isabella Stallworthy[1], Jed Elison[1], Daniel Berry[1]

University of Minnesota[1]

Existing evidence reveals the importance of parasympathetic nervous system synchrony between parents and infants as a core socio-regulatory process (Feldman et al., 2016). Yet open questions remain about the dynamic nature of parasympathetic synchrony at different temporal scales and the influence of context. The present study addresses these gaps by employing a dynamic systems approach to investigate different levels of parasympathetic synchrony between mothers and infants "moment-by-moment" during an everyday interaction perturbation.

Current Study. Forty-four typically developing infants (M age=9 mo) and their mothers completed a 6-minute modified 'Still-Face' task during which mothers interacted with their infants prior to responding a series of text messages for 2 minutes followed by resumed interaction. Respiratory sinus arrhythmia (RSA), an index of parasympathetic nervous system activity, was calculated from ECG for mothers and infants at at each 1 second of the task (Gates et al., 2015). Functional data analysis (Ou et al., 2019) and mixed effects models were used to calculate RSA synchrony at different temporal levels: state (RSA value/position synchrony), change (RSA 1st derivative/velocity synchrony), and process (RSA 2nd derivative/acceleration synchrony) (Deboeck et al., 2013) and any moderation by task epoch (i.e., face-to-face, texting, re-engagement)

Hypotheses. Based on existing literature (Skoranski et al., 2107; Lunkehheimer et al., 2015;2018; 2021; Ostlund et al., 2017), we hypothesized significant positive state and change synchrony, with attenuation (Feldman et al., 2011; Feldman & Eidelman, 2007) during the texting portion of the interaction task when mothers disengaged from their infants. Investigations of process synchrony and the presence of homeostatic processes, or synchrony across different RSA levels, were exploratory.

Results. Preliminary results reveal significant positive RSA synchrony at all levels -state ($p=0.009$), change ($p<0.001$), and process ($p=0.012$) -between mothers and infants. Results suggest that face-to-face engagement is associated with relatively high RSA synchrony at all levels. Maternal disengagement while responding to text messages immediately disrupts only RSA state synchrony ($p<0.001$; Figure 1) with her infant, while maintaining change and process synchrony. Re-engagement is associated with attenuated forms of all RSA synchrony (p's<0.001) despite resumed social interaction. Exploratory analyses also suggest the presence of a putative dyadic "homeostatic" or regulatory process (Deboeck et al., 2013; Saxby et al., 2020) unique to the texting period (p's<0.03) during which maternal RSA acceleration and infant RSA velocity are negatively coupled.

Findings expand our scientific understanding of the temporal levels at which parasympathetic synchrony occurs between mothers and infants. Results suggest that parasympathetic synchrony occurs at 1-second resolution in support of existing theory (e.g., Porges, 2007; Porges & Furman, 2001). Further, dyads synchronize their RSA at multiple levels of state, change, and process, and everyday perturbations may disrupt RSA synchrony, including some delayed effects that emerge only upon re-engagement. Findings offer a theoretically consistent approach to modeling RSA synchrony "in the moment," with novel insights about timing and potentially distinct parasympathetic mechanisms underlying social exchange.

S.11: Sitting, reaching, and grasping: How early motor skills give rise to foundational cognitive abilities

S.11.01: Reach-to-Grasp Behavior: Visual selection at work in 5- to 11-month-old infants (Corbetta)

Daniela Corbetta, Sabrina L. Thurman, Rebecca F. Wiener, Joshua L. Williams, Yu Guan

Planning goal-directed reaching typically involves the prior visual selection of a target area that one intends to grasp. For example, grasping a cup may involve looking at the handle of the cup prior to reaching for it. We know from eye-tracking studies conducted with adults that well-practiced reachers are adept at making such goal selection decisions in the moment and at bringing their hand accurately to the selected area. No existing studies, however, have examined young infants' ability to perform such precise visual-motor matching or even investigated when such ability might emerge in the first year of life. In this study, we used eye-tracking with objects that would entice visual scanning to examine (1) whether infants would visually select specific object areas prior to reaching for them and (2) whether they would successfully bring their hand to those pre-selected object locations. Sixty-eight infants aged 5, 7, 9, and 11 months were presented with four differently shaped objects for reaching (drumstick, dumbbell, plain rod, cup) presented one at a time over a series of trials. Most of these objects were 18cm long to entice visual scanning. In addition, because infants display little inhibition for reaching and are slow encoders, we held the objects out of their reach at a distance of 60cm for 5s to give them the opportunity to visually select an area of the object prior to moving the object in their reaching space for grasping. For each trial, we coded the area of the object where they looked the longest (i.e., largest

accumulated looking duration) and also identified the object area where the first hand contact occurred. Mixed Model analyses performed on the looking patterns on the objects revealed increased visual selection from 5 to 11 months of age. Overall, infants looked more at the top of the cups, at the spheres of the drumsticks and dumbbells, and at the middle area of the rods (all ps < .0001); these areas of focus increased significantly with age (all ps < .028), except for the dumbbells. For reaching, a similar trend was observed. The object area often touched first by the hand was the top, but also the handle for the cups, the spheres for both the drumsticks and dumbbells, and the middle of the rod for the plain rods (p < .001). With age, these visually selected object areas were increasingly targeted by the infants. Finally, additional analyses revealed that the first-looked object area predicted the object area most looked, which in turn predicted the area of the object subsequently contacted with the hand. Thus, these findings reveal that when given time to look at an object out of reaching space, infants can visually select an object area to contact and subsequently grab. These findings indicate that infants' ability to plan a reach and selectively decide where to grasp it develops in the first year of life.

S.11.02: Early grasping trajectories and later neural representations of infant fingers (Horger)

Melissa N. Horger, Kaitlyn Campbell, Peter J. Marshall, Valentina Parma

Through the second year of life, infants become more skilled at grasping, progressively reducing the number of fingers employed until only engaging with the thumb and index finger (i.e., pincer grasp). It is unknown whether the emergence of the pincer grasp, which occurs at approximately 9 months of age, is related to changes in neural body representations. This project represents the first attempt to combine a detailed behavioral account of the pincer grasp and later body representations in the sensorimotor cortex. Videos of naturalistic grasping were analyzed frame by frame; the kinematics of infants' grasps were extracted via a semi-automated system (TrHandy, Ab.Acus). In the present analysis, we focus on distances between digits, including thumb-to-middle (TM) and thumb-to-little (TL), and latency to first contact. To assess body representations, we derived the somatosensory mismatch negativity (sMMN) by recording EEG during tactile stimulation of infant fingers, with a focus on the relations between the middle finger and thumb and the middle finger and little finger. The sMMN provides a novel tool that has proven to be useful in the study of body representations, particularly around the segmentation or categorization of the body into different functional parts. The sMMN is derived from the EEG response to tactile stimulation of two body parts, with sMMN amplitude being greater if these body parts are not frequently used together in actions. We hypothesize that infants manifesting a more mature pincer grasp at 9 months (defined in kinemtic terms as greater TL and TM), will at 14 months (when the pincer grasp is established) show greater sMMN amplitude for the contrast between the thumb and the middle finger. Caregivers of 15 infants submitted videos of their infant reaching and grasping a pencil at 9 months (M = 293.21 days). Seven infants displayed a more mature grasp, with greater TM and TL distance than average (MTM = 58.35mm; MTL = 75.14mm). Latency was inversely related to digit distance; mature graspers were faster in executing the reach. Initial EEG analyses demonstrated an sMMN response to finger stimulation, as in previous work. Grand mean ERP waves displayed a consistent negative difference at FC1 and FC2 when comparing stimulation to the little versus middle finger. When comparing the thumb and middle finger, the sMMN response was less consistent. EEG data collection and analysis is ongoing. The presentation will link different trajectories of finger involvement in grasping and emergence of the pincer grasp to the sMMN, with a focus on the sMMN response elicited to a contrast of the middle finger and thumb, as a neural measure of the relations between these digits.

S.11.03: Self-reaching is an intermodal gateway to mirror-self recognition (Chinn)

Lisa K. Chinn, Katarina S. Patton, Claire F. Noonan, Jeffrey J. Lockman

Around the middle of the second year, human infants begin to recognize themselves in mirrors, an important milestone in the acquisition of awareness about the self. However, little is known about the mechanisms that underlie the development of mirror self-recognition (MSR). An influential account is that the development of MSR is a cognitive achievement tied to the ability to represent the self. In contrast, we investigate the hypothesis that the development of MSR is the product of intermodal learning associated with reaching to one's body. In Study 1, a small vibrotactile stimulus was placed at different locations on infants' faces (ears, mouth corners, chin, center forehead, lateral temples), one by one. Participants' (n=24, starting age=2-6 months) responses were recorded longitudinally approximately every two to three weeks until they reached to all target locations (ending age=6-12 months). Infants significantly improved in localizing and reaching to the stimuli across the first year (Wald x2 = 182.00, p < .001; Figure 1), with infants achieving success earlier for stimuli that were placed in perioral region of the face (i.e., mouth, chin). Next, in Study 2, some of these infants (n=17) returned to the lab for monthly visits beginning at approximately 14 months and continuing until they demonstrated MSR or became older than 20 months. During each visit, infants were prompted to reach to the visual-vibrotactile face target while looking in the mirror prior to performing the classic mirror mark task. The goal was to provide infants with experience with contingent proprioceptive, tactile, and visual information. We hypothesized that with such experience, infants would learn about the intermodal redundancies associated with reaching to one's body, thereby enabling them to reach to a mark on their body that was only visible in a mirror--as required in the classic mirror mark task. One control group was age-matched to the original group's first instance of self-recognition, and a second control group participated in longitudinal monthly visits where they performed only the mark task during each visit. Results indicated that the experimental group demonstrated MSR significantly earlier than both control groups. In the experimental group, 15 out of 17 infants indicated MSR (mean age of self-recognition=16.32 months). By contrast, for the age-matched control group, only 3 out of 15 infants indicated self-recognition (Fisher's exact test p <.001; Figure 2). Additionally, longitudinal control group infants gained MSR significantly later than the experimental group. During the mark task, we found that experimental group infants were not simply repeating a manual response learned during the vibrotactile trials; they were more likely to grasp the three-dimensional vibrotactile stimulus but touch or wipe the mark. Together, the results indicate that self-reaching can promote the development of mirror self-recognition. Self-reaching functions as an intermodal gateway through which infants learn how to localize and reach to stimuli on their bodies, including those that can be only seen in a mirror. The findings suggest that early sensorimotor experiences centered on the body contribute to broader forms of self-knowledge that underlie awareness of the self.

S.11.04: Sit, pay attention, play: The relationship between attention and sitting ability in typically developing and motor delayed infants. (Soker-Elimaliah)

Sapir Soker-Elimaliah, Michele Goncalves Maia, Karl L. Jancart, Regina T. Harbourne, Sarah E. Berger

Learning to sit independently prompts a cascade of subsequent developmental milestones. Paradoxically, while freeing infants' hands facilitates manual exploration and new opportunities for learning (Soska et al., 2010; Soska & Adolph, 2014), mastering postural control also imposes a cognitive load that can elicit cognition-action trade-offs (Berger et al., 2017; Berger et al., 2018). In the Focused

Attention (FA) task, infants sit in parents' laps or a high chair as they explore toys (Lawson & Ruff, 2001). However, previous examinations of infants' FA rarely account for attentional demands when infants with and without motor delay sit independently. This study examined 1) how differences in sitting conditions impact infants' ability to focus attention during object exploration and 2) whether motor delay changes the relationship between sitting ability and focused attention. Participants were 49 typically developing (TD) infants (23 males; Mage=7.15 mos) and 20 infants with motor delay (11 males; Mage=11 mos). All were pre-crawling, independent sitters. The Angles Video Goniometer© app calculated angular displacement of the trunk immediately after infants were placed in sitting, causing a perturbation to posture. TD infants received the FA task twice: supported in a highchair and sitting independently on the floor (Berger, et al., 2019). Delayed infants received the FA task as part of a play assessment in a related study (Harbourne, et al., 2021). Measures of FA included mean duration of FA bouts and global focused attention score (GFA; five-point scale of quality of FA, see Lawson & Ruff, 2001). We considered high GFA as scores 3-5, and low GFA as scores 1-2. For TD infants, an ANCOVA with sitting condition (supported, independent) as a within-subjects factor and angular displacement as a covariate on mean duration of FA bouts revealed main effects of condition, $F(1,47)=5.69$, $p=.02$, $\eta p2=.12$ (Figure 1), and angular displacement, $F(1,47)=6.29$, $p=.02$, $\eta p2=.12$. Pearson correlations revealed a significant relation between angular displacement and duration of FA bouts during independent sitting ($r(49)=.39$, $p<.01$), but no relation during supported sitting. For infants with motor delay, there was a significant negative relationship between angular displacement and GFA ($r(20)=-.41$, $p=.04$). Figure 2 shows a trend towards an interaction, whereby there was no effect of GFA on angular displacement for typical babies, but delayed infants with low GFA had greater angular displacement. An increase in trunk displacement from a perturbation may indicate more adaptive postural control in TD infants because they can easily regain stability while maintaining high attention. Postural control in motor delayed infants is likely to demand a greater share of infants' attention, reducing available resources for focus on objects. Postural stability, either because sitting was supported or because infants were skilled independent sitters, may allow greater attention to object exploration. However, in children with motor delays and less stability in sitting, GFA may suffer as resources are allocated to maintaining posture. Implications for early intervention with infants with motor delays will be discussed

S.12: Temporal structure in infants' everyday experiences

S.12.01 Infant vocalizations cluster with others' singing in everyday soundscapes (Abney)

Drew Abney[1], Caitlin Fausey[2], Swapnaa Jayaraman[3], Lauren Slone[4],Linda Smith[3]

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Humans develop in a social world rich with regularities in the behaviors of other people. Throughout development, two important sources of information are presented by faces and hands. Here, we investigated how the temporal properties of these two information sources unfolded through the first year of development. The visual scenes were collected by infants wearing head cameras during natural, unconstrained everyday activities.. The major finding is that visual experiences of faces and hands are characterized by bursts of temporal clusters of occurrences that are made up from short temporal repetitions of events in addition to episode-level repetitions of clusters of events over longer delays.

The head camera images were collected from a cross-sectional sample of 22 infants (14 female) who were all between the ages of 1 and 11 months of age. Videos were recorded at various times of day and

in multiple locations (home, playground, store, church, etc.) while infants were engaged in a variety of activities. The mean length of video collected per infant was 4.8 hours (SD=1.19) yielding 101 hours of head camera video (recorded at 30Hz) and over 10.9 million frames. For analysis, the data were pooled into two age groups, Younger infants from 1 to 6 months of age (N=10) and Older infants, 7 to 11 months of age (N=12) with approximately 50 hours video for each age group. Frames were sampled at a rate of 1 every 5 seconds. The total number of analyzed images was 66,734: 36,048 for the Younger group of infants and 30,686 for the Older infants. Each sampled scene was coded for the presence of faces and hands (see Figure 1).

We analyzed the cluster properties such as how many consecutive events were in a cluster of activity and how many clusters of events occurred every hour. A 'cluster' of events was indexed by (1) identifying consecutive frames with the same event, with minimal gaps of no events which were segmented by (2) a long interval before the cluster of no events and a longer interval after the cluster of events (see Figure 2). Overall, across event type and age group, there were ~2-3 runs of events in each identified cluster, which therefore contains ~35-45 seconds of information. Overall, the Younger group (Face events: 14.98 [14.80,15.16]; Hand events: 11.88 [11.52,12.23]) had less frequent clusters (per hour), but each cluster had more content relative to the Older group (Face events: 15.09 [14.95,15.24]; Hand events: 19.97 [19.83,20.11]).

The visual ecology of infants have temporal patterns that include clusters of information. The properties of these temporal patterns appear to change as a function of information type and by age. Having clustered bouts of information might aid in encoding and long-term retention of specific to-be-learned objects.

S.12.02: The temporal structure of infant locomotor activity (Hoch)

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Parents celebrate their infant's first word around the infant's first birthday. But infants practice vocalizations before their first word (e.g., Roy et al., 2015), and continue to do so as they add sounds and conventional words to their vocal repertoire. Therefore, infants' immense amount of vocal practice is likely a critical training ground for the development of language. Infants who produce mature vocalizations and receive adult responses have large vocabularies (Lopez et al., 2020), and infant object-directed vocalizations may signal a readiness to learn (Goldstein et al., 2010). What do infant vocal training schedules look like for infants across the second year of life--this period of rapid growth in sounds and words--and do they differ for infants learning different languages. Here we quantified the temporal structure of vocalizations produced by 100 infants during everyday activities in the home environment. We focused on infants from European-American (EA) and Latine backgrounds to broaden understanding of infant behavior and development beyond the typical population of infants represented in developmental research.

European-American (N=53) and Latine (N=47) 13-to-23-month-old infants were recorded at home during everyday activities for an average of 103 minutes (SD=17.42). Infant and mother language interactions were transcribed in English and/or Spanish in Datavyu at the utterance level. Utterances were separated by pauses and grammatical closure (for mother language). Temporal structure of

vocalizations by each speaker was quantified using Burstiness (Kim & Jo, 2016), a measure that considers the distribution of "timespans" (i.e., time distance between onsets of adjacent vocalizations) (Figure 1). Burstiness values range from -1 (periodic) to +1 (bursty), and they differentiate rhythmic activity with equal intervals of silence (periodic) from clusters of activity (bursty). Burstiness values of 0 are consistent with random temporal structures.

Analyses operated on 61,233 infant vocalizations (23% by Latine infants). Temporal profiles of infant vocalizations were bursty and similarly distributed across both samples, ranging from 0.10 to 0.58 in EA infants (M=0.34) and from 0.08 to 0.55 in Latine infants (M=0.30). Estimates of temporal structure did not differ between EA and Latine infants, $t(96.88) = 1.86$, $p=.066$. Notably, EA and Latine infant observed B values were significantly greater than simulated B values for random patterns of vocalizations (Figure 2). We quantified the temporal structure of mother vocalizations as reference, finding that mother vocalizations were also bursty in both samples.

Findings suggest that the training schedule for EA and Latine infants in their second year of life consists of many vocalizations organized in clusters interspersed with silence. That is, by 13 months of age infants learning English or Spanish have already adopted the timing of vocalizations characteristic of adult vocalizations. Bursty temporal patterns may be a critical aspect of the inputs for learning, supporting learning mechanisms and coordinated vocal exchanges with social partners. Ongoing analyses quantify temporal structures of different types of infant vocalizations to investigate if full words (e.g., ball) are more bursty than babbles (e.g., lala) and non-speech sounds (e.g., cries). Likewise, we will investigate age-related changes in EA and Latine burstiness estimates.

S.12.03: Temporal structure of infant vocalizations in the home environment (Suarez-Rivera)

Catalina Suarez-Rivera[1],Drew Abney[2], Catherine, Tamis-LeMonda[1]

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Infants generate immense amounts of locomotor practice through short, frequent, time-distributed bouts of activity. Many bouts of locomotion contain only 1-3 steps, but by 4 steps, survival analyses show that the probability of stopping is constant once infants get moving. Infants move more with development, but short bouts are common even after 9 months of walking. Although individual differences in time in motion are stable for infants tested in the same setting, the quality and quantity of movement varies across settings. We present data from 3 experiments that reveal how features of the physical and social environment affect the temporal structure of locomotor activity in walking infants.

Experiment 1: We tested 25 15-month-olds' locomotor activity during solitary free play in a "low-cost" condition (infants wore an unweighted, unpadded snowsuit) and a "high-cost" condition (infants wore a snowsuit loaded with 15% of their body weight; Figure 1A). In the high-cost condition, infants moved less and visited fewer areas in the playroom ($ts(24) \geq 2.8$, $ps \leq .01$). In the low-cost condition, infants moved more in the second half of the play time, whereas in the high-cost condition, locomotor activity was stable over time ($F(1,24) = 5.35$, $p = .03$). In both conditions, infants visited more areas of the playroom in the first half of the play time ($F(1,24) = 21.54$, $p \leq .001$).

Experiment 2: We recorded 40 12- to 20-month-olds' locomotor activity during free play in two toy conditions (locomotor or manual toys) crossed with two social conditions (alone or together with their caregiver; Figure 1B). Infants moved more in the locomotor toy conditions (chased balls, pushed stroller,

etc.) than in the manual toy conditions (mostly sat to play); playing with their caregiver further reduced infants' locomotor activity with manual toys because caregivers mostly watched from the sidelines for locomotor toys, but joined infants' play for manual toys (Fs(1,39) ≥ 27.97, ps ≤ .001). Regardless of condition, infants' locomotor activity was stable between the first and second halves of the play time (Fs(1,39) ≤ 3.30, ps ≥ .08).

Experiment 3: We observed 30 13- to 19-month-olds and their mothers playing together and recorded each partner's locomotor activity and step-to-step location. Although infants moved more than their mothers (ts(29) ≥ 2.93, ps ≤ .01), dyads spontaneously synchronized their locomotor behavior. Measures of infants' and mothers' locomotor activity were highly correlated (rs ≥ .68, ps ≤ .001), and most dyads' spatiotemporal paths through the playroom were so similar that one partner's path could be used to identify the other's (Figure 2). Cluster analyses revealed that, for about half the dyads, infants moved first and their caregivers followed. For the second half of dyads, both partners moved to and from their partner's locations. Infants initiated more simultaneous bouts of locomotion (64%) than their mothers and led most bouts (82%) when both partners were in motion.

Together these studies show that the temporal structure of infants' locomotor activity is sensitive to locomotor costs, the affordances of toys, and the availability of play partners.

S.12.04: Infant vocalizations cluster with others' singing in everyday soundscapes (Fausey)

Caitlin Fausey[1], Jennifer Mendoza[1], Heather Anderson[1], Allyson Kuznia[1], Alice Wang[1], Christine White[2], Madison Edgar[1]

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Introduction. Evidence across methodologies, timescales, and communities suggests that coordinated sound streams in which infant vocalizations and caregiver speech are temporally proximal drive language development (Goldstein & Schwade, 2008; Kuchirko et al., 2018). Auditory experiences in everyday life include not only speech but also music (Costa-Giomi & Benetti, 2017; Mendoza & Fausey, 2021). Given that infants often prioritize attention to singing (Shenfield et al., 2003), could singing also structure infants' everyday opportunities to practice vocalizing? Here, we quantify associations between singing and infant vocalizations at the daily, minute, and second timescales in everyday life.

Method. We analyzed 467 hours of infants' everyday audio (Mendoza & Fausey, 2021).

Infants wore a digital language processor (LENA; Ford et al., 2008) for up to 16 hours at home (Median=13.13 hours per recording). Caregivers were not told about music or language as analytic targets. One audio recording from each of 35 infants between the ages of 6 and 12 months (M=38.78 weeks) was analyzed.

Annotators identified everyday music by listening continuously to each recording. Musical sounds were operationalized as live or recorded singing, instrument playing, and pitched, rhythmic, repetitive patterns that were vocally or instrumentally produced. Annotators marked the onset of a music episode upon hearing a musical sound and its offset upon no longer hearing music. Annotators next identified the musical features (vocal, instrumental, live, and/or recorded), voices, and tunes within these episodes (Mendoza & Fausey, 2021). Inter-rater agreement exceeded .90 for all annotations.

Infants' vocalizations were automatically identified ("child vocalization count"; Ford et al., 2008; see Cristia et al., 2020, for discussion of automatic classification accuracy). Each everyday audio recording is represented as a timeseries of seconds, some of which are live vocal music and/or infant vocalizations (Anderson et al., 2021).

Results. 315 minutes of live vocal music (Median=6.52 minutes per recording) and 549 minutes of infant vocalizations (Median=15.00 minutes per recording) arose in this sample of infants' everyday audio. Importantly, manually annotated live vocal music and LENA-identified infant vocalizations were not one-and-the-same; only 14% of seconds with live vocal music also included infant vocalizations. We highlight two discoveries about clustered opportunities for early language practice.

First, infants who encountered more live vocal music during their day also vocalized more ($r(33)=.48$, $p=.003$; Figure 1). Second, infant vocalizations occurred in close temporal proximity to live vocal music. On average, 2% of infants' daily vocalizations occurred within 5 seconds of live vocal music. 26% of infants' daily vocalizations occurred within 5 minutes of live vocal music and 42% within 10 minutes. Adult speech was also often part of these audio clusters (Figure. 2).

Next steps. These observations suggest that theories of infants' vocalization practice should include music. Ongoing cross-recurrence quantification analyses (Coco & Dale, 2014) will reveal additional structure among music, speech, and vocalizations across timescales nested within infants' full days, in order to evaluate the intriguing possibility that caregiver singing may extend the duration of individual infant vocalization episodes in a supportive back-and-forth dynamic of audio sustained attention (Yu & Smith, 2016).

S.13: Atypical development doesn’t happen in people, but in the spaces between people: dyadic perspectives on emotion dysregulation

S.13.01: Parent-Infant Co-Regulation of Emotion and Attention in Response to Others? Dynamic Positive and Negative (versus Neutral) Facial Expressions (Aktar)

Evin Aktar, Heleen Vonk, Eliala Salvadori, Cristina Colonnesi

Infants actively construct their social environment from the moment they acquire the ability to coordinate gaze and emotional expressions with the parent at around 2-3 months of age (Messinger & Fogel, 2007). This ability allows infants and parents to coordinate and synchronize gaze and facial expressions with each other during early dyadic interactions (Als et al., 1979; Colonnesi et al., 2012). Following this period, an important transition occurs in social cognition: External objects, people or situations become part of the parent-infant communication, making the interaction triadic (Carpenter et al., 1998). Parents play an active role in the opening of the dyad to the external world by increasingly incorporating novel objects, people and situations into their interactions, and by actively encouraging infants' interest in these forms of novelty (Aureli et al., 2017).

Earlier studies have shown that triadic exchange processes can be activated when infants passively observe computerized presentations of novel objects paired with positive or negative (vs. neutral) facial expressions (e.g., Hoehl & Striano 2010a, 2010b). The present study focuses on infant-parent co-regulation of facial expressions during triadic interactions in a community sample of parent-infant dyads (N= 119, 6- and 12-month-old infants and one of their parents). Participants' naturally unfolding positive and negative affect expressions were observed while the dyads were passively viewing computerized

presentations of dynamic happy, angry, fearful,sad and neutral emotional expressions from male and female strangers. The duration of parent and infant affect displays, as well as parent-infant shared affect, were reliably coded by independent raters. Results were analyzed in mixed regression models accommodating the current repeated data structure.

Preliminary analyses revealed significant differences in the duration of infant facial displays of positive versus negative affect, irrespective of the emotion on screen (see Figure 1.a). Infants were more likely to express positive than negative affect $F(1, 349.44) = 37.52$, $p < .001$). The duration of infant emotion displays was overall longer during happy and sad versus neutral displays on screen. In turn, the duration of parents' positive versus negative affect displays changed as a function of the emotion displayed on the screen $F(4, 805.664) = 33.05$, $p < .001$). Just like their infants, parents were more likely to express positive than negative affect, but this difference was especially pronounced in the case of happy facial displays on screen (see Figure 1.b). Analyses on the duration of parent-infant shared affect expressions revealed a similar pattern, $F(4, 764.77) = 11.54$, $p < .001$. Parent-infant dyads showed overall more positive than negative affect, with this difference being especially clear when the emotion of the stranger displayed on screen was positive (see Figure 1.c). The findings suggest that parents and infants in community samples use positive affect to regulate their own emotions and co-regulate the dyad's emotional experiences. Patterns observed in the parental and shared affect expressions reveal that this positive regulation strategy becomes especially clear during strangers' positive affect displays.

S.13.02: Learning to calm down: The role of observational learning and parental emotion regulation strategies in the emotion regulation process in toddlerhood (Schoppmann)

Johanna Schoppmann, Silvia Schneider, Sabine Seehagen

Emotion regulation is considered to develop primarily through the parent-child relationship, but precise mechanisms that explain when and how toddlers acquire specific strategies are only rudimentarily understood. A recent study investigated observational learning as a learning mechanism for emotion regulation in toddlerhood (Schoppmann et al., 2021). Twenty-four-months-old toddlers (N = 96) participated in two waiting situations designed to elicit negative affect. In between both waiting situations toddlers in the experimental conditions observed an adult distracting herself while also waiting for a desired stimulus. Toddlers in the control condition took part in an age-adequate standardized imitation task. The activity level of distraction was experimentally manipulated, that is toddlers in one experimental condition saw the model distract herself in an active way (that is, playing actively with a push-along animal) whereas toddlers in the second experimental condition saw the model distract herself in a calm manner (that is, playing with Duplo® toys while remaining seated). In the first waiting situation, toddlers' distraction strategy (active distraction; calm distraction) correlated with their temperament such that more active toddlers also distracted themselves more actively (less active toddlers used more calm distraction). The 2 (waiting situation: 1,2) X 3 (condition: active model, calm model, control) mixed-model ANOVA revealed a significant interaction effect, $F(2,93) = 4.58$, $p = .013$, $\eta p2 = .09$, indicating that toddlers demonstrated more distraction after having observed a model distract herself than toddlers in the control condition who had not observed a model distract herself. Post-hoc analyses revealed no differences between experimental conditions. Additionally, more active and more calm toddlers did not profit more from an active model than they did from observing a calmly playing model.

Building on these results, we correlated parental emotion regulation strategies when angry with toddler's expression of negative affect and distraction strategies in a waiting situation in the same sample (Schoppmann et al., under review). Parental emotion regulation strategies were sampled with a self-report questionnaire (FEEL-E questionnaire; Grob & Horowitz, 2014). We found that the parental strategies problem-focused actions, cognitive problem-solving, forgetting and adaptive emotion regulation strategies (overall score) correlated significantly and negatively with toddler expression of negative affect, (smallest $p = .043$). The parental strategy problem focused actions also correlated positively with toddler distraction, $r = .026$, $p = .011$. When controlling for parental education level and child temperament, results changed only slightly.

Results from both studies suggest that toddlers may in part learn to regulate their emotions by observing others, thereby placing a large responsibility on the caregiver who not only has to be competent in co-regulating the toddler but also in regulating him-/or herself in order to help the toddler develop adaptive emotion regulation. These implications highlight the need for prevention and intervention methods to support caregivers in their emotion regulation abilities. Moreover, toddlers seem to imitate an emotion regulation strategy not only from parents, but also from strangers, highlighting the potential of including different caregivers in the process.

S.13.03: The transmission of anxiety and stress states from parent to infant: mechanisms of emotion dysregulation in dyads at elevated likelihood of mental health conditions (Smith)

Celia Smith, Emily Jones, Tony Charman, Sam Wass

Clinically elevated levels of anxiety represent the most prevalent child mental health condition in the world. Available evidence suggests a key role of environmental influences in the development of anxiety, with recent research suggesting that early childhood is a crucial period for identifying environmental risk factors. As yet, though, our understanding of the early life causative factors that contribute to the development of anxiety conditions are limited.

One area that may elucidate the intergenerational transmission of anxiety is that of parent-infant dynamics, as these early relational patterns are thought to play an influential role in later socio-emotional development. Investigations into these dynamics have typically been focused on observable behaviour in short segments of lab-based interaction, despite the need for ecologically valid and multi-method approaches in investigating anxiety precursors.

Here, we present the results of a study in which we used miniaturised wearable microphones and autonomic monitors (heart rate, heart rate variability and movement sensors) to record day-long naturalistic, home recordings from N=74 dyads of 12-month-old infants and their parents. Participating parents completed a clinical screener to test for anxiety symptoms. Our analyses examined how levels of physiological stress tend to cofluctuate during the course of the day in infants and their caregivers. We also examined how the occurrence of spontaneous caregiver vocalisations during the day associates with changes in physiological stress in the caregiver and child.

Our results suggested that, across the whole day, more anxious caregivers tended to show elevated physiological synchrony between their own stress fluctuations and those of their child. Overall, less anxious mothers showed responsivity that was limited to 'peak' moments in their child's arousal; whereas more anxious mothers showed greater reactivity to small-scale fluctuations in their child's

stress state (Figure 1). Less anxious mothers also showed behaviours akin to 'stress buffering' - downregulating their arousal when the overall arousal level of the dyad was high; these behaviours were absent in more anxious mothers.

In addition, we looked at how caregiver vocalisations associate with changes in physiological stress in caregiver and child. Our results suggested that anxious caregivers were more likely to vocalise intensely at states of high arousal (Figure 2a), and to produce intense vocalisations that occurred in clusters (Figure 2d). High intensity vocalisations were associated with more sustained increases in autonomic arousal for both anxious caregivers and their infants.

Our findings have implications for understanding the role of physiological co-regulation in dyads where the caregiver is anxious. They also have implications for using this to inform intervention strategies for dyads needing support for elevated levels of anxiety.

S.13.04: Needing to shout to be heard? Affective dysregulation, caregiver under-responsivity, and disconnection between vocal signalling and autonomic arousal in infants from chaotic households (Wass)

Sam Wass, Louise Goupil, Emily Greenwood

Higher levels of household chaos have been related to worse child outcomes across areas including cognitive and academic development, language and mental and physical health outcomes. One area in particular that has attracted attention are the well-replicated relationships between household chaos and affect dysregulation, as measured using a variety of different measures (Marsh et al., 2020).

How and why chaos impacts on affect dysregulation remains unclear, but research suggests that this is mediated by an impact on caregiver responsivity. Higher levels of household chaos are known to relate to less responsive and more intrusive caregiving styles, with previous studies suggesting that relationships previously observed between household chaos and executive function may be mediated by caregiver responsivity (Vernon-Feagans et al., 2016).

In order to understand why these relationships between household chaos, child affect dysregulation and caregiver under-responsivity emerge, we designed special clothing containing miniature cameras, microphones and autonomic monitors to obtain day-long recordings in home settings from a cohort of N=92 12-month-old infants and their caregivers from the South-East of the UK. All naturally occurring infant vocalisations during the day were hand-coded to differentiate cries from speech-like vocalisations. Our analyses examined changes in autonomic arousal around infant vocalisations, in infant and caregiver. The same participants also attended a lab visit where emotion reactivity was measured using the still face protocol.

Our findings point to a disconnect between what infants communicate and their physiological responses, that are likely to reflect what they experience. Specifically, in noisier households which families self-reported as being more chaotic, infants were more likely to produce negative affect vocalisations such as cries at lower levels of arousal (Figure 1, Figure 2). This disconnection between signalling and autonomic arousal was also present in a lab still face procedure, where infants from more chaotic households showed reduced change in facial affect and slower physiological recovery despite equivalent change in arousal during the still face episode.

Our results also suggest that, in home settings, caregivers from high chaos households show smaller arousal changes around infant vocalisations, in particular around negative affect vocalisations. When we examined how caregiver responsivity varies as a function of infant arousal at the time of the vocalisation we found that all caregivers are less responsive to low arousal vocalisations. However, when we subdivided this by household chaos we found that, whereas low chaos caregivers did differentiate between high and low arousal vocalisations, high chaos caregivers did not. In other words, infant arousal at the time of the vocalisation influenced the likelihood of a caregiver response in low chaos households, but the same relationship was not observed in high chaos households.

Overall, our data suggest that caregiver responsiveness is an important driver of the transition to functional flexibility of vocalisations, and that this transition is at risk in high chaos households. In these households, infant vocalisations (in particular negative vocalisations and high intensity vocalisations) are not more likely to occur at times when infant arousal is elevated; and they do not elicit responsiveness in the caregiver. But they also suggest that vocalisations are an important driver of co-regulation: where this goes right vocalisations have functionality and elicit caregiver responsiveness, aiding recovery in the infant.

S.14: Building infant social competence: Combined influences of caregiving, infant cognition, and infant brain development

S.14.01: Neural and Behavioral Predictors of Twelve-month Joint Attention (Broomell)

Alleyne Broomell[1], Morgan Foss[1], Maya Berkwitz[1], Martha Ann Bell[2] [1]Western Carolina University, [2]Virginia Tech Joint attention is an early form of social cognition, and involves directing attention of others (initiating joint attention; IJA) and responding to bids for shared attention. But how does this social cognition develop? Research has shown that IJA relies on neural and behavioral processes that overlap with executive function (EF), and that both IJA and EF are observable in young children. Moreover, the neural foundation of both EF and IJA may relate to functional connectivity between the frontal and temporal cortex (Broomell et al., 2019). Thus, we hypothesized that infants' early EF and neuroconnectivity would each longitudinally predict development of IJA. Forty-eight infants (24 girls) and parents participated in a longitudinal study with monthly visits across the second half of the infant's first year. Protocol was identical at each visit; here we focus on 6-month predictors of 12-month social cognition. Infant resting baseline EEG was recorded at the beginning of the 6-month visit and frontal-temporal EEG coherence was calculated for left and right hemispheres (F3-T7, F4-T8) as a measure of functional neuroconnectivity. To assess EF, the 6-month-old infants completed a standard EF task (Bell & Adams, 1999) which involved hiding a toy under one of two identical bowls equidistant from a midline point. Infants' eyes were brought to midline after the toy was hidden, and the first look to one of the two bowls was coded as correct or incorrect to assess infants' memory for the location of the toy. At 12 months, infant joint attention was assessed using the Book task from the Early Social Communication Scale (ECSC; Mundy et al., 2003). The experimenter showed the infant an open book and directed their attention to an image with a point. Lower level initiating joint attention (IJA) was coded as infants' eye contact bids to the experimenter or caregiver while actively manipulating the book, or as alternating gaze between eye contact and the book. At 12 months, caregivers completed the MCDI and reported the highest educational degree earned by the mother. Two multiple regression analyses have been conducted to date. First, 6-mo frontotemporal EEG coherence and EF were entered as predictors of IJA at 12 months. Right hemisphere coherence (F4-T8) was the only significant predictor,

accounting for 34% variance in IJA (Table 1). Second, 6-mo EF and infant verbal comprehension (MCDI) were entered as predictors of IJA at 12 months, controlling for parent education level. Infants' EF was the only significant predictor, accounting for 31% of variance in IJA (Table 2). Findings demonstrate that infant EF and frontal-temporal neuroconnectivity are each important for development of IJA. However, development occurs in a social context, with parent-infant interactions laying the foundation for early social cognition (Moore & Corbit, 2019). We thus also hypothesize that caregiver behaviors during caregiver-infant interactions may also influence the development of infant IJA. We will code caregiver behaviors during the spontaneous caregiver-infant interactions that took place between tasks at each visit, with a focus on caregiver behaviors that facilitate infant attention. We will conduct a comprehensive multiple regression with 6-mo EEG coherence, EF, and caregiver behavior predicting 12-mo infant IJA. Results of this comprehensive regression will be reported and implications for building infant social competence across the first year will be discussed.

S.14.02: Examining the Role of Caregiver Behaviors in the Development of Infant Social Cognition (Brandone)

Amanda C. Brandone[1], Zhangzhichun Xu[1] [1]Lehigh University In the first year of life, rapid developments occur in social cognition, including developing an understanding of the intentional nature of human action (Woodward et al., 2009) and the capacity to engage in joint-attentive interactions with social partners (Mundy et al., 2007). Research suggests that a variety of motor, cognitive, and social factors shape social-cognitive development in infancy (de Moore & Gerson, 2020). Infants' social-cognitive development is likely influence by interactions with their caregivers. Caregivers provide regular models of behavior that may feed into infants' developing understanding of intentional action. Moreover, caregivers scaffold infants' joint attention and provide opportunities for learning about action by following and supporting infants' focus of attention (Adamson & Bakeman, 1985). Despite a robust literature on the role of caregivers in infant development, relatively little is known about how caregivers support the development of joint attention and intention understanding. Thus, we examined how individual differences in the amount and quality of caregiver behavior map onto variability in infants' social cognition in the first year of life. Specifically, we examined whether the frequency and responsiveness of parents' infant-directed actions during free play predicted infants' intention understanding and joint attention. Participants included 203 8-12-month-old infants (M = 9.30, SD = .99) and their caregivers. During a single laboratory visit, infants completed an 8-minute free-play session with their caregiver as well as multiple measures of social cognition. We used a microanalytic coding scheme to code the total number of object-directed action bouts parents produced during free play, as well as the proportion of action bouts that followed (rather than redirected) infants' focus of attention ('caregiver responsiveness'). Infants' understanding of intentions was assessed using an anticipatory-looking paradigm (Brandone et al., 2019). Infants' responding to joint attention (RJA) was assessed using gaze-follow and point-follow tasks (Carpenter et al., 1998). Finally, infants' spontaneous attempts to initiate joint attention (IJA) using gestures (pointing, showing, reaching for distal objects) were coded during a semi-structured play task with an experimenter (Mundy et al., 2003). Results revealed considerable variability in caregiver behavior that predicted infants' social-cognitive abilities (see Table 1 for descriptive statistics). Specifically, caregiver responsiveness predicted infants' intentional action processing and use of IJA gestures (but not their RJA performance) after controlling for infant age (Table 2). Thus, infants whose parents were more responsive during free play showed better intentional action understanding and produced more attempts to initiate joint attention with a social partner. Although

the total number of object-directed action bouts parents produced also varied considerably across participants (see Table 1), only the responsiveness and not the general frequency of parental behaviors was related to infants' social-cognitive abilities. Overall, these results are consistent with the hypothesis that responsive caregiver behaviors that follow infants' focus of attention may play a role in shaping the development of social cognition during the first year of life. Questions about the directionality and mechanisms explaining these relationships will be discussed.

S.14.03: Contingent and Responsive Caregiving shapes the Infant Brain to Support Emerging Social Development in the First Year of Life (Bowman)

Lindsay C. Bowman[1], Serena K. Mon[1], Tahl I. Frenkel[2] [1]University of California Davis, [2]Reichman University (IDC) HerzliyaCaregivers are central to infants' social development. In particular, caregiving behavior that is dependent or contingent upon infants' changing cues and states (caregiver responsiveness) have been associated with infants' positive social engagement (e.g., Markova & Legerstee, 2006). Inspired by animal models of social interaction (e.g., Dettmer et al. 2016), it has been hypothesized that, in humans, repeated exposure to caregiving behaviors elicits infant neural responses that over time shape infants' brain development to support adaptive social functioning. However, there has been no empirical examination of how caregiver responsiveness during interactions with infants may influence infants' brain and social development. Indeed, infants' real-time neural responses during caregiver-infant interactions are little explored or understood. Thus, the mechanisms by which caregiver-infant interactions influence infants' brain and emerging social competencies are unknown. In a longitudinal study, we examine how caregiver responsiveness to 4-month-old infants predicts infants' brain maturation/organization, infants' neural responses to their caregiver during real-time caregiver-infant interactions, and infants' social behavior, each assessed 6 months later at 10 months of age. In a home visit, 4-month-old infants interacted with their mothers in unstructured 5-minute face-to-face play sessions. Caregiver responsiveness was measured with both microanalytic and global coding of 'infant-leads-parent-responds interactions' (e.g, Feldman, 1998). Six months later, 10-month-old infants' 'baseline' electroencephalographic (EEG) activity was recorded in lab (while infants viewed floating bubbles) as an index of general maturation/organization of the infant brain. At 10 months, infants' neural responses to their mothers' behaviors during real-time mother-infant interactions were also assessed with EEG. Specifically, in two conditions, mothers were instructed to imitate their infants (to maximize contingent responding), and then to follow instructions delivered through an ear-piece to produce infant-friendly behaviors completely unrelated to the real-time infant behavior (to maximize non-contingent behavior). Infants' neural activity to each type of maternal response (imitative or non-contingent) was extracted. At this 10-month lab visit, infants' empathic and prosocial behaviors were also assessed in response to an experimenter feigning a hurt finger (modelled after common paradigms; Roth-Hanania et al., 2011). Preliminary analyses reveal that greater caregiver responsiveness during interactions with 4-month infants predicted greater 10-month functional maturity and organization in the infant brain (i.e., greater 6-9hz baseline EEG alpha power and greater frontal-temporoparietal EEG coherence; N=59), as well as stronger 10-month infant neural responses to real-time contingent maternal behaviors (i.e., greater event-related alpha suppression to instances of mothers' imitative responses; N=20) (Figure 1). Moreover, infants' brain activity was associated with increased 10-month prosocial and empathic behavior toward the experimenter feigning pain (Figure 2). More complex analyses (e.g., mediation models) will be conducted on the final data set. The significance of these

findings will be discussed in terms of how caregiver responsiveness can shape infants' brain development to support emerging social behavior.

S.14.04: We Need to Talk More about Infants' Social Contingency Detection (Paz)

Yael Paz[1], Tahl I. Frenkel[1] [1]Reichman University (IDC) Herzliya Mother-infant interactions are intricate and dynamic, involving constant adaptation of one's behavior to another's behavior over time. Research attempts to capture the dyadic nature of these interactions and assess their role in shaping infant's social development. Findings suggests that the contingent reciprocal structure of maternal behaviors--i.e. the extent to which behaviors are contingent upon infants' changing cues and states--may be critical in fostering infant social development. Through exposure to contingent reciprocal exchanges, infants are thought to develop an understanding of how the self and other interact, laying a foundation for more complex social understanding. These types of exchanges are behaviorally linked to children's better social adjustment and higher empathic and prosocial capacities (Feldman, 2007; Feldman & Eidelman, 2009). However, from an individual differences perspective, an unanswered question remains: are all infants able to benefit from mother's contingent reciprocity at the same level? Many studies focused on infants' contingency detection (CD) as a marker for early learning abilities (Tarabulsy et al., 1996). Yet, there is a paucity of research dedicated to the study of infants' contingency detection in social situations (S-CD), despite the link between CD and social deficiencies (Northrup et al., 2017). S-CD was found to be associated with contingent learning in non-social situations while remaining a distinguished ability (Reeb-Sutherland et al., 2012). In a longitudinal study (N=151), we hypothesized that infant's S-CD will be a limiting factor, moderating predictive links between maternal contingent reciprocity assessed in early infancy, and child social adjustment assessed in later infancy and preschool. Maternal reciprocity was observed during freeplay at 4-months, infants' S-CD was assessed using the still-face paradigm at 4 and 10-months. Infants' social abilities were assessed at the end of the first year of life (observed prosocial behavior), and when children were 4-years old (maternal report on child's peer problems using the SDQ questionnaire). Results supported our hypothesis. Infants' S-CD at 4- and 10-months moderated the link between maternal reciprocity and infants' prosocial behavior at the end of the first year of life (4-months S-CD: β=.38, p=.007; 10-months S-CD: β=.27, p=.029). At both ages, maternal reciprocity predicted prosocial behavior only for infants with high levels of S-CD, but not moderate or low levels of S-CD. Additionally, S-CD at 10-months moderated the link between early maternal reciprocity and problems with peers at 4 years (β=-.25, p=.041). Maternal reciprocity predicted fewer peer problems, but only for children with high S-CD; no association was found for children with low or moderate levels of S-CD. In conclusion, infants' S-CD abilities were found to moderate the link between maternal contingent reciprocity and social behaviors examined at the end of the first year of life and preschool. The findings shed light on a somewhat neglected ability, the social aspect of CD. We will discuss possible directions for future research emphasizing the importance of studying S-CD to better our understanding of normative and abnormal social development (i.e., ASD).

S.15: Developmental origins of body representations and self-awareness

S.15.01: Neural correlates of self-recognition in 6- to 8- month-old infants (Filippetti)

Silvia Rigato[1], Eleanor Richardson[1], Maria Laura Filippetti[1] [1]University of Essex Introduction: Self-recognition, i.e. the ability to identify one's own facial features as being part of the self, is thought to develop with the emergence of overt self-directed behaviours, e.g. embarrassment in front of a mirror at around 24 months (Rochat, 2009). However, infants' looking behaviour studies suggest that infants

show a visual preference for other- vs self-face well before displaying overt behaviours in front of reflective surfaces (e.g. Bahrick, Moss & Fadil, 1996), suggesting a familiarity effect to the self. Yet, one's own face is not just familiar. The self-face holds a special status in the way we may distinguish it from others, and recognise it, as our own. This study will disentangle the role of familiarity and own-face specificity for self-recognition by examining ERP responses at both N290 and P400 (face-selective components) as well as Nc (familiarity). Experiment 1 compares the self-face, another peer's face, and the mother's face; Experiment 2 compares images of the self-face morphed into another peer's face. With the morphing method (Devue & Brédart, 2011), we examine at what point the self-face is no longer processed as self and instead starts to be processed as the other-face, and hence loses its self-specifying features. Hypotheses: If N290 and P400 ERP components indicate own-face specificity, we should observe a distinct neural signature for infants' processing of their own face. In addition, as the percentage of other being incorporated into the self-image increases, amplitude of these ERP components will decrease. The mother's face represents a visually familiar stimulus stored in long-term memory; thus, we anticipate that this stimulus will elicit a greater Nc amplitude compared to the self-face that is less visually experienced. Study population:We will test 76 full-term, healthy 6-to-8-month-old infants. We determined sample sizes through power analyses (G*Power) using medium effect sizes and at least 80% power to detect a significant effect of Face Type on the ERP component, in Experiment 1 and 2 separately (N = 38 for each experiment). Methods:For Experiment 1, the experimental stimuli are images of the infant's own face, another peer's face and their mother's face, whereas for Experiment 2 the images used are of the infant's face and their own face morphed into another peer's face. We will investigate neural responses at both N290 and P400 given previous results from Stapel et al. (2017), those from our pilot study (see Figure 1), as well as the suggestion from the literature that the adult N170 face-sensitive component emerges due to the integration of these two distinct components (Halit et al., 2003). To examine effects of familiarity, we will also test whether differences between self- and other-faces are present in the infant Nc. Results: The study has received in-principle acceptance (IPA) as a registered report by the journal Child Development. We aim to present the full results at ICIS 2022. However, pilot data (N = 9 - Figure 1) show that the face-sensitive P400 component is enhanced by self-face images compared to images of a peer's face.

S.15.02: The development of self-other comparison and distinction in infants (Kampis)

Dora Kampis[1], CharlotteGrosse Wiesmann[2], Victoria, Southgate[1] [1]University of Copenhagen, [2]Max Planck Institute for Human Cognitive and Brain Sciences A conceptual self has been argued to entail an awareness of the self as distinct from, but in relation to, others (Mead, 1934). Detecting similarities and differences between self and other -or self-other comparison- is essential for understanding the self in relation to others and is relevant in the context of understanding the development of the self, thinking about the self in interaction with others, and self-other alignment. In our study we aimed to tap into this social dimension of the self, and to probe whether it is related to other markers of self-concept development, such as mirror self-recognition and verbal self-reference. We developed a novel task testing whether infants map a state observed on their parent's face to themselves, to probe whether they use their self-other map to actively intervene in order to align the self with the other. Infants aged 16 to 26 months were presented with a sticker on their parent's cheek or forehead (depending on condition) without seeing how the sticker had been placed there. The infant was then offered a sticker, and we observed whether infants spontaneously placed the sticker in the same location on their own face. Results showed that infants (n=102) differentially placed the sticker in the matching location on

their own face (Fisher's exact p< .001). Additionaly, those who recognized themselves in the mirror tended to place also the sticker in the matching location on their face (X2(2, N=79) = 3.261,p= .035, one-sided). There was also a significant relation between matching sticker placement and use of own name (X2(1, N=91) = 4.361,p=.038), but not with first-person pronouns (X2(1, N=91) < .001,p= .992). These results suggest that infants actively intervened to emulate a state observed on their parent's face by mapping it to their own face. Thus developmentally, around the emergence of self-representation, the ability to map others to oneself might emerge as well; which combined with the recognition that others are distinct from oneself, may give rise to the challenge of switching between these two perspectives. Young infants have been proposed to be altercentric: to focus more on others' perspectives than their own (Southgate, 2020). But around the time of a conceptual sef emerges; they may begin to show more focus on their own perspective and knowledge. We probed this hypothesis with a task assessing altercentric modulation in infants (Kampis & Kovacs, 2021), where infants searched longer in a box when another person believed an object still to be present. We used this longer search as an index of altercentrism and found a decrease of altercentrism from 19-24 to 25-36 months (t(155)= 2.185, p=.03), in line with the possibility that once infants begin to understand the differences between themselves and others, they also begin to reference their own perspective and knowledge to themselves.

S.15.03: Primitive coding of the body-self boundaries in prenatal and postnatal life (Garbarini)

Irene Ronga[1], Francesca Garbarini[1] [1]University of Turin Introduction:The presence of a spatial modulation of multisensory integration (MSI) is considered a hallmark of a the ability to identify our own body and its boundaries. In the present talk, I will present you two experiments in which we exploited a MSI paradigm to investigate the emergence of a primitive coding of the body-self boundaries in the human development. In a first experiment, we investigated whether an electrophysiological marker of MSI is present and spatially organized in newborns (Ronga et al., PNAS 2021). In a second experiment, we piloted the feasibility of recording fetal gaze behavior in response to visual stimuli, in order to move our research question to the prenatal life (Ronga et al., in progress). Hypotheses: Previous pioneering behavioral studies, measuring eye-fixations, suggested the presence of cross-modal congruency effects at birth (e.g. Filippetti et al., Curr. Biol. 2013; Orioli et al., Curr Biol. 2018). Accordingly, in our first experiment in newborns, we expected to observe an electrophysiological signature of MSI with super-additive responses to bimodal stimuli (ERPs exceeding the sum of unimodal responses). Furthermore, larger MSI effect in the near space (as compared to the far space), would describe a spatial modulation of MSI. In our second experiment, in human fetuses, we expected to replicate the face-like configuration preference shown by Reid at al. (Current Biol. 2017) in near term fetuses, by recording lens (instead of head) movements, also extending our observation at the bigging of the third trimester. If promising, lens movements should be used to investigate, in human fetuses, the emergence of MSI (with increased gaze behavior in response to bimodal than unimodal stimuli) and its spatial modulation (with increased gaze behavior in response to spatially congruent than incongruent bimodal stimuli). Study population: Experiment 1: 25 human newborns of 52.50 ⍰ 19.51 hours (mean ±SD). Experiment 2: 9 fetuses at two time-points, i.e. 26 and at 37 weeks post gestation. Methods: Experiment 1: we recorded electroencephalography to compute ERPs to unimodal (audio and tactile) and bimodal (audio-tactile) stimulation in newborns (and adults as controls). Participants received tactile (electrical) stimuli on the hand dorsum, while auditory stimulation (a 50 ms tone) was presented either near (< 5 cm) or far (140 cm) from the stimulated hand. Experiment 2: 2D sonographic scan was used to record lens movements in response to visual stimuli consisting of face-like or inverted configurations of three dots.

See Figure 2. Results: In experiment 1, we demonstrated the presence of a genuine electrophysiological pattern of MSI at birth, with older newborns showing a larger MSI effect. Importantly, as for adults, MSI were spatially modulated by the proximity to the body. In experiment 2, we successfully replicated the face-like preference of fetuses in both time-points, thus confirming the reliability of lens movements recording in fetuses (see Figure 1). This promising measure will be used to investigate the emergence of a primitive coding of the body-self boundaries in prenatal life.

S.15.04: Multisensory bodily space in sighted and visually impaired infants (Bremner)

Andrew, J Bremner[1] [1]University of Birmingham As adults our representations of limb and body position result from the combination and integration of information from somatosensory receptors with visual and auditory cues. In this talk I will describe findings from my own lab and from those of my collaborators which shed light on the development in infancy of an ability to combine and integrate auditory, tactile, visual cues to form spatial representations of the body. I will also discuss evidence concerning the developmental processes by which these abilities emerge during infancy, with specific reference to findings from infants with severe visual impairments. I will first report on a series of studies into early ability to co-locate bodily tactile stimuli with respect to stimuli arriving from vision and audition. In these experiments we found that when presented with visual flashes or auditory beeps which moved backwards and forwards between their hands, both 6- and 4-month-old sighted infants demonstrated visual preferences indicating that they are able to register co-location between tactile stimuli and stimuli arriving from vision and audition. This shows that, sensitivity to visual-tactile and auditory-tactile correspondences underpinning body representations is available early in postnatal development. In a second strand of research we nonetheless find evidence that the spatial representations of the body undergo development in the first months of life. Our studies of infants orienting responses to tactile stimuli on the body indicate that crossed-limbs deficits, which are a marker of the presence of representations of the body's canonical layout in external space, emerge between 4 and 6 months of age in sighted infants. A role for visual experience in the development of spatial representations of the body in external space is indicated by studies which show an absence of the crossed-limbs deficit in tactile localisation in congenitally blind adults. In a recent study (see Figure 3), we have examined behavioural orienting responses to tactile and auditory cues on the hands in age matched groups of sighted and severely visually-impaired infants (Age range 5-35 months). The visually-impaired infants showed a distinct multisensory phenotype of body representation in early postnatal development. In contrast to sighted infants they showed no crossed-hands deficit, indicating a more limited influence of representations of the external layout of the body on spatial behaviour, they showed attenuated audiotactile spatial integration and interference, and placed more weight on tactile than auditory cues when the two were presented in conflict. Together these studies show that: i) although multisensory experience of the body is available early in infancy if not before, spatial representations of the body in the external world undergo development as a result of visual experience, and ii) that visually impaired infants develop a distinct sensory phenotype of body representations. Importantly, evidence of audiotactile spatial integration in visually impaired infants, albeit to a lesser degree than in sighted infants, signals the potential of multisensory rehabilitation methods in early development.

S.16: The development of children´s regulatory skills: parenting contribution in three different studies

S.16.01: Father-child and mother-child coregulation from a behavioral and physiological lens: How it relates to infant self-regulation? (Prieto)

Fernanda Prieto, Daniela Aldoney

Self-regulation skills develop in early childhood and seem to be highly predictive of success in different areas of development. Parent-child coregulation is one of the mechanisms that has been found to be critical to child regulatory skills, but there remain major gaps in the literature. First, almost all studies to date have been conducted with mothers. Fathers play a key role in children's regulatory development (Rinaldi & Howe, 2012), yet we know little about father-child coregulation processes in early childhood Second, few studies have examined moment-to-moment links between parent and child physiology and behaviors observed during the same event. The present study aims to understand how the co-regulation of physiology and affect influences self-regulation in early childhood. We examined whether (1) co-regulation of affect in mother-child and father-child relates to children's self-regulation at age 36-months, (2) physiological co-regulation is associated with children's self-regulation at age 36-months, and (3) the relation between coregulation of affect and physiological functioning differed between mother-child and father-child interactions, considering that little research to date has addressed how dynamic father-child interaction patterns contribute to early child development. Twenty- four 24 children (50% boys) and their mothers and fathers participated in a 2-hour lab assessment. Mother/father- child interactions were videotaped and coded for coregulation (flexibility, dyadic positive and none positive affect, positive and negative affect synchrony (Lunkenheimer et al., 2011)). We then used the Gridware program, which involves a graphical approach (see Hollenstein, 2007) to plot the sequence of dyadic states as it proceeds in real time on a grid representing all possible behavioral combinations of the dyad. We created State Space Grids (SSG) for each dyad (Figure 1). Children's regulatory skills (hot and cold) were assessed using the Early Years Toolbox (Howard, 2015) and the Snack Delay task, a delay of gratification task. For the physiological data we attached three disposable electrodes to the chest of parents and children using a lead II placement to collect ECG signal. Data were collected using Mindware Technologies ambulatory monitors (Gahanna, OH). Results showed that children in dyads who displayed higher levels of coregulation of positive affect had better delay of gratification skills. Father-child physiological coregulation contributed differently to hot and cool aspects of children´s self-regulation. For the mother-child dyads emotional coregulation was found to be relevant to children's hot self-regulation. Results suggests that the development of children's SR skills involves both physiological and emotional dyadic processes, and that fathers and mothers contribute in different ways to the development of these skills. Limitations and future research directions are discussed.

S.16.02: Quantity and quality of maternal and paternal practices and children´s executive skills. (Aldoney)

Daniela Aldoney, Fernanda Prieto; Carolina Panesso

Adequate development of executive function (EF) in early childhood has been related to a broad range of child outcomes (Distefano et al., 2018). Given that children´s development is highly malleable during the first years of life, there is a window of opportunity to promote strong EF skills during the preschool

years. In line with ecological models (e.g., Bronfenbrenner & Morris, 2006) research shows that the development of EF is associated with both proximal (parenting quality and practices) and distal factors (parental characteristics) (Vrantsidis et al., 2019). Higher educated parents tend to engage more in activities that stimulate children's cognitive functioning and EF, such as educational play (Kalil et al., 2012). Moreover, good parental EF skills may equip parents to display a type of parenting that is promotive of EF and serves as context for the child to practice these skills (Cuevas et al. 2014). Growing up in a context with high cognitive stimulation and responsive parents have been associated with better EF skills in children (Korucu et al., 2019). Despite the growing evidence of the importance of EF the literature has limitations. First, studies have predominantly focused on the mother-child relationship, thus the role of fathers has been understudied. Second, studies on parents´ and children´s EF with low-income families are rare, even more in samples outside U.S. and Europe. Third, most studies focus either on quantity or quality of parenting practices; including both allows a better understanding of the context in which the child develops. In the present study, we examine (1) the caregiving context of 115 three-year-old children living with both parents in Chile and (2) the contribution of distal (maternal and parental levels of education) and proximal processes (quality of the parent/mother- child relationship and frequency of cognitive stimulation) on children´s EF skills. Each parent answered a sociodemographic questionnaire and reported on the frequency of five activities with their children (singing song, reading a book, tell a story, play with a toy, and imaginary play). Mother/father-child interactions were videotaped; responsiveness was coded using the PARCHISY (Deater-Deckard, 2000). Both parents and children's EF were measured using the Minnesota Executive Function Scale (MEFS; Carlson & Schaefer, 2012). Mothers and fathers displayed similar quality of parenting. However, mothers reported higher frequency of cognitive stimulation than fathers (Table 1). Results from multiple hierarchical regression showed that for mothers, education, but not maternal EF, related to child´s EF ($B = 0.25$; $p<0.01$) and that cognitive stimulation and responsivity was significantly related to child's EF ($B = 0.25$; $p<0.01$; $B = 0.29$; $p<0.05$ respectively). None of the paternal variables related to child´s EF skills. The similarity in the quality of mother/father-child interaction suggest that fathers have the potential to positively influence their children; but they may not spend enough time with their children to be as influential as mothers. Our data highlight the importance of frequency and quality of parenting behaviors in children's EF development

S.16.03: Mother and fathers parenting skills and children reported executive function (Panesso Giraldo)

Daniela Aldoney, Carolina Panesso, Fernanda Prieto, María Josefina Escobar

Executive function (EF) --higher order thought processes that are foundational for reasoning and problem solving-- emerges in the first year of life (Best & Miller, 2010) and matures rapidly during early childhood (Anderson, 2002; Zelazo et al., 2008). Given the importance of the first years of life in the development of EF skills, research has focused on parenting (Bernier, Carlson, Deschenes, & Matte-Gagne, 2012; Bernier, Carlson, & Whipple, 2010; Bibok, Carpendale, &Muller, 2009) as sources of individual differences in children's EF. Parents who are able to respond in a flexible and adaptive way to their children´s requirements foster the development of better EF (Gomez Muzzio & Munoz Quinteros, 2015; Rodrigo, Quintana, Carlos, Cabrera Casimiro, & Máiquez Chaves, 2009). Less is known however, about how specific maternal and paternal parenting practices relate to specific EF dimensions. Our study aims to address this gap in an understudied population; a sample from a none WEIRD country. While socialization practices vary across cultures, it is possible that relations between parenting practices and

child EF that hold in one culture do not bear out in another culture (Baumrind & Thompson, 2002 Harkness et al, 2007, Lucassen et al, 2015). Participants in this study included 300 Chilean children (age 3-5) and their parents from middle-high socioeconomic background. Parents completed questionnaires on demographic data (education, income), children´s EF (BRIEF-P; Gioia, Espy & Isquith, 2016) and parenting skills (E2P: Gomez Muzzio & Munoz Quinteros, 2015). The E2P questionnaire is a 4 point Likert scale (1= almost never - 4= always) and includes 54 items organized in four parenting dimensions each with four components: (1) bond (mentalization, sensitivity, emotional support, and involvement; (2) training (cognitive stimulation, guidance, positive discipline, and socialization); (3) protection (safety, basic needs, daily life organization, social support); (4) reflection (anticipation, monitoring, self-monitoring, parental self-care). This scales was created and validated in Chile. All data were collected online. Preliminary analysis of a subsample (n= 147; fathers=72; mothers= 74) showed no differences between boys and girls in the Inhibitory Self-Control and Emergent Metacognition, but boys outperformed girls in the flexibility scale (M: 57.0, SD: 13.1 for boys and M: 53.3, SD:13.1 for girls). Fathers reported better flexibility skills in boys than girls (B = 5.4 p<0,05). When we examined differences between mothers and fathers, both displayed similar levels of parenting skills. A multiple regression analysis showed that - only for fathers - the bond dimension predicted children´s emotional control scores (B = 0.62; p<0,05). Next steps - with the complete sample - include examining relationships between sociodemographic variables, parenting and children´s EF and cross parental effects, will help to better understand specific contribution of fathers and mothers on children´s EF. These preliminary results suggest that even though mothers and fathers seem to be equally "good parents" they contribute differently to children´s EF. Parents evaluate their children´s specific EF skills slightly different. Analyzing cross parental effects may offer a new angle to understand maternal and paternal contribution to children´s development.

S.17: Baby's got rhythm: Neurobehavioral attunement to singing, music, and speech

S.17.01: Infant Neuro-Behavioral Attunement to Maternal Singing (Markova)

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Previous studies have shown that listening to music entails a powerful entrainment effect, which is observable from very early on in life at the behavioral but also neural level. For example, already 5-month-olds move rhythmically to music (Zentner & Eerola, 2010), and 7-month-olds' brains entrain to beat and meter of rhythmic patterns (Cirelli et al., 2016). Infant-directed (ID) singing could be one way for caregivers to introduce musical rhythms into their interactions with infants (Cirelli et al., 2018). ID singing has particular acoustic characteristics that may make the rhythmicity of the auditory input very salient for even very young infants, and thus allow their brain to attune to the rhythms carried through the mother's voice (Provasi et al., 2014). However, no previous studies have examined infants' attunement to a very natural and socially meaningful stimulus, such as maternal ID singing. Consequently, the goal of our study was to examine neuro-behavioral attunement to maternal singing in 7-month-old infants.

In total, 60 mother-infant dyads were observed when infants were 7 months old during two singing conditions that differed in rhythm - a playsong and a lullaby - the order of which was randomized between participants. All mothers sang the same two songs and were instructed to sing 8 verses of

each. Each singing condition was preceded and followed by a baseline (i.e., three baselines in total), during which mothers and infants watched infant-friendly videos (e.g., colourful aquarium) for 60 s without any further communication. In Study 1 (n = 30 dyads), we measured infant EEG, while in Study 2 (n = 30 dyads), we observed infant rhythmic behaviors. To calculate neural attunement in Study 1, we used a forward encoding model utilizing temporal response functions. We extracted the sound envelope from the audio recordings of maternal singing and used them to predict the infants' EEG response. In Study 2, we coded rhythmic movements as all movements of body parts or the entire body that were repeated at least three times in the same form at regular short intervals (< 1 s; Thelen, 1979).

In Study 1, cluster permutation analysis of the temporal response functions for the two conditions revealed one significant negative cluster at 200-400 ms of the EEG signal mapped onto the sound envelope. When testing for the predictive accuracy of infants' neural attunement we found it to be more precise in centro-parietal electrodes in the playsong than in the lullaby condition ($p = .001$). In Study 2, we found infants to show more rhythmic movements in the playsong condition than in the lullaby condition ($p = .003$).

These results suggest that infant's brains and movements not only attune to social musical stimuli presented by their caregivers, but also that they do so differently for different types of ID songs. ID playsongs may be acoustically more salient allowing infants and caregivers equally to tune into the content of their social exchanges.

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S.17.02: Infant and caregiver rhythmic movement to speech and music (Rocha)

Sinead Rocha[1], Helen Olawole-Scott[1], Adam Attaheri[1], Áine Ní Choisdealbha[1], Perrine Brusini[1], Sheila Flanagan[1], Natasha Mead[1], Panagiotis Boutris[1], Samuel Gibbon[1], Christina Grey[1], Isabel Williams[1], Henna Ahmed[1], Emma Macrae[1], Usha Goswami[1]

[1]University of Cambridge

The ongoing BabyRhythm project is a longitudinal study of 122 infants from two to 30 months of age, investigating neural entrainment and sensorimotor synchronisation to acoustic rhythm, in relation to language acquisition. To track infant rhythmic movement, we measured infant ability to move in time with speech and non-speech rhythms from 5 - 11 months of age using Motion Capture. We find that infants become faster ($F(5,86) = 5.38$, $p < .001$) and more rhythmic ($F(5,74) = 20.92$, $p < .001$) drummers over their first year, but that a general increase in the regularity of drumming produced with age is attenuated when infants drum along with more complex linguistic stimuli (a repeated Syllable sound and sung Nursery Rhymes; stimuli*age interaction ($F(15,1128) = 3.63$, $p < .001$)).

For a subsample of participating families (N = 53), during the 11-month Motion Capture session we additionally quantified how accurately parents could drum along with, and bounce their babies to, a Nursery Rhyme. Parent accuracy was variable, with greater accuracy (a lower tempo mismatch) during the drumming task than the bouncing task (Drum M = 0.015 seconds mismatch, SD = 0.01 seconds, Bounce M = 0.026 seconds mismatch, SD = 0.02 seconds; $t(1,42) = -4.414$, $p < .001$; see Figure 1).

We predicted that infant synchronisation ability would be predicted by parental synchronisation ability, but we did not find evidence to support this hypothesis (all $p > .05$). We also asked whether infant drumming at 11 months of age was predicted by the general musicality of the home environment measured via the Music@Home Questionnaire (Politimou et al., 2018), or by the level of reading difficulty experienced by the parents, measured via the Adult Reading History Questionnaire (Lefly & Pennington, 2000). We do not find evidence for the musicality of the home environment or parental reading difficulty predicting infant drumming ability at 11 months (all corrected $p > .05$).

The Temporal Sampling framework (Goswami, 2011) proposes that atypical rhythmic synchronisation to slow rhythm patterns characterises child language disorders. Children's temporal accuracy/variability of tapping predicts language and phonology (e.g. Corriveau & Goswami, 2009; Woodruff Carr et al., 2014). Our data on rhythmic movement in infancy tests this hypothesis via a rich battery of follow up language assessments conducted between 10 and 24 months of age. Measures of semantics, phonology, grammar, speech timing and gesture were taken at repeated intervals. Raw scores for infant language comprehension and production from the Communicative Development Inventory (CDI) are shown in Figure 2. Here we stratify our sample into 'high' and 'low' language children by CDI productive vocabulary scores at 24-months. Our next work will predict high/low language outcome from the early sensorimotor measures described above.

S.17.03: Your turn, my turn. Neural synchrony in mother-infant proto-conversation. (Nguyen)

Trinh Nguyen[1], Lucie Zimmer[2], Stefanie Hoehl[1]

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Long before developing the capacity to verbally communicate, infants use pre-linguistic vocalizations as a means of early social communication (Bornstein et al., 2015). These vocalizations have an adult-like

rhythm and resulting infant-caregiver "proto-conversations" resemble the universal turn-taking structure of human conversation (Provasi et al., 2014; Henning et al., 2005; Levinson, 2006). Recently, interpersonal neural synchronization has been proposed as a neural mechanism facilitating information exchange during verbal and non-verbal conversation. More specifically, neural synchrony was linked to turn-taking during mother-child conversation in preschoolers (Nguyen et al., 2021). Here, we present a functional near-infrared spectroscopy (fNIRS) hyperscanning study looking at the temporal dynamics of neural synchrony as well as infants' own neural responses during mother-infant proto-conversation. We hypothesize that more frequent turn-taking during mother-infant proto-conversation is related to higher interpersonal neural synchrony between mother and infant. In addition, we investigate whether infant brain development is related to infants' turn-taking abilities. Interhemispheric functional connectivity, as a measure of infant brain maturation (Kelsey et al., 2021), is expected to be related to infants' shorter and thus more contingent turn duration.

In the current study, 57 four- to six-month-old, full term-born infants (27 female infants) and their mothers were tested simultaneously with fNIRS hyperscanning while engaging in free, dyadic play for five minutes. fNIRS was measured in 22 channels located over the inferior frontal gyrus as well as lateral and medial prefrontal cortex (PFC). Neural synchrony (using wavelet transform coherence analysis) was assessed over 1-minute epochs. We micro-coded infants' and mothers' vocalizations and derived turn-taking patterns for each 1-second epoch as well as the sum of turns for the 5-minute interaction from these codes.

Results from generalized linear mixed-effects modeling revealed that turn-taking in proto-conversations between infants and mothers was significantly related to higher neural synchrony in the medial PFC, $z = 2.696$, $p = .007$, but not in the lateral PFC and inferior frontal gyrus, $p > .905$. Infants' interhemispheric functional connectivity as an index of brain maturation was related to infants' response offset, $z = -2.317$, $p = .020$. The higher the interhemispheric connectivity, the more contingent were the infant's turns.

Findings are discussed to point out the role of the vocal and auditory modality in early social communication and the potential functional role of interpersonal neural synchronization for parent-infant proto-conversation.

S.18: Cascades of manual exploration onto language outcomes

S.18.01: Sitting and Manual-Oral Exploration Relate to Babbling (Marcinowski)

Marcinowski, E. C., Hsu, L.-Y., McCoy, S. W., & Dusing, S. C.

Introduction. Motor skills early in life change how infants explore the environment (Soska, Adolph, & Johnson, 2008) and communicate (Iverson, 2010, 2021). Attainment of independent sitting increases the amount of play (Marcinowski et al., 2019) and increases the likelihood of manual-oral pairing (Soska & Adolph, 2013). Infants' vocalizations exhibited more diverse supraglottal consonants while mouthing objects, as compared to non-mouthing vocalizations (Fagan & Iverson, 2007). Given the aforementioned connections between sitting, manual-oral exploration, and babbling, this project investigates concurrent relations between these three domains at the emergence of independent sitting.

Methods. Typically-developing infants (n=35) were recruited at sitting emergence (M=5.1 months, range:4.3-6.9) were assessed across 3 longitudinal visits (initial visit, +3, +6-8 weeks) for mouthing

behavior, stage of sitting, and babbling production. Sitting emergence was defined as prop sitting for 3+ seconds through arms-free sitting without position changes or locomotion. While supported by researchers in sitting, infants were video-recorded playing with 3 standard toys (pop-up, gumball machine and gumballs, seriated cups) one-set-at-a-time for three 2 minute trials. From video, reliable coders scored sitting stage (prop, wobbly/arms-free, stable/arms-free) and the total duration of object or body mouthing using Datavyu v1.3.5. Parents completed a babbling survey at each visit. The number of endorsed consonants (out of 24) and vowels (out of 17) were summed at each visit.

Results. A model including continuous age, the average total duration of mouthing, and sitting stage progression (prop, wobbly/arms-free, stable/arms-free) to predict vowels or consonants was analyzed, using a multilevel longitudinal model. The progression of sitting from prop through arms-free sitting predicted consonants ($p=0.01$) and vowels ($p=0.02$), above and beyond age ($p<0.05$). In the same model, total mouthing duration also predicted consonants ($p=0.02$), but not vowels ($p=0.83$). Interestingly when consonants were separated by articulation location, consonants articulated at the front of the mouth and palate were predicted by total mouthing ($p=0.03$).

Conclusions. Increases in manual or oral exploration may be one mechanism by which sitting increases the amount of consonant types produced by infants. Both consonants and vowels were enhanced by the progression of sitting. The emergence of independent sitting sets in motion a cascade of different manual-oral events and subsequently babbling. These results are discussed in the context of the developmental timing of postural, exploratory actions, and language early in infancy.

S.18.02: Lateralized Manual Mouthing Behaviors during Infancy Relate to Language at 2 and 5 years (Contino)

Campbell, J. M., Marcinowski, E. C., & Nelson, E. L.

Introduction. Do lateralized manual behaviors involving oral exploration influence the development of language? Previous research has described the co-occurrence of mouthing behaviors and vocalizations during infancy (Ejiri & Masataka, 2001). Other research has identified that infants with an early, consistent right-hand preference for object manipulation have higher language scores at 24 months (Nelson, et al., 2013). This research attempts to link the literature on mouthing behaviors and lateralized hand-use by examining the relation between hand-use for mouthing behaviors on later (24 and 60 month) language abilities. Methods. Infants' (n=40; 16 males) mouthing actions were observed monthly (6 to 14 months). Infants sat across from a researcher who presented objects (n=17 pairs of objects) shoulder-width apart, within reaching distance. Once objects were on the table, the infant could manipulate the objects without interference. The session recordings were analyzed using the Noldus Observer® XT. The number of mothing actions performed with each hand was recorded until 6 manipulations had occurred. The hand used for each active manipulation was identified. The number of mouthing actions performed with the right and left hands were used to calculate the proportion of right- and left-hand use (R/R+L; L/R+L). These proportions were then used in analyses to predict language scores. At 24 and 60 months of age, language was assessed using the Preschool Language Scales 5th edition (PLS-5). Results. Multivariate regression analyses were conducted to assess the relation between lateralized hand-use while mouthing objects and expressive and receptive language scores derived from the PLS-5. The proportion of right-hand use while mouthing predicted both expressive ($p=0.02$) and receptive ($p<0.01$) language scores at 24 months of age. The proportion of left-hand use during mouthing actions also predicted both expressive ($p=0.02$) and receptive ($p<0.01$)

language scores at 24 months of age. The proportion of right-hand mouthing actions predicted expressive (p=0.05) language at 60 months, but not receptive (p=0.06) language. The proportion of left-hand mouthing actions predicted expressive (p=0.05) language at 60 months, but not receptive (p=0.06) language. Total mouthing actions predicted expressive language scores at 60 months of age (p<0.01) as well as receptive language scores at 60 months (p<0.01). Conclusions. The research objective was to examine whether lateralized mouthing behaviors have an influence on language scores at 24 and at 60 months. Both right- and left-hand mouthing actions predicted an increase in PLS-5 language scores, such that as mouthing actions with the right or left hand increased, there was an increased in PLS-5 score. Total mouthing actions also predicted PLS-5 scores. As the number of mouthing actions increased, the PLS-5 score increased. These results indicate that mouthing is beneficial for both expressive and receptive language, regardless of which hand is performing the action. While research indicates that the mechanism by which mouthing and expressive language are related is through the development of the muscles related to producing language, the research on the mechanism which links receptive language and mouthing actions is lacking.

S.18.03: Infant and Toddler Hand Preference Trajectories Differentially Predict Language Outcomes (Campbell)

Contino, K., Campbell, J. M., Coxe, S., Gonzalez, S. L., Hayes, T., Marcinowski, E. C., Michel, G. F., Ramos, M., & Nelson, E. L.

Objective: The idea that changes in one domain can exert developmental effects on another domain is a concept known as developmental cascades (Masten & Cicchetti, 2010). Motor development during infancy and early childhood provides opportunities for social interactions in a changing environment, which in turn, has been linked to the emergence of language and communication skills (Iverson, 2021). The acquisition of new motor skills thus has cascading and cumulative effects on later language. Prior work has connected attainment of gross motor skills to language, but few studies have explored relations between fine motor skills and language (Gonzalez et al., 2019). Previous studies have shown toddler hand preference trajectories for role-differentiated bimanual manipulation (RDBM; non-preferred hand supports the object for the preferred hand's actions) predicts language outcomes at 24, 36, and 60 months (e.g., Gonzalez et al., 2020). However, it is unknown whether hand preference trajectories for reaching, an earlier manual skill used to assess handedness in infants, are also linked to language or whether different manual skills measured at different points in development differentially predict language skills.

Methods: Ninety typically developing monolingual English infants (N=90; 47 male, 43 female) were assessed for reaching hand preference at 9 monthly visits from 6-14 months of age (32 data points). Children returned to the lab as toddlers and were assessed for RDBM hand preference at 6 monthly visits from 18-24 months of age (29 data points). Hand use data were coded offline with the Noldus Observer. Handedness Index (HI) scores were calculated for each timepoint using the formula (R-L)/(R+L), where R was the number of right-hand actions and L was the number of left-hand actions. Trained observers administered the Preschool Language Scales 5th edition (PLS-5; Zimmerman et al., 2011) when children were 24, 36, and 60 months of age. The PLS-5 is a standardized assessment that measures a child's receptive and expressive language abilities.

Results: Using latent growth curve analysis (LGCA), the best fitting model for the infant data revealed four hand preference trajectories: Left, Variable Right, Moderate Right, and Stable Right. For toddler

data, three hand preference trajectories were identified: Right-Mild Left, Right-Moderate Left, and Left-Moderate Right. Custom scripts in R were used to compare the amount of variance explained in PLS-5 language scores for infant versus toddler trajectories (Table 1).

Conclusions: These findings suggest that while hand preference trajectories do predict language outcomes above and beyond traditional predictors (i.e., SES), motor-language links are variable. Relations may vary across manual skills, developmental time, and type of language skill. The strongest link observed was between infant reaching hand preference trajectories (measured from 6 to 14 months) and receptive language skill assessed at the final study timepoint of 60 months.

S.19: Delineating the early development of perceptual categorization with EEG frequency-tagging

S.19.01: Brain-anchored categorization of phylogenetically-relevant stimuli at early ages (de Heering)

Adélaïde de Heering[1]

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Infants have long been considered as passive recipients mostly because they lack language and show a limited behavioral repertoire. The development of sophisticated and non-invasive electrophysiological (EEG) paradigms, among which is frequency-tagging, has however demonstrated that this is not true: human infants are, from very early on, equipped with elaborated cognitive abilities that can be tracked developmentally from very young ages. Among these capabilities is visual categorization that the infant brain is gifted with very early. Visual categorization evidences the capacity of the brain to consider different visual items as related to each other despite they vary in term of their low-level properties (e.g., contrast, luminance, color). Meanwhile, categorization also attests from its capacity to exclude other visual items from that same category despite their physical resemblance to the included items. During this talk I will outline the origin of this complex activity and characterize its nature when it applies to living items. More specifically, I will demonstrate that face categorization is particularly marked at the right occipito-temporal lobe in infants as early as 4- to 6-months of age. Evidence is taken from a highly significant entrainment response extracted from scalp recordings of a few minutes only when they watch streams of stimuli presented at a fixed rate of 6 images per second (6 Hz), with faces appearing every 5th item (f/5 frequency = 1.2 Hz). Critically, categorization is also observed in response to animals that infants have never experienced before (i.e., snakes and frogs), which underlines the role predispositions play in driving the neural response. The use of a similar frequency-tagging paradigm to demonstrate so indicates, however, the involvement of more occipital regions than when socially relevant stimuli such as faces are processed. In line with earlier behavioral studies (LoBue & DeLoache, 2010; Turati et al., 2002), it will therefore be argued here that frequency-tagging is particularly sensitive to inborn statistics, which offers the infant brain a solid substrate to categorize phylogenetically relevant stimuli such as faces and snakes. It will also be suggested that, when looking at scalp topographies, the tool reliably informs about the impact of visual experience on the infant brain.

S.19.02: Developmental origins of high-level superordinate and global categorization (Peykarjou)

Stefanie Peykarjou[1], Stefanie Hoehl[2], Sabina Pauen[1]

[1]Heidelberg University, [2]University of Vienna

Adults and infants form abstract categories of visual objects (Quinn & Johnson, 2000), and adults are particularly fast at discriminating animate from inanimate stimuli (Macé et al., 2009). Adults are highly adept at categorization, independent of systematic differences between animate and inanimate stimuli in their basic visual properties (Stothart et al., 2017). However, only little is known so far about developmental origins of this high-level visual categorization. We employed frequency tagging while recording scalp electroencephalography (EEG) to characterize the development of superordinate- and global-level categorization from infancy to adulthood (Rossion et al., 2015). This paradigm provides an implicit, objective, robust measure of visual categorization (de Heering & Rossion, 2015; Rossion et al., 2015), requiring both discrimination between categories and generalization across exemplars. In Experiment 1, categorization of 160 variable animal and furniture items was tested in infants (4-, 7- and 11-month-olds, N = 140, 70 males), children (5-6-year-olds, N = 21, 19 males) and adults (N = 20; 6 males). Phase-scrambled sequences served as control to evaluate the contribution of low-level factors to categorization. Conditions were tested within-subjects in children and adults, and between-subjects in infants. Each trial consisted of short stimulation sequences (infants: 20 seconds, children, 40 seconds, adults: 60 seconds) in which 4 items of the same category were presented consecutively, constituting the standard category. Base stimulation frequency F was 6 Hz (i.e., 6 images/second), and each 5th stimulus belonged to the deviant category. The categorization of the target category was thus tagged at 6/5 = 1.2 Hz and its harmonics (multiple integers; F/5; nF/5). In adults and children, significant categorization responses ($Z > 1.64$, $p < .05$) emerged in posterior-occipital and anterior regions of interest (ROIs) for original and phase-scrambled images. Categorization was stronger for original than phase-scrambled trials, and, particularly in kids, stronger for animal than furniture deviants (Bayes Factors10 > 100, providing extreme evidence). In infants, significant categorization responses were observed only in the posterior-occipital ROI. At 4 and 7 months, categorization responses were observable, but relatively weak (i.e., confined to single harmonics). Only at 11 months, the categorization response was observed in most participants (68%) and enhanced for original compared to scrambled images (Bayes Factors10 > 3, moderate evidence). Still, responses were observed in fewer participants and less harmonic compared to children (100%) and adults (87.5%). In Experiment 2, the same approach was used to measure categorization of broad animate and inanimate categories in adults (N = 20, 7 males), children (5-6-year-olds, N = 20, 9 males), and infants (11-month-olds, N = 23, 10 males). Data analysis is under way, but preliminary analyses reveal a similar data pattern as in Experiment 1 in adults and children, with stronger categorization of original than phase-scrambled images, and of animate than inanimate oddballs. Overall, these data indicate that superordinate (animal-furniture) categorization at a glance starts to develop during the first year of life, with key features emerging at 11 months. However, expert categorization continues to evolve during early childhood. Similar results are expected for global (animate-inanimate) categorization.

S.19.03: Maternal odor tutors neural face categorization in younger, but not older, infants (Rekow)

Diane Rekow[1], Jean-Yves Baudouin[2], Anna Kiseleva[1], Bruno Rossion[3], Karine Durand[1], Benoist Schaal[4], Arnaud Leleu[1]

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Learning to understand the multisensory environment is challenging for the developing brain. To deal with inputs entering from all sensory modalities, the brain relies on perceptual categorization, i.e., differentiating stimuli between categories (discrimination) and grouping stimuli within categories

(generalization). In the visual realm, one of the most salient visual categories from the first moments of life is made of conspecific faces. In the chemical realm, the sense of smell is also a potent channel for the young infant, who is rapidly able to learn olfactory cues for their own survival (e.g., feeding and self-regulating, Schaal et al., 2020). A recent line of evidence suggested a direct tutoring function of smell on the development of face categorization demonstrating the role of maternal body odor (Durand et al., 2013), which shapes the neural categorization of human faces (Leleu et al., 2020) and of common objects configured as faces (Rekow et al., 2021). However, these findings were obtained in 4-month-old infants, at an age when such face categorization is not yet fully developed and remains challenging. Whether this odor effect operates later in development, when face categorization becomes more efficient by itself, remains to be established. Here, we recorded the scalp electroencephalogram (EEG) of 4- to 12-month-old infants (N = 50) while they were watching streams of rapidly changing natural images (6 images / sec leading to a 6-Hz frequency of stimulation) including living and non-living objects. This leads to a general visual response recorded at the same frequency in the EEG frequency spectrum that measures neural activity common to all visual stimuli (low-level cues, contrast, etc.). Importantly, images of faces were periodically inserted once per second, to elicit a face-selective response at 1 Hz in the EEG spectrum if the infant brain discriminates faces from other objects and generalizes across the different faces, i.e., a neural marker of face categorization. During visual stimulation, infants were exposed to either a T-shirt imbued either with their maternal odor or to an unworn, control T-shirt, used as baseline. With this frequency-tagging approach, we show that the magnitude of the face-selective neural response increases with age over occipito-temporal regions, marking the development of face categorization. Critically, while the strength of the face-selective response increases, the maternal odor effect (i.e., larger face-selective response in the maternal than the baseline odor condition) decreases as a function of age. At the same time, the general visual response remains unchanged by age or odor. These results confirm that olfaction plays a key role in the development of face perception, with a developmental trade-off between the senses. This supports the view that perception is largely multisensory in infancy, before unisensory inputs become sufficient to optimally trigger perception. More generally, this study provides further evidence to feed the ongoing debate as to whether the senses collaborate or interfere with one another early in life (Bremner et al., 2012).

S.19.04: Neural categorization of voices at four months of age (Pia Calce)

Roberta Pia Calce[1], Diane Rekow[2], Francesca Barbero[1], Anna, Kiseleva[2], Siddharth Talwar[1], Arnaud Leleu[2], Olivier Collignon[1]

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Human voices are among the most relevant sounds in our daily life. Neuroimaging studies in adults demonstrated the existence of regions in the superior temporal sulcus- the "temporal voice areas" (TVAs)- that respond preferentially to voices vs other sounds (Belin et al., 2000). Further behavioral and electrophysiological studies also suggested that this voice sensitivity is not accounted for by low-level auditory features, but rather by higher-level categorization of vocal sounds (Barbero et al., 2021; Agus et al., 2017). How early in the developing brain such selective categorical response occurs remains however poorly understood. Auditory developmental research has mainly focused on language development (Sharifian et al., 2019) investigating the ability of infants to discriminate between native and foreign languages, or differentiate speech from non-speech sounds, phonemes, and even syllables (Gasparini et al., 2021; Dehaene-Lambertz et al., 2010; Karzon et al., 1989.), without directly addressing

whether voices are processed differently than other sounds. When investigating voice perception, studies could not disentangle the role of low-level acoustic properties of voice sounds, leaving open the question of whether infants can process voices as one homogeneous perceptual category (Grossmann et al., 2010). In the present study, we investigate whether a voice-selective response occurs already in the infant brain, relying on electroencephalography (EEG) frequency-tagging. This approach provides an objective marker of the brain's automatic ability to categorize vocal information with a high signal-to-noise ratio within a short testing duration, making the technique optimal for testing infants. Twenty-three 4-month-old infants listened to streams of heterogeneous sounds presented periodically at 3.33 Hz to elicit a brain response at the same frequency in the EEG amplitude spectrum. Importantly, variable voice stimuli were inserted as each third sound (1.11 Hz) to elicit an additional response in the EEG spectrum if the infant brain discriminates voices from other sounds and generalizes across heterogeneous vocal exemplars (standard condition). Moreover, infants were also presented with a scrambled version of the same stimuli that disrupts intelligibility but preserves spectral content. Here, a response at the voice rate would be interpreted as merely driven by low-level features. The analysis is conducted in the frequency domain at sounds (3.33 Hz) and voice rates (1.11 Hz) in both conditions. Results show no amplitude difference between standard and scrambled conditions at the general sound frequency (3.33 Hz), suggesting that intelligible sounds are processed similarly to their scrambled version. Importantly, we observe a neural response over temporal channels at the voice presentation rate (1.11 Hz), that is significantly larger in the standard condition, this pattern being consistent across individual infants. Taken together, these results indicate that the infant brain successfully recognizes variable voice excerpts as items of the same category. The comparison with their scrambled version suggests that voice selectivity does not merely rely on acoustic frequency content, bringing evidence of high-level voice categorization as early as 4 months of age.

S.20: Effects of Bilingualism on Infant Visual Attention and Exploration

S.20.01: Visual Recognition Memory & Cross-Modal Transfer Skills among Monolingual & Bilingual 18-Month-Olds (Rocha-Hidalgo)

Joscelin Rocha-Hidalgo, Kate Freda, Caroline Telesz, Olivia Blanchfield, Rachel Barr

Aim: Marian et al. (2018) proposed that bilingualism modulates audio-visual integration, suggesting that individuals' linguistic experience plays a role in how they bind sensory information. We aim to investigate whether these differences of binding sensory information based on previous language experience extend to a tactile-visual pairing.

Singh et al. (2015) demonstrated that bilingual infants are more efficient in recognizing familiar stimuli than their monolingual peers. We predicted that bilingual infants would show higher Novelty Scores on cross-modal trials than monolinguals demonstrating that they could encode and transfer information between modalities.

Participants: We tested 38 (18 girls) monolingual and 27 (12 girls) bilingual 18-month-olds in their homes. Language exposure was assessed using the Language Exposure Assessment Tool (LEAT, DeAnda et al., 2016) and classified as bilinguals if they heard a second language (L2) for at least 20% of the time.

Tasks and Stimuli: Recognition memory for intra-modal trials was assessed using three visual paired-comparison (VPC) trials. We used three unique pairs of stimuli. The cross-modal trials consisted of up to

11 trials where familiarization happened haptically but was tested visually (Rose & Feldman, 1995; Figure 1 & 2).

Procedure: Each trial consisted of two phases: a 10-second familiarization phase (VPC = visual, crossmodal-transfer = haptic) and a 10-second test phase. For the haptic familiarization phase, one of the items was placed in one of the infant's hands, shielded by the experimenter cupping her hands around the child's hand until 10 seconds had passed. After familiarization ended, both the familiar and novel pieces were placed on the board. At the midpoint of the 10-second test phase, the experimenter reversed the position of the stimuli to control for children's possible preferences of position.

Results and Discussion: Mixed effect regression models indicated no significant differences between monolinguals and bilinguals in either Intra-modal or Cross-modal trials. In the Intra-modal task, only bilinguals looked at the novel stimulus above chance, showing a novelty preference. Neither monolinguals nor bilinguals showed a novelty preference during the Cross-modal task. This indicates that children, regardless of language background, were not successfully transferring the knowledge acquired during the haptic familiarization to the visual test. These response patterns were not consistent with Rose and Feldman (1995), who conducted the study in the lab. The inherent distractions from the home environment could have played a role in why we see so much variability in performance and why we did not replicate the findings from the original study.

Modeling the heterogeneity that arises from growing up in a bilingual home is important for understanding how this arrangement could impact an individual's cognitive development. To consider the heterogeneity of growing up bilingual, we will conduct a latent profile analysis to identify language groups based on L2 exposure, speakers' nativeness to the languages, and speaker's proficiency and code-switching. The distinct language profiles identified will be then used to examine their novelty preference and looking switches on the Intra- and Cross-modal tasks rather than solely focusing on a binary classification using children's L2 exposure.

S.20.02: Early bilingual experience is related to attentional development (D'Souza)

Dean D’Souza, Hana D’Souza

Infants adapt to the external world by sampling (exploring) it. The more variable the environment, the more sampling (exploration) is required. Infants who regularly hear two or more languages are likely to be exposed to more varied language input than infants who regularly hear one language. These 'bilingual' infants are also likely to receive less input from each language. Given these exogeneous sampling constraints, how do bilingual infants keep pace with their monolingual peers? We propose that they do so by rapidly orienting towards speakers and placing more weight on gathering information (exploring). Whereas monolingual infants may be drawn to familiar stimuli so they can build detailed representations of their environment, bilingual infants may err on the side of exploration and collect more samples from their more varied environments. These would include visual as well as auditory samples, because visual input facilitates language learning. In support of our proposal, we found that infants raised in bilingual homes switch attention between visual stimuli faster and more frequently than infants raised in monolingual homes (D'Souza et al., 2020). But this may have been due to non-language (e.g., cultural) differences. To address this problem, we investigated whether attention switching could be associated with a continuous measure of language experience. We hypothesised that the less exposure to English infants raised in the UK have (1) the faster they abandon attention to a

visual stimulus in order to shift attention to a novel stimulus and (2) the more often they switch attention between two visual stimuli.

In addition, we investigated the potential trade-off between time spent seeking new information (exploration) versus processing familiar information (exploitation). We hypothesised that bilingual infants exploit information in less depth and thus develop weaker but more plastic representations of their more complex (less predictable) environments.

Fifty-six 7-9-month-olds from bilingual homes were administered two eye tracking tasks: the gap-overlap task (Johnson et al., 1991) and a graded change detection task. In the gap-overlap task, infants were presented with a central stimulus followed by a peripheral target. The time it took the infant to saccade to the peripheral target was measured. At the onset of the peripheral target, the central stimulus either remained onscreen (the overlap condition) or disappeared (the baseline condition). In both conditions, the infant had to switch attention. But in the baseline condition, the infant also had to disengage attention from the central stimulus in order to shift it. Therefore, by subtracting baseline saccadic reaction times (SRTs) from overlap SRTs, we can measure how quickly infants abandon visual processing of one stimulus in order to shift to a new stimulus. In the second task, two visual stimuli were presented. One stimulus gradually changed across trials. The number of times the infant switched looking between stimuli was measured.

We found that the continuous measure of language experience was indeed associated with attention switching (Table 1). Also, preliminary analyses suggest that bilingual infants require more time to process familiar stimuli (Figure 1). This supports our hypothesis of an exploration-exploitation trade-off.

S.20.03: Allocation of Attention to Familiarity and Novelty in Monolingual and Bilingual Infants (Singh)

Leher Singh, Marina Kalashnikova, Paul C. Quinn

Recent studies have reported differences in attention between monolingual and bilingual infants (D'Souza et al., 2020; Kalashnikova et al., 2021; Singh et al., 2015). These studies suggest that bilingual infants, when given a choice between familiar and novel stimuli, attend more to novel stimuli relative to monolingual infants. This preference is thought to reflect an adaptation to a more complex environment which may be more conducive to broad sampling of information (D'Souza & D'Souza, 2021; Singh, 2021).

In this study, we sought to determine how monolingual and bilingual infants deploy attention to familiar and novel stimuli over time. Using the classic paradigm of Fantz (1964), we presented infants with a series of 10 trials consisting of images of two visual stimuli (cats or dogs) shown on the left and right of the display. One cat (or dog) image remained constant throughout the trials (familiar stimulus). The other stimulus consisted of a different exemplar of a cat (or dog) that varied on each trial. Over the succession of the trials, infant attention to the familiar stimulus was tracked to determine change over time in attention to the constant (familiar) stimulus relative to the changing (novel) stimulus.

The sample consisted of 24 bilingual and 27 monolingual infants tested at 5-6 months of age and 21 bilingual infants and 23 monolingual infants tested at 9-10 months of age. Infants were assigned randomly to a cat or dog condition and presented with one constant image and multiple variable images. Their attention to the constant (familiar) stimulus (PTL) was tracked across three time blocks of the experiment.

A Linear Mixed Effects model with proportion of looking time (PTL) to the familiar object as the dependent variable, and infant age, language background, and time block as predictors, yielded a significant language background by block interaction. As there was no effect or interactions with age, analyses collapsed across age groups. Follow up pairwise comparisons showed that PTLs in Block 1 were significantly higher for monolingual than bilingual infants, ß=.062, t=2.152, p=.032, reflecting an early familiarity preference in monolinguals and a novelty preference in bilinguals. As the task progressed, monolingual PTLs decreased significantly (Block 1 vs. Block 2, ß=.066, t=2.876, p=.004; Block 1 vs. Block 3, ß=.073, t=2.960, p=.003). This was not the case for the bilingual infants whose PTLs remained stable between Blocks 1 and 2, ß=.001, t=.034, p=.973, and Blocks 1 and 3, ß=-.018, t=-.670, p=.503. As shown in Figure 1, preferences for the familiar (constant) and the novel (variable) stimuli in the groups unfolded in opposition to each other throughout the task. Bilingual infants rapidly oriented towards the novel stimulus, and their novelty preference remained stable. Monolingual infants showed an initial preference for the familiar stimulus and then oriented towards the novel stimulus, replicating attentional change over time reported by Fantz (1964). Our findings suggest that when presented with the same visual information, the temporal dynamics of visual attention differ for monolingual and bilingual infants.

S.20.04: Attention and labelling in monolingual and bilingual caregiver-infant interactions (Kalashnikova)

Marina Kalashnikova, Dorotea Bevivino, Leher Singh

Infants' early linguistic input consists primarily of infant-directed speech that they hear during interactions with their caregivers. The conceptual, linguistic, and acoustic properties of this input are shaped by multiple factors related to the infant, the caregiver, and their interaction (Rowe & Snow, 2020). For instance, when caregivers and infants engage in joint play with objects or describe images in picture books, caregivers monitor their infants' behaviours and attention, which allows them to produce an objects' label when the infant directs sustained attention to this object. These optimal labelling episodes lead to more successful encoding and consolidation of novel labels, thus fostering infants' early lexical development (e.g., Abney et al., 2020).

Recent evidence suggests that infants' individual linguistic experience may have an effect on their attentional allocation patterns already in the first year of life. Contrary to their monolingual peers, bilingual infants have been shown to disengage attention from familiar referents in their environment and produce more frequent attentional shifts to novel referents (D'Souza et al., 2020). These attentional patterns are proposed to emerge as adaptations to bilingual infants' highly variable linguistic environments, but to date, it is unknown whether they can, in turn, shape infants' linguistic environments by impacting the quality of linguistic input that bilingual infants receive in interactions with their caregivers.

This cross-sectional study investigated labelling behaviours produced by caregivers of 9- (N = 20) and 5-month-old (N = 20) monolingual and bilingual infants during naturalistic interactions (in addition to objective experimental measures of infants' visual attentional allocation patterns; Talk 1 in this symposium). Families were recruited from a bilingual community, so all caregivers were proficient bilinguals, and the groups differed solely according to infants' bilingual experience. Monolingual infants received less than 10% of exposure to a second language, and bilingual infants received at least 25% exposure to their non-dominant language. Caregivers' speech was audio-recorded when they described

four images to their infant. The number of lexical shifts produced by the caregiver when describing each image (a proportion score controlling for the total number of utterances produced for each image) was computed. A shift was scored every time a caregiver moved from describing one semantic category represented on the image to the other (see Figure 1 for a visual representation). Preliminary analyses of the speech addressed to 9-month-olds in this sample demonstrated that caregivers of bilingual infants produced significantly more lexical shifts than caregivers of monolingual infants (Figure 2). This talk will discuss the effects of infants' age (5 vs. 9 months) and infants' and caregivers' individual patterns of language proficiency and use on caregivers' production of lexical shifts in infant-directed speech. We will discuss these findings in the context of the quality of bilingual infants' early linguistic environment, and its relation to their linguistic and cognitive development.

S.21: Parenting in context: Everyday family contexts and their influence on caregiving 'in the wild'

S.21.01: Maternal sensitivity 'in the wild' is highly variable and systematically varies across contexts (de Barbaro)

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Caregivers' sensitive responses to infant distress are theorized to form a foundation for infants' social-emotional development. However, there is limited data on parents' responses to infant distress as experienced by infants. Gold-standard measures of maternal sensitivity are typically assessed from five-minute "free play" settings. These short observations rarely contain instances of infant distress. They likely also restrict variability associated with "everyday caregiving" where caregivers may juggle other needs and responsibilities at home, including care of other children. Thus, while sensitivity assessed in "free play" may represent caregiving in "ideal" conditions, we know little about the variability of caregiving "in the wild", nor how everyday home contexts may affect caregiving in the moment.

In the current work we examine variability in caregivers' sensitivity to infant distress captured in 24-h audio recordings of infants' everyday home interactions. We further assess the degree to which everyday contexts predict variation in caregiver sensitivity to infant distress both at the within and between persons levels.

N = 87 families shared 72+ hours of infant-worn audio recordings collected over the course of a week. N=28 24-h recordings, each from a distinct infant, were selected for annotation. Research assistants annotated all instances of infant fussing and crying. Individual instances of distress occurring within five minutes of one another were grouped into a single episode, following similar approaches (ICC=0.85). A second team annotated caregiver sensitivity to distress for each identified distress episode (ICC=0.83). A third team of annotators coded the context of distress episodes, noting the audible presence of other individuals, media, target caregiver doing chores or other emotionally intense interactions occurring during the course of the ongoing distress episode (ICC=0.93).

On average, infants had 12.3 (range 1-26) episodes of distress in 24h, ranging from 1-58 minutes in duration (M=5.5min, SD=2.3min). 17% of responses to distress were from individuals other than the mom. Excluding all non-mom responses, multilevel models indicated that rankings of everyday maternal sensitivity to distress was highly variable across individual instances of distress, with 63.5% of

differences attributable to within-person variance (see Figure 1). Using multilevel models, we tested three possible predictors of variation in maternal sensitivity. Participant-mean media presence was associated with decreased caregiver sensitivity ($p<.0001$), however, within-person differences in media presence did not predict sensitivity ($p>.5$). Mean differences in the presence of other emotionally intense interactions did not predict sensitivity ($p>.05$). However, controlling for participant-mean differences in emotional intensity, within-participant increases in the presence of other emotionally intense interactions during the distress episode predicted decreases in caregiver sensitivity ($p<.01$). Qualitative descriptions revealed that 75.0% of ongoing emotionally intense interactions involved an argument with or tantrum of another child. Differences in the presence of other individuals or ongoing chores did not predict sensitivity at the within or between persons levels (all $p>.05$). Overall, our results suggest that average measures of sensitivity to distress are not representative of infants' everyday distress and regulation experiences. Additionally, variation in mothers' sensitivity to distress is associated with both regular and dynamic structure in their everyday ecological environments.

S.21.02: Comparing maternal sensitivity in three home contexts during infants' first year: Feeding, free-play, and bedtime (Teti)

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Much can be learned from observing parenting of infants in the home (Repetti et al., 2012). It is rare, however, for researchers to conduct observations in more than one home context. There is good reason to do so. Different home contexts may vary in the challenges they create for parents, including those created by infants themselves, and parents may vary in their ability to meet them. It is reasonable to expect parenting quality to vary across home contexts, to vary in stability across infant age, and to link differentially with external correlates. The present study addressed these questions by examining maternal sensitivity with infants in three observational contexts in the home: feeding, free-play, and bedtime.

Data for this study were drawn from 167 families participating in a study of parenting, sleep, and infant development from 1 to 24 months, funded by NIH. The present study focused on data collected at 1, 3, 6, and 9 months of infant age. Maternal sensitivity with infants was examined in three home contexts that were video-recorded: Feeding (for 5-to-10 minutes), free-play (10-15 minutes), and putting infants to bed (no time limit), using the Emotional Availability Scales (Biringen et al., 1998). In addition, infant-mother attachment was assessed by blind coders at 12 months with the Attachment Q-Set (Waters et al., 1995).

Analyses revealed little stability of sensitivity during infant feeding across the first year (Pearson rs = .10 - .24, M = .18). By contrast, stronger stability was found for mothers' sensitivity during free play (Pearson rs = .22 - .51, M = .41) and infant bedtimes (Pearson rs = .32 - .61, M = .53). Additional correlational analyses revealed low-to-moderate coherence between mothers' sensitivity across the three contexts (Pearson rs = .15 - .45, M = .28). A subsequent repeated measures general linear model analysis revealed main effects of context and age, and a context X age interaction (see Figure 1). Sensitivity was higher in the feeding context compared to free play and bedtime, $p < .01$; there was a general downward trend in sensitivity from 1 to 9 months, $p < .01$; and an age X task interaction was found that reflected differences in the significant trends ($p < .01$) exhibited by mothers' sensitivity in the three contexts

(quadratic for feeding, cubic for free play, and linear for bedtime). A final set of analyses was conducted to determine if maternal sensitivity in the three contexts predicted infant attachment security to mother at 12 months, as attachment theory would predict. Analyses revealed no linkages between maternal sensitivity in any context at 1 month and infant attachment security. However, at 3, 6, and 9 months maternal sensitivity during free play and bedtime, but not during feeding, was significantly predictive of 12-month infant-mother attachment (Table 1).

These results revealed that maternal sensitivity in the home contexts of feeding, free play, and bedtime was not redundant. These findings and additional points about the role of context in impacting maternal behavior will be discussed.

S.21.03: Caregiving in the Daily Life: Infant Placement and Language Exposure (Humphreys)

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Pre-mobile infants spend time in a variety of physical contexts (e.g., on playmats, in bouncy seats, in highchairs). These physical contexts afford infants very different types of movement- for example, a seating device provides postural support and constrains movement, while a playmat offers no support and allows infants to move freely. In turn, opportunities for infant behavior have potential implications for caregiving behaviors. Thus, in this paper we explore how different physical contexts may indicate, or even shape, the language input infants receive from their caregivers.

Given evidence that infants experience increased verbal interaction when being worn in a carrier compared to spending time in a seating device, we hypothesized that a given infant would experience fewer adult words when in locations that enable physical independence from a caregiver (e.g., in a seating device, on the floor) compared to other locations. One specific sub-category of interest was "seating devices" (i.e., any device that restricts movement and "contains" an infant apart from a caregiver) given evidence of widespread use in home and childcare settings. Thus, we also aimed to assess whether the use of infant seating devices explained variation in language exposure. We expected that a given infant would be exposed to fewer words while spending time in these devices (within-child effect) and also that infants who spent more time in seating devices would be exposed to fewer daily adult words (between-child effect).

We examined links between infant placement and language exposure in a sample of 60 4- to 6- month-old infants (38% male, 85% White, 8% Black, 2% Asian, 5% multiracial, 7% Hispanic) using repeated survey sampling (12 samples per day across 3 days) of their mothers and continuous audio recordings. Responses when the mother could not report on the infant's location or when the infant was asleep were excluded from analyses.

Confirming pre-registered hypotheses, infants were exposed to fewer words (Incidence Rate Ratio=0.52 [0.43, 0.62]) when spending time in locations that enable physical independence from caregivers (e.g., floor mats, seating devices). Exploratory analyses focused on the category of infant seating devices (e.g., bouncy seats, highchairs) and revealed that infants experienced fewer adult words (Incidence Rate Ratio=0.58 [0.45, 0.75]) while spending time in, compared to out of, seating devices. Additionally, infants with higher rates of seating device use tended to experience fewer adult words (r=-.32) and less consistent language exposure (r=-.42) throughout the day. These results support previous work linking

language exposure to contextual factors and further suggest that the use of seating devices may explain individual differences in caregiver speech to infants.

S.21.04: Maternal speech decreases during periods of detected ambulatory phone-use (Mikhelson)

Miriam Mikhelson[1], Adrian Luong[1], MckenseyJohnson[1], Peter Wu[1], Kaya de Barbaro[1]

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Mobile devices are increasingly integrated into everyday life, with potentially concerning implications for caregiving behaviors. In laboratory settings, parental phone-use has been associated with reduced mother-infant engagement and positive affect, as well as worse real-time word learning (e.g. Myruski et al., 2018; Reed et al., 2017). Similarly, parental phone-use in public settings such as parks or waiting rooms is negatively associated with caregiver sensitivity and responsiveness (Vanden Abeele et al., 2020, Wolfers et al., 2020). However, caregivers' decisions to use their phones and their interactions with their children may differ in these situations relative to the everyday interactions in the privacy of their homes. Thus, in the current study we conduct ambulatory (24h+) observations of phone-use, maternal speech, and infant utterances in home settings to examine whether caregivers' real-time phone-use reduces their speech in everyday interactions with their child.

Our sample consists of 12 infants (33% male, M=3.49 months, SD=2.21) and their mothers in the context of a larger study (N=87). The dyads in our sample were chosen due to their contribution of phone-use data.

Each dyad contributed up to 72 hours of data collected over the span of a week. Infants wore a LENA audio recorder and Movisens motion sensor, and mothers installed a mobile application, Beiwe, that continuously tracked phone-screen activation. Maternal speech and infant utterances were extracted from LENA's automated outputs. We identified all daytime (7am-7pm) minutes in which the phone screen was on or off, excluding minutes of infant sleep determined using Movisens data. Participants contributed an average of 20.61 hours (SD= 5.87; range = 10.32-33.37) of simultaneous daytime audio, accelerometer, and phone-use data, with an average of 7.68 hours with screen-on time (SD= 4.59; range = 2.22-17.75). We compared maternal word count and infant utterance distributions across minutes that the phone screen was on versus off. To account for differences in mean hourly rates of speech across the day, we compared phone-on and phone-off minutes independently for each one-hour daytime interval. Given the highly skewed and zero-inflated nature of language data in home settings, we used the Anderson-Darling test, which assesses differences in skewed distributions with an emphasis on the tails, and the distributions' upper quartile values to determine the direction of the differences.

A-D tests indicated that mothers spoke less during phone-on vs phone-off minutes for 8 of 12 daytime hours, (see Figure 1) confirming our main hypotheses. Infant vocalizations decreased during phone-on minutes for some hours, but less consistently than maternal word count (see Figure 2), suggesting that additional variables may be influencing the effect of maternal phone-use on child speech. Future work will investigate whether these relationships are present at the within-person level. Broadly, our current findings highlight how a ubiquitous everyday context - spending time on the phone- is associated with changes in real-time caregiving behaviors. Additionally, they suggest an underlying real-time mechanism by which parent device-use may affect infants' language development.

S.22: The Content and Form of Early Action Understanding

S.22.01: Neural correlates of action anticipation and perception as a function of motor development: a combination of mu ERD and functional connectivity analyses (Chung)

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Behavioral evidence shows that experience with an action is associated with infants' action perception (Hunnius & Bekkering, 2014; Woodward & Gerson, 2014). However, less is known about the neural processes associated with this action-perception link. Neural mirroring, the recruitment of similar neural activity during the production and perception of action, has been suggested as a mechanism that links action experience and perception. The desynchronization of alpha waves (6-9Hz in infants) in EEG over the sensorimotor cortex--known as mu suppression--that occurs both during action execution and perception has been hypothesized to be associated with neural mirroring in humans. However, contradictory findings exist regarding the association between mu suppression and motor familiarity in infant EEG studies. Neural mirroring is found to be associated with actions that infants have experience with and for motor skills in which they are competent in (Cannon et al., 2016). Others suggest neural mirroring is not restricted to actions in one's own motor repertoire but extends even to non-executable actions (Southgate & Begus, 2013). These findings challenge the assumption that mu suppression is a unique neural correlate of the motor familiarity of observed actions. Moreover, research has been focused solely on neural motor activity even though other processes, i.e. visual processes, may also be inherent during action processing (Fox et al., 2016). Exploring functional connectivity between networks, rather than mu as an isolated neural marker, may be a better indicator of the underlying mechanism of the action-perception-link.

In the current study, we aimed to explore the neural correlates of anticipation and perception of actions as a function of infants' motor development. Nine and 12-month-old infants viewed familiar actions (grasping) and novel actions (tool use) as we measured their distinct motor and visual activity as well as the functional connectivity (FC) between these processes. Infants' motor skills were then assessed by measuring latency to grasp. A significant suppression of mu (motor activity) and occipital alpha (visual activity) was found, but mu suppression was stronger for grasping than tool-use. Furthermore, greater visual-motor FC was found relative to two control networks (frontal-central; parietal-central) during observation of familiar action, a pattern not observed for novel action. We then explored the specificity of visual-motor FC and its relation to motor development by estimating the strength of FC between visual and motor areas relative to the overall level of connectivity across the scalp. Greater motor skills (grasp latency), longer exposure (age) and greater familiarity with the presented action was associated to greater specific FC in the visual-motor circuit, particularly during action anticipation. Critically, no relation was found between experience and FC in control networks, suggesting a unique role of the visual-motor circuit on the link between action experience and action encoding.

These findings indicate that motor development in infancy shapes the neural underpinnings of anticipating and perceiving others' actions. This study paves the way for future research to use methods that investigate functional neural networks in socio-cognitive development rather than limiting analyses to isolated markers of brain activity such as oscillatory power in the EEG.

S.22.02: Open-minded, not naïve: Three-month-old infants can learn that objects and locations are the goals of other people's reaches (Woo)

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As adults, we readily infer others' goals from their actions. If someone reaches for a teddy bear over a ball, for instance, we infer that they likely desired the bear, rather than whatever stood at the location of the bear. The present experiments probe the foundations of such goal attribution through studies of 3-month-old infants.

Developmental research has probed early capacities for goal attribution by presenting infants with an agent who repeatedly reaches for an object in one location over another object in a second location, and examining infants' expectations of what the agent will reach for when the objects switch locations (Woodward, 1998). Using this paradigm, classic research has found that 3-month-old infants, who cannot reach for objects by themselves, appear to lack expectations that agents will continue acting on the same objects that they had previously reached for (Sommerville et al., 2005). After gaining first-experience reaching for objects (with assistance), however, 3-month-old infants expect that agents will pursue their goals consistently. These findings are suggestive that infants learn to appreciate others' goals through their own personal experience reaching.

Do 3-month-old infants fail to view reaching as goal-directed, or are they uncertain which properties of objects (what versus where an object is) are relevant in different contexts? In the standard paradigm, a person reaches not only for the same object, but the same object in the same location. It may be ambiguous, then, whether the agent reached for the object because of what it was, or because of where it was. Infants may come to appreciate that reaching is more likely directed at objects than locations through their experience reaching for objects, regardless of where they are. If young, prereaching infants are uncertain about whether agents reach for objects because of what they are versus where they are, then they may find reaches to a new object and reaches to a new location to be equally novel when the objects switch places for the test phase of Woodward's paradigm.

Here, we show that 3-month-old infants can attribute either object goals or location goals to an agent, when provided with strong evidence that the agent acts on the same object regardless of where it is (Exp. 2), or the same location regardless of what object is there (Exp. 3). By contrast, when 3-month-old infants received ambiguous evidence about why an agent acted on an object, infants did not expect the agent to continue acting on the same object nor the same location (Exp. 1). Our findings suggest that before infants reach for objects themselves, infants can adaptively learn about others' goals based on what evidence they receive. That is, they are not ignorant about the goals of others' reaches, but open-minded as to what those goals may be.

S.22.03: Investigating the developmental origins of dehumanization: Infants' understanding of ingroup and outgroup members' goals (Yuen)

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Humans are a cooperative species that tend to help others and avoid inflicting harm. Harm aversion is especially pronounced: adults are willing to incur high costs to spare others from harm (Crockett et al., 2014) and become distressed when merely simulating acts of harm (Cushman et al., 2012). But if humans find harming others so aversive, why do we continue to witness atrocious and seemingly remorseless acts of violence in our societies? Psychological research offers an explanation in the form of the dehumanization hypothesis, positing that perpetrators of violent acts perceive outgroup members (e.g., different race) as "less human" than ingroup members, which then allows perpetrators to mentally justify violence (Andrighetto et al., 2014; Cuddy et al., 2007; Haslam, 2006; Leyens et al., 2007; Over, 2021). Some developmental work suggests that even 6-year-olds may already dehumanize outgroup others; for example, they attribute less human traits to members of a different race (Costello & Hodson, 2014), and perceive outgroup faces as less human (McLoughlin et al., 2018). These findings point to the possibility that dehumanization emerges early in development, perhaps even at ages at which infants are already sensitive to ingroup and outgroup differences. Indeed, literature suggests that by their first birthday, infants not only distinguish between ingroup and outgroup members, but show preferences for their ingroup: They prefer same-race over other-race individuals, and prefer those who speak their native language versus a foreign one (Bar-Haim et al., 2006, p.; Begus et al., 2016; Kinzler et al., 2007; Xiao et al., 2018). However, it remains unclear whether, beyond ingroup favoritism, infants also engage in outgroup dehumanization.

In this project, we investigate the developmental origins of dehumanization through studies of infants' understanding of ingroup versus outgroup members' goals and goal-directed actions. Past work suggests that infants attribute goals to animate agents (e.g., humans), but not to inanimate objects (Woodward, 1998); therefore, if infants dehumanize outgroup members, they should ascribe them less agency, thus be less likely to understand their actions as goal-directed. In three experiments, conducted in-person (Exp. 1), virtually via Zoom (Exp. 2), and asynchronously via Lookit.com (Exp. 3), 11 months old monolingual-English infants were familiarized to videos in which an experimenter continuously reaches for one of two objects (adapted from Woodward, 1998). Afterwards, the locations of the objects switched, and infants saw events where the experimenter either reached for the same object or the other object. Critically, prior to the reaching events the experimenter first established themselves as either an English (ingroup) or Spanish speaker (outgroup). Preliminary results from Exp. 1 show that infants expect ingroup members' actions to be goal-directed, but hold the opposite expectation for outgroup members. By contrast, preliminary results from Exp. 2 and 3 suggest that infants did not perceive the reaching actions as goal-directed in either condition. Together, while Exp. 1 suggests that 11-month-olds perceive actions of ingroup members (but not outgroup members) as goal-directed, Exp. 2 and Exp. 3 suggest that the effect may be fragile and susceptible to methodological differences.

S.22.04: Evaluating infants' reasoning about agents using the Baby Intuitions Benchmark (BIB) (Yasuda)

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Infants have a rich, commonsense capacity to infer the underlying goals and preferences of other agents in the environment merely by observing their actions. Artificial intelligence, in contrast, does not (Lake et al., 2017). A recently proposed machine-learning benchmark, the Baby Intuitions Benchmark (BIB; Gandhi et al. 2021), challenges AI to reason about other agents like human infants do. State-of-the-art,

deep-learning-based agency reasoning models (e.g., Rabinowitz et al., 2018) fail on BIB's tasks requiring a representation of an agent's preference or rational action. Putting infant intelligence in direct dialogue with machine intelligence for the first time, here we test 11-month-old infants on BIB.

Across six tasks, BIB asks whether infants: 1) represent an agent as having a preferred goal object (Preference Task, after Woodward, 1998); 2) bind specific preferences for goal objects to specific agents (Multiagent Task, after Buresh & Woodward, 2007); 3) understand that physical obstacles restrict agents' movements to preferred goal objects (Inaccessible Goal Task, after Scott & Baillargeon, 2013); 4) represent an agent's sequence of actions as instrumental (Instrumental Task, after Sommerville & Woodward, 2000); and 5) infer that a rational agent will move efficiently towards a goal object (Efficiency and Irrational Agent Tasks, after Gergely et al., 1995). Because BIB's tasks present agents and objects with simple movements, minimal cues to animacy, and from an overhead perspective, they challenge the abstractness of infants' knowledge (Figure 1). Because BIB tests six competencies in a presentatioanlly consistent way, moreover, infants' patterns of successes and failures will both replicate and extend the literature on infants' knowledge.

We have currently collected 254 datasets across 53 infants, including 28 infants who each contributed six datasets, completing all of BIB's tasks. With a preregistered sample size of 32 infants completing all six tasks, we anticipate finishing data collection by late-December 2021. Here we report data from 26 pilot participants (12 females, Mage = 11 months 4 days, range = 10 months 13 days - 11 months 26 days) tested on BIB's Preference and Efficiency Tasks, with half of the infants receiving each task first; four infants completed only one task so there were 24 infants per task.

A linear mixed-effects model for each task with Expectancy (expected vs. unexpected) as a fixed effect and Participant as a random-effects intercept revealed that infants looked longer to the unexpected test trials in both tasks (Preference: $\beta = 3.24$; $p = .040$; Mexpected = 5.26, Munexpected = 8.50; Efficiency: $\beta = 4.50$; $p = .016$; Mexpected = 7.96, Munexpected = 12.47; see Figure 2).

Our findings promise to reveal essential properties of human's early emerging reasoning about agents, and BIB serves as a model for revealing the foundational knowledge that humans possess both within and across essential content domains of everyday life. Infants' pilot performance on BIB, moreover, demonstrates clear differences between artificial and human intelligence. These differences are critical to address if we aim to create machine common sense and artificial intelligence that we better understand and that better understands us.

S.23: Audiovisual speech processing in typical and atypical development: A perspective from multiple levels of analysis

S.23.01: Audiovisual speech processing in infants at risk for autism: Changes in sensitivity to temporal synchrony and selective attention in the first year of life (Lozano)

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The detection of temporal synchrony is crucial to the development of socio-communicative skills, especially language acquisition (Bahrick, 2010). It typically develops in the first year of life, tightly coupled with changes in infants' selective attention to talking faces. Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder primarily defined on the basis of socio-communicative deficit, frequently

entailing language impairments (Eigsti et al., 2011). Given the high heritability of ASD, these atypicalities usually extend to some first-degree relatives, such as infants at risk for autism (HR-infants, henceforth; Hudry et al., 2014). According to some approaches of the emergency of ASD, primary early perceptual and attentional atypicalities would underlie later impairments in higher-order socio-communicative abilities associated to ASD (Johnson, Jones & Gliga, 2015; Campos, 2018). On the basis of the Intersensory Impairment Hypothesis (Bahrick & Todd, 2012), we predict that HR-infants would show early atypicalities in both the detection of temporal synchrony and the pattern of selective attention to audiovisual speaking faces. This study first explores if, compared to low-risk infants (LR-infants, hereafter), HR-infants show a reduced sensitivity to temporal synchrony in audiovisual speech in the first year of life. Secondly, it examines whether, during this period, HR-infants differ from their control peers in the pattern of changes in selective attention to talking faces. The trajectories of the two groups in these skills were longitudinally followed at 4, 8 and 12 months. By using a preferential looking task, we presented two audiovisual speaking faces, one in synchrony an one temporarily misaligned. Selective attention was also measured by recording infants' eye-gaze to the talker's eyes and mouth. Our data still need some in-depth reanalysis, but preliminary results show interesting trends. Unlike predicted, both groups succeeded in detecting temporal synchrony. By contrast, groups followed different patterns of shifts in the selective attention to facial features across time. Whereas LR-infants shifted their pattern of preference to the eyes and the mouth across the first year of life and selectively focused on the mouth from the second half of this period, HR-infants did not vary their pattern of preference, thus finding the audiovisual redundancy equally salient across time. Furthermore, group differences in the allocation of attention were observed at the end of the first year of life. While LR-infants preferred to rely on the talker's mouth, HR- infants preferred to look at the eyes, thus showing opposed patterns. Altogether, our preliminary results suggest that HR-infants show atypical selective attention from the second half of the first year and differ from their typical peers at the end of this period. This finding, if confirmed, would converge with the view that language development impairments shown by some children with autism and their infant siblings are linked to atypicalities in early audiovisual processing, particularly in selective attention to speaking faces. However, our data do not yet allow us to draw conclusions about the possible role of these atypicalities in the development of ASD itself, nor to robustly conclude from "domain-general" approaches for the emergency of that heterogeneous spectrum of disorders.

S.23.02: Infants' Individual Differences in Perceiving the McGurk Effect (Cannistraci)

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Infants are exceptional learners, and their precocious ability to learn language supported by concurrent perceptual and cognitive development. Perceptual learning involving audiovisual speech has been linked to later receptive and expressive language abilities (e.g., Bahrick et al., 2018; Young et al., 2009). One demonstration of infants' ability to integrate auditory and visual speech is infants' perception of the McGurk Effect illusion (Burnham & Dodd, 1996; 2004). In the canonical McGurk effect, an auditory /ba/ stimulus is temporally synced with a visual /ga/, and this combination is perceived as /da/ or /tha/. The illusory, fusion effect is interesting but not unequivocal--some adults report perceiving the auditory stimulus (i.e., /ba/) or combinations (e.g., /bga/). Here, we examined individual differences for 33 (16 girls) 4.5-month-old's perceptions of McGurk Effect stimuli using a stimulus alternating habituation task (Singh et al., 2016) designed to test two perceptual contrasts in a within-subjects design. All infants were

habituated to the canonical McGurk Effect (auditory /ba/, visual /ga/) and tested on counterbalanced test blocks composed of two trials: one control trial (i.e., habituation stimulus) and one test trial that alternated between the habituation stimulus and either a congruent /da/ or /ba/ (Figure 1). Infants who perceived the fusion percept should dishabituate to the novel /ba/ test trial and non-fusing infants should treat the auditory /ba/ as familiar, and dishabituate to the /da/ test trial. Single sample t-tests revealed that infants' difference scores for /da/ test trials were significantly different from chance, $t(32)=3.253$, $p=0.003$, $d=0.566$, but difference scores for /ba/ test trials were not, $t(32)=1.190$, $p=0.243$, $d=0.207$. These results suggest that infants restored their looking time to /da/ test trials, evidence of perceive auditory /ba/ for the canonical McGurk stimuli. The within-subjects design afforded the ability to probe individual differences in the infants' perception for the McGurk Effect (Figure 1). While 12 infants responded as auditory perceives (novelty preference for /da/, 11 infants responded as if /ba/ was novel (i.e., McGurk fusers). Three infants treated both /ba/ and /da/ as novel, suggesting they may have perceived an alternate fusion percept (e.g., /tha/) or a combination percept (e.g., /bga/, /gaba/) and seven infants did not treat either test stimulus as novel, which may be typical, noisy infant data. These results suggest that, as a group, the infants tested did not perceive the canonical fusion McGurk Effect. This result fails to replicate previous findings by Burnham and Dodd (1996; 2004) who found that infants perceive the fusion effect using habituation methods. This null effect may be due to experimental noise rather than legitimate individual differences, though pilot data from adult participants using the same stimuli suggest that the distribution of results for infants is comparable to the adult pilot data (Cannistraci, Hay, & Buss, 2019; 46% fusers, 54% non-fusers. Our results suggest that individual differences in the perception of the McGurk Effect have their origin in infancy and begs the questions whether these individual differences are stable and functionally relevant for auditory and visual speech perception across the lifespan.

S.23.03: The sensorimotor activation in audiovisual speech perception in infants (Szmytke)

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Speech used to be studied as a purely auditory phenomenon. However, speech perception may engage not only auditory modality but visual cues from the vocal gestures like lips and face can provide helpful information (Teinonen et al., 2008). Research using neuroimaging techniques show that when viewing and listening to speech, not only areas of the brain related to hearing or vision are activated, but also parts of the motor cortex (Hickok et al., 2011). The involvement of sensorimotor areas can be observed during passive listening to speech in adults (Jehnson et.al., 2015), but this phenomenon is still not well understood in infants. Intriguingly, in infants, it was shown that blocking the tongue movement with the teether can affect speech sound discrimination (Bruderer et.al., 2015), providing some evidence that the motor system plays a role not only in the production but also in the perception of speech. Thus, this study aimed to test directly whether the motor system is activated during audiovisual speech perception in comparison to non-speech visual stimuli and if this activation is correlated with language outcomes. The activity of the motor cortex, related to both perception of the action and its execution, can be measured by EEG (Pfurtscheller & Da Silva, 1999). Studies with infants have shown that motor activity can be observed within a mu band (6-9 Hz), measured over central electrodes on the scalp (Cannon et.al., 2015; Rayson et al., 2017). In this study, we tested a group of 11- to 12-month-old typically

developing infants (n=51) and measured the changes in power in the mu frequency band. The oscillations were monitored over the left (C3) and right (C4) lateral sensorimotor cortex and their power was averaged from five electrodes from each side. During the testing session, infants watched video clips of an actress reciting nursery rhymes in native language and dynamic toys that emit sounds. All the videos were displayed in pseudorandom order. Within the same EEG meeting, Mullen Scales of Early Learning were also used to measure receptive and expressive language skills. Results showed that infants had higher desynchronization of the motor system on both hemispheres during speech perception in comparison to non-speech movements. The obtained ratios between two conditions were tested against zero for both hemispheres (t(50)=-2.94, p=.005, d=1.29; t(50)=-2.235, p=.03, d=1.37). This implies that the motor system is more involved in speech processing than processing other types of movement. Further analysis revealed that the desynchronization of the motor system was correlated with expressive language (r=-.398; p=0.005). To our knowledge, this is the first EEG study showing the involvement of sensorimotor areas in response to audiovisual speech using changes in power in the mu frequency band. Moreover, the oscillatory data correlated with infants' concurrent language skills, which provides bridging evidence that speech perception and production are intertwined with the sensorimotor system in infancy.

S.23.04: The development of integration of audiovisual speech across the first year of life: an fNIRS study (Dopierala)

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By five months of age, infants can integrate audiovisual speech (e.g., Rosenblum et al., 1997); between 8 and 10 months of age, they become increasingly sensitive to native speech sounds (Werker & Tees, 1984) and start to rely on higher-level cues to integrate audiovisual speech (Lewkowicz & Ghazanfar, 2009). Previous infant neuroimaging studies showed different brain responses to audiovisual speech depending on whether it can or cannot be integrated (Kushnerenko et al., 2008; Altvater-Mackensen & Grossmann, 2016). However, these studies focused on the integration of incongruent audiovisual speech, which in adults differs from the integration of congruent speech (Erickson et al, 2014). The integration of congruent audiovisual stimuli in adults results in specific higher (super-additive) or lower (sub-additive) cortical responses when compared to the responses to unisensory stimuli (Meredith & Stein, 1983). However, the neural correlates of integration of congruent audiovisual speech, and how they change over the first year of life, have never been tested. Therefore, our study aimed to investigate whether such non-linear cortical responses (super- or sub-additive) emerge in infancy and to clarify their development. To measure developmental changes in neural correlates of integration, we tested two groups of infants: 5-month-olds (M= 5.8, final N=20) and 10-month-olds (M = 9.7, final N=22). Infants watched synchronous audiovisual and asynchronous auditory/visual syllables. In the asynchronous condition visible articulation lagged 660ms behind audible articulation, creating perception of alternating audio and visual syllables (Lewkowicz 2010). With a 46-channel fNIRS (Gowerlabs NTS), we measured responses over the fronto-temporal cortices. To better understand the development of cortical specialisation we applied two types of analyses. We used multivariate pattern analyses (MVPA, Mercure et al., 2019) to decode patterns of cortical responses to synchronous and asynchronous speech

and RM ANOVA to identify channels showing different responses depending on condition (Figure 1). In 5-month-olds, patterns of oxygenated haemoglobin responses for synchronous and asynchronous audiovisual speech could be classified at a level significantly greater than chance over the right hemisphere (p=.044). Channel-wise RM ANOVAs showed that the successful classification was driven by sub-additive responses over right inferior frontal channels (p≤.001, corrected). In 10-month-olds, classifications were unsuccessful (p>.5) even though two bilateral channels showed sub-additive responses to synchronous audiovisual speech (p<.05, uncorrected). Together these results show the possible developmental timeline of the emergence of non-linear cortical responses to integration of congruent audiovisual speech. Around 5 months of age, the integration of audiovisual speech is supported by the right hemisphere and thus likely relies on a low-level mechanism (not specific to speech). With age, infants start to show bilateral responses to integration, however the super-additive response is not observed by 10 months of age. The present work expands on the previous studies that have predominantly focused on testing single age groups and had a limited cortex coverage, showing age-related changes in fronto-temporal responses to integration of audiovisual speech.

S.24: The impact of learning context on early language learning and teaching

S.24.01: Why nouns are learned earlier than verbs: Does the child see a cup when hearing "cup" ? The impact of word-learning context on the infant's visual experiences (Sun)

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Why nouns are learned earlier than verbs: Does the child see a cup when hearing "cup"? The impact of word-learning context on the infant's visual experiences During early language learning, young children learn nouns earlier and faster than verbs (Gentner, 1982) and nouns dominate in their early vocabularies (e.g., Fenson et al., 1994; Goldin-Meadow et al., 1976). The prevalence of noun learning has been demonstrated in different languages (e.g., Gentner, 1982; Jackson-Maldonado et al., 1993) and by various experimental paradigms (e.g., Imai et al., 2008; Kersten & Smith, 2002; Waxman et al., 2013). Some argue that the robust noun dominance is accounted for by the dominant perceptual features that nouns call to mind, i.e., referents of nouns are more concrete, imageable, and coherent across time and contexts than the referents of verbs (Golinkoff et al., 2002; Gentner & Boroditsky, 2001). Despite the evidence of noun dominance, the processes through which word referents are established are still unclear. The present study documents infants' moment-to-moment visual experiences in parent-child object play by observing 38 parent-infant dyads with infants at an average age of 10.8 months. In the object play sessions, parents were asked to use a set of toys to demonstrate four nouns and four verbs (cued by trial, each lasting 40 seconds). To zoom into the microstructure of an infant's word-referent mapping experiences, head-mounted eye trackers were used to record the infant's egocentric views that were synchronized with corresponding gaze locations. Trained coders annotated parents' noun and verb usage, infants' sustained attention (SA), and the social coordination between parents and infants, including (1) joint attention (JA) and (2) and word-referent mapping instances when infants look at the referent coupled with parent's labels (noun/verb). All of these variables have been shown to predict word learning (e.g., Morales et al., 2000; Pereira et al., 2014; Yu & Smith, 2012). To accommodate the within-dyads variations in displaying the objects, general mixed-effect models were selected and object manipulation was nested by dyads. The main findings highlight the effect of trial type, i.e., the difference in visual experiences between noun and verb trials. Infants spent more time in fixating and maintaining

sustained attention on the target objects when parents used nouns than when they used verbs (ß = 17. 75, p < .001), whereas there was no effect of trial type on infant attention toward the parent's hand actions (see Figure 1). The trial effect was also robust across the socially coordinated instances: parents and infants generated significantly longer (1) JA and (2) word-referent mapping events when parents used nouns than verbs (see Figure 2). The present study probes into the infant's visual experiences when parents teach nouns and verbs, and it documents that infant attention differs as a function of learning context. Given the greater social coordination achieved when parents use nouns, infants had more learning opportunities to couple the seen object with the heard word in a timely manner, which serves the establishment of noun-object associations. The impact of learning contexts will be further discussed in terms of the significance of domain-general mechanisms for both noun learning and verb learning as well as potential individual differences.

S.24.02: Learning words from picture books: Does the type of illustration matter? (Weber)

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Learning words from picture books: Does the type of illustration matter? Picture books are a popular medium to promote language acquisition in young children. However, relatively little is known about how the context in which words are introduced in such books impacts word learning in toddlers. Eng et al. (2020) found that extraneous illustrations hinder reading comprehension in beginning readers, but does this result translate to word learning in toddlers? Further, book sharing is known to mediate word learning and different types of books promote different teaching techniques by caregivers (Fletcher & Finch, 2015; Flack et al., 2018). The present study aimed to better understand how illustrations, while holding text constant, impact both joint book reading interactions and word learning. Thirty-seven 19-23-month-old toddlers were introduced to 32 food and vehicle words through books with either contextually-rich illustrations or isolated pictures on a white background (Figure 1). Children and their parents participated in three lab visits. At each visit, parents completed vocabulary checklists, where they indicated if their child produced a range of food and vehicle words, including those introduced in our books. Children also participated in a comprehension task, modeled after the Peabody Picture Vocabulary Test, where each word was tested. To examine joint reading interactions, parents read the books with their child in the lab, replicating typical reading practices at home. Each visit was approximately eight weeks apart, providing ample time for growth, learning, and forgetting. Parents read our intervention materials at home only between the first and second visits. Parents were given no explicit instructions on how often or in what way to read the provided books. Between the second and third visits, no materials were provided. We found that the context, or illustration, with which vocabulary words were presented influenced parent reading techniques. There were longer interactions ($t(24)=2.28$, $p<.05$) and more target words were produced ($t(24)=2.08$, $p<.05$) by parents reading contextually-rich illustrated books. We initially found no differences between the two book conditions in our language measures. However, differences emerged when looking at typically-developing and late talker-children separately. Late talkers (<20th percentile on the Macarthur-Bates Communicative Development Inventory at the outset of our study) only learned 4.5/32 target words on average by the end of the study, compared to typically-developing children who learned on average 12/32. An analysis of typically developing toddlers alone (N=24) revealed an effect of illustration type on word learning. According to parent-report checklists, children in the contextually-rich illustrations condition made

greater strides in learning to produce words targeted in our books than children in the isolated condition (compared to control non-pictured words) t(19)=2.17, p<.05. The pattern was different in the comprehension task: children who received books with target words presented in isolation performed better, t(18)=2.14, p<.05. Overall, the illustrations accompanying words in picture books change the way parents read picture books to their children, though their impact on word learning differs for production(or parent-based) and comprehension (or child-based) measures. This study also highlights the importance of more tailored interventions for late talkers.

S.24.03: The role of joint engagement in parent-child interactions and language learning for toddlers at elevated likelihood of ASD (Roemer)

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The role of joint engagement in parent-child interactions and language learning for toddlers at elevated likelihood of ASD Dyadic toy play interactions are filled with labels from parents, helping infants map words onto objects (e.g., Tomasello, 1988). Infants also shape their own opportunities for learning - emerging communicative skills create opportunities for parent input, creating a collaborative, dynamic landscape for language learning (e.g., Adamson et al., 2020). However, these skills may diverge for toddlers with an older sibling with autism spectrum disorder (ASD), who are at elevated likelihood (EL) for ASD (Ozonoff et el., 2011) and non-ASD language delays (Marrus et al., 2018) compared to toddlers with no family history of autism (typical likelihood, TL). Joint engagement ("JE", i.e., playing together with the same object) is an important context for language learning (Bottema-Beutel et al., 2014) and the target of promising interventions for children with ASD (Kasari et al., 2010). However, few studies have examined parent labels in the context of JE during play in EL toddlers. Here, we present findings on parent labels within coordinated and supported JE (i.e., JE with and without eye contact) in relation to language development. Participants included TL (n=12) and EL (n=43) toddlers. Parent-toddler dyads were videotaped at home during toy play at 18 months. Episodes of coordinated and supported JE were coded, and parent speech was transcribed. Utterances including labels were identified and further classified based on sentence position, with labels in the salient sentence-final position (e.g., "there's the bear!") differentiated from labels not in sentence-final position (e.g., "the bear is eating"). Language skill was measured using the Mullen Scales of Early Learning and the MacArthur-Bates Communicative Development Inventory at 24 and 36 months. EL children were evaluated at 36 months and classified into three groups: EL-ASD (n=12), non-ASD language delay (EL-LD, n=17), and no diagnosis (EL-ND, n=14). Dyads in all outcome groups spent substantial time in supported JE (30-43%). EL-LD and EL-ASD toddlers spent on average 15-16% of the interaction in coordinated JE compared to 25-26% for EL-ND and TL toddlers, though between-group differences were not significant. When controlling for concurrent expressive language, parent labels in coordinated JE positively predicted language skills for TL toddlers ($p < 0.01$), but labels across engagement states were negatively related to language for EL-ASD toddlers ($ps < 0.05$; Figure 1). Further, parents of EL-ASD toddlers provided significantly more labels in sentence-final position than their EL-ND peers in the context of coordinated JE ($p < 0.01$), but not in supported JE (Figure 2). Collapsing across outcome groups, sentence-final position labels in supported JE were positively related to language ($p < 0.05$), but those in coordinated JE were negatively related to language ($p < 0.05$). Taken together, findings suggest a nuanced relationship between parent labels and language. During toy play with EL-ASD toddlers already showing delays at 18 months, parents may fill

moments of coordinated JE with frequent, salient object labels. However, these labels in sentence-final position show differential relations with language depending on JE context. Thus, the context of joint engagement matters in understanding the role of parent labels in language learning for toddlers with ASD.

S.24.04: Associations between preschool activity contexts and infants' language abilities (Perry)

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Associations between preschool activity contexts and infants' language abilities Preschool teachers use activity contexts to organize the day and give infants regular opportunities to interact socially and engage with various tasks. Activity contexts vary in terms of structure, with some activities being structured (e.g., circle time) and some being unstructured (e.g., free-play). Different activities also afford opportunities for infants to engage in different types of language interactions, which in turn, may contribute to infant's language development. Infants with developmental disabilities (DD) who have increased risk of language delays may particularly benefit from more structured teacher-led activities with highly routinized interactions. The purpose of the current study is to assess how individual differences in the proportion of time spent in those activities relates to the assessed language abilities of infants with and without DD. Participants include 74 infants (M=48.57 months; 44 with DD; 30 typically developing, TD) enrolled in 8 inclusive preschool classrooms. During monthly observations, the beginning and end time of each infant's participation in each activity was recorded. Structured activities included circle time, story time, and organized play. Unstructured activities included free play, outside play, and meal times. Transitions between activities, naps, and personal care times were also recorded but not included in the comparison. Infants' expressive and receptive language abilities were assessed via the Preschool Language Scales (PLS-5). For each infant, we calculated the amount of time they participated in structured activities as a proportion of their total class time, and then averaged this proportion over observations. As can be seen in Figure 1, there was variation within and across classes with respect to the proportion of time infants spent in each activity. Because infants within a class are likely more similar in the amount of time spent in each activity, we used mixed effects regression with infants nested in classes to account for that class level variation. We predicted children's PLS-5 scores from their group (DD versus TD) and their proportion of time in structured activities. Infants with DD had lower expressive (M_DD=78.95; M_TD=114.66), B=33.72, se= 4.26, t=7.91, p<.00001; and receptive language scores (M_DD=86.91; M_TD=114.18), B=25.81, se= 3.65, t=7.07, p<.00001; than their TD peers. However, all infants seemed to benefit from more time spent in structured activities, as evidenced by a main effect of time in structured activities, particularly on their expressive language, B=39.41, se= 19.36, t=2.04, p=.045, and lack of interaction between time in structured activities and group (Figure 2). The effect of time in structured activities on infants' receptive language was only marginally significant, B=29.022, se= 16.58, t=1.75, p=.084. Together, results suggest a potential role for structured activities in supporting children's language. Notably, the association between time in structured activities and language was strongest for infants' expressive language. This finding could indicate a potential mechanism by which structured activities, in which teachers may elicit more verbal responses from children through call-and-response routines, provide infants with opportunities to practice language and build their expressive skills. Overall, these findings highlight the importance of considering the role of context in creating teaching and learning opportunities.

S.25: The ontogenetic roots of children's early socio-emotional competencies

S.25.01: Exploring the Social Origins of Young Children's Prosocial Attention (Becker)

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Infants and toddlers prefer to look at social interactions (e.g., Thiele et al., 2021) and show increased physiological arousal in response to seeing others needing help (Hepach, Vaish, & Tomasello, 2012; 2015). Here we aim to explore the interrelations and their development of social and prosocial attention in 10-, 14-, and 24-months-olds. Our goal is to shed light on what constitutes the origins of young children's prosociality by examining the degree to which children's prosocial attention (seeing others needing help and being helped) can be explained by their social attention (seeing others interact). We will investigate the underlying physiological and motivational mechanisms of infants' and toddlers' (pro)social attention using an eye tracking task. Therefore, we present children with videos showing two adults engaging in three kinds of activities (rolling balls, building towers, and hanging up socks). We manipulate the interactive relationship between the two adults in a way that they engage either in a social interaction, a prosocial interaction, or a non-interactive action (control scenario). The stimuli are pseudo-randomized and presented in blocks consisting of two tasks, a free looking task (one single video at a time) to measure children's response to each condition separately, and a preferential looking task (two videos presented simultaneously) pairing the experimental with the control condition. We are using eye tracking and pupillometry to measure children's physiological responses as hints on the underlying mechanisms of young children's (pro)social attention. Based on simulated data analyses we aim to invite 120 participants, 40 children in each age group. With a sample size of 120 we will be able to detect effects of medium size in our analyses of systematic changes in pupil dilation as well as effects of small size in our looking times analyses. We have started data collection in August 2021 and thus far 83 children took part in our study (10-months-olds, N = 17; 14-months-olds, N = 24; 24-months-olds, N = 42). We will conduct our preregistered statistical analyses once data collection is completed. This study is part of a larger data collection project additionally measuring facial electromyography, and children also take part in an associated study involving active social and helping interactions as well as a control condition. The results of this project speak to ongoing debates (Köster et al., 2019) as to whether children's attention to other's needs can be explained by their attention to other's interactions. This will inform our understanding of the development of children's prosociality more generally. This study is preregistered at OSF (https://osf.io/m632a/?view_only=d6e6c8d63a734d2eafa06ea82124ac45).

S.25.02: To help, or not to help: The development of empathic concern and personal distress in children at 2- and 3-years-old (Henderson)

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From the 2nd year of post-natal life, children show empathic concern (EC) and personal distress (PD) when observing someone in need (Eisenberg & Eggum, 2009; Fabi et al., 2019). However, despite considerable research suggesting that empathy is an important mechanism underlying helping behavior (Eisenberg et al., 1988; FeldmanHall et al., 2015; Hoffman, 2008; William et al., 2014), little is known about the developmental trajectories of the indicators of empathy in individual children.

Using data from an ongoing longitudinal study, in this presentation we report the findings of a study examining how indicators of empathy develop across 2- to 3-years and whether EC and PD predict helping at 2- and 3-years of age. Children participated in instrumental- and emotion-based helping tasks modelled after Svetlova et al. (2010). We coded children's helping (0 = no help, 1 = help after prompted, 2 = help after verbal cue, 3 = spontaneous help), and signs of EC and PD children exhibited (1 = none, 2 = mild, 3 = moderate to high) immediately after the experimenter expressed their need.

As expected, children's EC increased with age in the instrumental, $F(1) = 4.61$, $p = .03$, and emotion based tasks, $F(1) = 13.10$, $p < .001$. Regarding PD, children showed higher levels of PD at age 2 in the instrumental tasks, $F(1) = 8.72$, $p = .003$ (Figure 1). For PD during the emotion-based tasks, there was no effect of age, $p > .05$, but there was a trial effect, $F(2) = 101.58$, $p < .001$. Children showed higher PD in tasks where the experimenter displayed distress (e.g., crying, sadness) compared to discomfort (e.g., cold) or frustration (Figure 2).

Furthermore, linear mixed-effects modelling analyses revealed that children who showed higher levels of PD were less likely to help spontaneously during instrumental tasks, $F(1) = 32.79$, $p < .001$. There was an interaction effect between PD and age on children's helping scores in the emotion-based tasks, $F(1) = 16.90$, $p < .001$. Children who showed high PD were less likely to help spontaneously and this effect was more pronounced at age 3 compared to age 2. There was no effect of EC on children's helping scores.

Together, these results provide novel evidence around the unique developmental trajectories and situational nuances of empathic concern and personal distress in individual children. Whereas empathic concern seems to increase with age, personal distress seems to stay relatively stable (at least from 2- to 3-years of age). In contrast to previous literature, empathic concern did not influence children's helping behavior. However, consistent with theory, our findings suggest that high personal distress result in a flight or freezing response inhibiting children's tendency to help.

S.25.03: Infants Imitate Prosocial Models One Week Later (Schuhmacher)

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In the scope of two experimental studies, we aimed to investigate whether observational learning has the potential to affect the development of infants' helping behavior in the second year of life. Thereby, we wanted to substantiate recent theoretical assumptions (and initial studies) on the role of social experiences in the emergence and development of early prosocial behavior. Building on first findings on the effect of prosocial modelling in 1- and 2-year-olds (Donhoue et al., 2020; Schuhmacher et al., 2019; Williamson et al., 2013), we tested in Study 1 whether 22-month-old infants also imitate helping actions one week after initial demonstration (i.e., deferred imitation). During visit 1 (demonstration phase), infants (N = 54; 27 girls; all European) observed an adult model either helping or not helping another individual. During visit 2 (test phase; 7 days later), infants had the opportunity to assist an unfamiliar experimenter in similar situations. Infants in the prosocial model condition helped the experimenter more frequently (i.e., in M = 1.71 out of 2 tasks, SD = 0.69) than infants in the control condition (M = 1.21, SD = 0.83), $U = 187.50$, $z = -2.44$, $p = .02$, Cohen's $d = .67$. These findings support the assumption that deferred imitation is a powerful social learning mechanism that also has the potential to affect early prosocial development.

However, since there was only one baseline control condition in Study 1, this study (as well as other initial findings) leave room for at least two alternative explanations: first, that infants simply mimic prosocial actions and, second, that infants help simply because they have observed someone in need during the modeling phase. Thus, we planned Study 2 which aims to scrutinize the causal effects of observational learning on children's prosocial behavior. This study is currently submitted as a registered report and will implement four different conditions to control for alternative interpretations as mentioned above: Depending on condition, infants either observe a needy target and an active model (i.e., prosocial model condition), a needy target and a passive model (i.e., neediness and passive model condition), a non-needy target and an active model (i.e., no-neediness and active model condition), or a non-needy target and passive model (i.e., no-neediness and passive model condition = baseline condition). Based on an a priori power analysis we will collect data from N = 240 infants (n = 60 per condition; Mage = 16 months; range: 14- to 18-month-olds) to detect small effect sizes (f = .175). However, since we will use a group sequential plan (Lakens et al., 2021) we expect testing to be stopped earlier, probably after having assessed N = 160 infants. Data collection will take place from February 2022 until August 2022. Since we apply a group sequential plan, we will be able to report preliminary findings in July 2022 at the ICIS conference based on pre-scheduled interim analyses without inflating Type 1 error rate.

S.25.04: Sweetheart, can you help your sister: Observational learning of the emotion regulation strategy distraction from parents and siblings in 2-year-olds (Schoppmann)

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Emotion regulation is fundamental for adaptive functioning and well-being throughout the lifespan. Its development begins in early infancy and is considered to be a life-long challenge. The development of emotion regulation is thought to occur through the parent-child relationship, but further potential significant relationships are barely considered. Prior studies found that toddlers learn to apply an emotion regulation strategy through observing both parents and strangers (Schoppmann et al., 2019; Schoppmann et al., 2021). The role of siblings in the development of emotion regulation has however mostly been neglected in research, although sibling relations are considered as a natural context for learning about emotions (Kramer, 2014). In general, it has been found that toddlers with siblings imitate more behaviors than toddlers without siblings (Barr & Hayne, 2003). Therefore, we investigated whether toddlers learn to apply the age adequate emotion regulation strategy distraction by observing either their older sibling or their parent. Twenty-four-month-old toddlers (+/- 1 month) participated in two waiting situations designed to elicit negative affect. In between, they either watched their parent or their older sibling demonstrate how they distracted themselves while waiting. Toddlers in an age-matched control condition read a picture book in between waiting situations. A priori analyses estimated a final N = 66. Due to the corona-pandemic, we had to pause data collection at n = 55 included toddlers. In preliminary analyses, distraction proved to be adaptive, that is distraction correlated negatively and significantly with negative affect in both waiting situations (r = -.433, p = .001 and r = -.381, p = .001, respectively) but also in the change scores (waiting situation 2 negative affect and distraction scores - waiting situation 1 negative affect and distraction scores, respectively). Toddlers who applied more distraction in the process of the study also demonstrated less negative affect in the process, r = -.414, p = .002. Descriptive statistics regarding distraction revealed tendencies towards

equivalent levels of distraction in both experimental conditions and a decrease of distraction in the control condition, as has been found in previous studies (see Table 1; Schoppmann et al., 2019, Schoppmann et al., 2021). A 2 (waiting situation: 1,2) X 3 (sibling condition, parent condition, control condition) mixed-model ANOVA revealed no significant main effects or interaction effect, largest $F(1,51) = .642$, $p = .421$, $\eta p2 = .012$.

Though conclusions are not final at this point, we consider it relevant to include siblings into research investigating the development of emotion regulation. If older siblings take a prominent role in the development of emotion regulation for their younger siblings (or maybe also vice versa), they may be a further pathway to promote emotion regulation.

S.26: Towards an ethical and inclusive science of language development

S.26.01: Increasing Diversity in Participant Samples in Developmental Psychology (Ferjan Ramirez)

Naja Ferjan Ramírez[1], Patricia Kuhl[1]

[1]University of Washington

We published a study entitled, Parent Coaching Increases Conversational Turns and Advances Infant Language Development, in the Proceedings of the National Academy of Sciences in January 2020. Here we examine factors that influence the diversity of the final sample of families included in the study. To recap the study, we assigned 79 families of 6-mo-old infants to a parent coaching intervention group or a no-coaching control group to determine whether specific parental language variables ("parentese") can be enhanced through intervention. Naturalistic audio recordings were made in both groups at 6, 10, 14, and 18 mo of age. Parent coaching reviewed parents' use of parentese from recordings and discussed the social engagement that promotes children's language skills. Intervention increased parental use of parentese and parent-child turn-taking; both were correlated with children's language growth and outcomes (Ferjan Ramírez, Lytle, & Kuhl, 2020). The results of the study demonstrate that the Intervention was successful in enhancing parental and infant language, and exit surveys collected from participating parents indicate that they were highly satisfied with their experience. The final sample of families included in the study was overwhelmingly White, which does not mirror the population demographics of the Seattle area (Table 1). Here we identify factors that we believe affected the composition of the final sample. We first turn to recruitment procedures: We recruited from the University of Washington Subjects' Pool, an administrative mechanism used by many researchers that offers a convenient way to recruit infant participants of various socioeconomic (SES) backgrounds from the Seattle metro area. As shown in Table 1, the racial composition of the subject pool does not match the diversity of Seattle, with non-dominant groups significantly under-represented. Furthermore, while we contacted families regardless of their infants' racial background, our inclusion criteria (see below) likely favored White participants as suggested by their successful recruitment into the study (Table 1). Finally, while the overall attrition rate in the study was low (90% of participants whose baseline data was collected stayed in the study), White participants had a disproportionally higher chance of completing the study (Table 1). We also examine some of the inclusion criteria and requirements of our randomized control trial that may have disproportionally favored White participants. For example, English had to be the only language spoken in home, parent coaching appointments were held in the lab at the University of Washington, and data was collected on weekends when both parents were home and not working. We discuss how these requirements may contribute to the ways in which cultural norms permeate

methods in developmental psychology, reducing diversity. In the final part of our presentation, we propose concrete steps that we believe would increase diversity in developmental psychology experiments. These include diversifying recruitment pools; conducting exploratory research in non-dominant communities prior to intervention; delivering interventions within non-dominant communities and by non-dominant community members. We invite colleagues to discuss other measures that can be integrated into developmental research and peer review

S.26.02: What Counts as Verbal Input? Implications for Studying Child Language Development Across Populations (Scaff)

Camila Scaff[1], Marisa Casillas[2]

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Theoretical frameworks and methodological approaches regarding early language development have developed in line with the population of historical focus in our field: children from white EuroAmerican, middle-to-upper class backgrounds, particularly monolingual English-speaking children from the United States. In this presentation, we provide examples to illustrate how this tradition of oversampling populations (and thereby overfitting methods and theories) has bounded our view of language development. In particular, we here focus on (a) what "counts" as linguistic input and (b) how we choose what is relevant for scientific investigation.

What counts as linguistic input? In the current literature, huge emphasis has been allocated to adult speech towards young children, in particular maternal speech, at the cost of learning about speech available in other registers and from other speakers. We present data from verbal input studies in multiple cultural contexts, including multiple subsistence-based communities using both more inclusive (e.g., all speech; all speech to all children) and more strict definitions of child-directed speech.

Results show that children often find themselves in speech-dense environments, however this speech is simply not frequently directed to them--this is particularly the case in some of the subsistence communities (see Figure 1). Also, as a function of community, we perceived large variation in terms of speaker sources (i.e., who is addressing the child, Figure 2). In particular, directed speech from other children varied hugely in frequency from site to site, and varying with age (Figure 2).

What are relevant topics of investigation? We acknowledge that science is cumulative, and that the repeated process of making and testing predictions can point us toward fruitful paths for future research. That said, because our field has historically taken account of an extremely limited slice of human variation in early language environments, we should be wary of our biases regarding which questions and approaches are conventionally considered interesting or acceptable (e.g., increasing inclusion of qualitative approaches, smaller samples, different conceptions of "language" and child-rearing, etc.). Doubly limited--both in terms of observed data (oversampling) and researcher perspective (lack of diversity among researchers themselves)--developmental science has extraordinary work to do in encouraging its own decolonization and broadening its view of human diversity.

In the second half of this talk we reflect upon our experiences running language development research in communities whose perspectives are outside those traditionally considered in Academia. We discuss how we learned about and reacted to the relevance of our (imported) research topics to those in the participating communities, highlighting strengths and weaknesses of the decisions we made, as well as

our commitments moving forward. In particular we consider how we could better include community perspectives into our research, how we understand our responsibilities to the community, and what scientific, practical, and personal obstacles we anticipate in pursuing more equitable research in these contexts.

S.26.03: Does Talking to Children Matter? A New Look at Old Work (Weisleder)

Adriana Weisleder[1]

[1]Northwestern University

Research on early language development has been dominated by studies of children from white, middle-class, monolingual families in western countries (or what has come to be known as WEIRD: Western, Educated, Industrialized, Rich and Democratic). There is growing awareness about the importance of including participants from non-WEIRD contexts and from racial and ethnic minorities within western countries. However, broadening of participant demographics is not always accompanied by a broadening of the methods and theoretical frameworks used to understand language development in diverse contexts. As others have noted, this combination - the inclusion of participants from non-dominant backgrounds in studies that use methods and perspectives developed for and by people from dominant backgrounds - can result in research that problematizes the language practices of minoritized children and families (e.g., Medin et al., 2017; Ochs & Kremer-Sadl, 2020; Rogoff et al., 2017). In this talk, I use examples from my own work to illustrate and further interrogate this issue. Specifically, I revisit previous work that examined links between language input, language processing efficiency and vocabulary development among children from Spanish-speaking immigrant families in the United States. I analyze the study's methods and interpretive frameworks and show that, although the study made efforts to reduce potential cultural biases in measuring the language environments and abilities of Latinx children (see Table 1), it nevertheless fell short of adopting a strengths-based approach when interpreting the study's findings and implications. I then revisit the study's design and findings using theoretical frameworks from cultural and minority psychology (e.g., García Coll et al. 1996; Cabrera et al., 2019) to explore why this is the case. I argue that (1) a failure to take into account racism, xenophobia, and other experiences of discrimination to which Latinx and immigrant families are subjected represents a significant omission in understanding the forces shaping language development for children in this study, (2) a failure to take into account processes of cultural maintenance and adaptation in Latinx families may have led to a misrepresentation of the sources of individual differences in children's language development, and (3) using vocabulary size and speed of spoken word recognition as markers of successful language learning unintentionally privileged outcomes consistent with the language practices of white middle class families, and may have failed to capture aspects of language development that were culturally and contextually relevant. Together, these design choices and omissions shape our understanding of the relationship between language input and language development in children whose experiences differ from those of the dominant cultural in the United States. In the last part of the talk, I reflect on my own experiences conducting research with Latinx families, and on the challenges we need to face if we are to develop a research agenda that not only includes participants from underrepresented backgrounds but also honors the interests, concerns, and lived experiences of those participants and their communities.

S.26.04: Complicating the Language Gap Research using Critical Race Theory (Kuchirko)

Yana Kuchirko[1], Irena Nayfeld[1]

[1]CUNY Brooklyn College

The language gap is one of the most widely cited explanations for socioeconomic disparities in children's school readiness (Golinkoff, Hoff, Rowe, Tamis-LeMonda & Hirsh-Pasek, 2018; Hoff, 2013; Suskind, et. al, 2015). Since Hart and Risley's 1995 publication on SES differences in parental language input to infants, the language gap has been criticized for privileging white families' language practices, for portraying ethnic-racial minority families as deficient, and for disregarding the multitude of language socialization practices not captured by word counts and vocabulary (Avineri et al., 2015; García, & Otheguy, 2017; Sperry, Sperry, & Miller, 2018). What is missing from prior work is an examination of how the language gap is part of a larger discourse about race and inequities. We build on Critical Race Theory (CRT) to 1) examine how the language gap is a majoritarian narrative that is part of racial discourse; 2) identify a 4-step research process that upholds this majoritarian narrative; and 3) offer pathways for researchers to challenge this majoritarian narrative using core tenets from CRT: decentering whiteness, centering on the margins, and embedding children within racialized structures. In the first part of our talk, we will focus on how the language gap discourse is an example of a majoritarian narrative (Solórzano, & Yosso, 2002), defined as a "bundle of presuppositions, perceived wisdoms, and shared cultural understandings persons in the dominant race bring to the discussion of race" (Delgado & Stefancic, 1993, p. 462). Following a "standard formula" majoritarian narratives are characterized by a sequence of explanations for social issues that are constructed and interpreted as objective and neutral while implicitly reinforcing racial/ethnic hierarchies. We believe that this majoritarian narrative can be discerned from even the starting of articles, which often begin with a statement about SES- and race/ethnicity-based differences in language outcomes, and then put forth individual-level explanations for those disparities. Such articles usually conclude with calls for interventions with families and teachers to boost children's vocabulary. This majoritarian narrative is established and maintained by what we posit is a 4-step research sequence: 1) Skill "X" (In this case, children's vocabulary) is established as foundational to children's academic outcomes; 2) Skill X is studied across SES and ethnicity/race, documenting that minoritized children from low-income households underperform in comparison to middle-class, white children on observed and reported measures; 3) Predictors of SES and racial/ethnic gaps in skill X are examined (e.g., mothers' language input, education, knowledge of infants' development); 4) Interventions are implemented to close gaps in skill X. The limitations of this majoritarian narrative are that it focuses solely on individual children in micro-contexts, reflects norms largely based on white populations, and doesn't address the myriad of structural, ideological, contextual, racial, and cultural factors that shape language development and create inequities in learning outcomes. Thus, in the second part of our talk, we will draw upon interdisciplinary scholarship to highlight funds of knowledge research that focuses on the language practices of ethnic-racial minorities and examine the role of racialized structures in shaping children's language experiences.

S.27: Use of timely methods of cognitive neuroscience to understand infants cognition

S.27.01: Face selective responses present in multiple regions of the human infant brain (Kosakowski)

Heather Kosakowski[1], Michael A. Cohen[1], Lyneé Herrera[2], Isabel Nichoson[3], Nancy Kanwiser[1], Rebecca Saxe[1]

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Faces are easily identifiable visual objects as well as a rich source of social information. How does the infant brain develop the ability to recognize faces and identify potential social partners? A prominent framework, which we call the Serial Hypothesis, predicts that faces emerge in a sequential bottom-up manner with face-selective responses emerging in subcortical areas (e.g., amygdala or superior colliculus) followed by visual perception areas (e.g., fusiform face area (FFA) in the ventral temporal cortex (VTC)), and last in social-perception regions such as the superior temporal sulcus (STS) and social evaluation regions such as the medial prefrontal cortex (MPFC). Alternatively, it is possible that as soon as infants' brains process the visual features of faces, they also evaluate social-emotional face features. This framework, which we call the Parallel Hypothesis, predicts that face-selective responses will be present in STS and MPFC and the same time in development as VTC. To test whether infants' face-selective responses emerge serially, we collected functional magnetic neuroimaging (fMRI) data from a large cohort of human infants (n=49, 2.5-9.7 months) while they watched movies of faces, bodies, objects, and scenes. We observed face-selective responses in VTC, STS, and MPFC (all Ps<0.05) but we did not observe an effect of age in any region (all Ps>0.1). In the highest resolution data (n=20) we observed subcortical face responses that were not fully selective. We next asked if just the youngest infants (n=15; 2.5-4.6 months) would exhibit face-selective responses in visual-perception regions but not yet in social-emotional regions. In the youngest infants, there was weak evidence for face-selectivity in VTC (all Ps≤0.09) and strong evidence for face-selectivity in STS and MPFC (all Ps≤0.03), which does not support the Serial Hypothesis. In a last effort to find evidence for the Serial Hypothesis, we randomly selected subsets of 15 infants and asked if any subset of infants would exhibit face-selective responses in VTC but not yet in STS or MPFC. Of 2500 random sub-samples, only 1.2% of subsets of infants (31 instances), had face-selective responses in VTC but not STS or MPFC whereas 85% of subsets (2131 instances) had face-selective responses in STS and/or MPFC. Thus, subsets of infants who have face-selective responses in VTC but not STS or MPFC are very rare and non-representative. In sum, using fMRI we observed face-selective responses in VTC, STS, and MPFC of young infants, providing initial evidence in support of the Parallel Hypothesis. What mechanisms might explain the parallel emergence of face-selective responses? Perhaps infants are born with a modality-independent social brain network that readily responds during human interactions. Alternatively, perhaps prosocial interactions engage reward mechanisms resulting in the simultaneous emergence of face-selective responses across cortex. Whatever the answer turns out to be, our results suggest that the Serial Hypothesis of cortical development is not a sufficient account to explain the emergence of face selectivity; with only a couple of months of experience infants' brains process faces as more than just a common visual pattern in their environment.

S.27.02: Mechanisms of early cognition through awake, task-based brain imaging in infants (Yates)

Tristan Yates[1], Nicholas Turk-Browne[1]

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The study of adult cognition was revolutionized by fMRI: when applied during tasks, it can access internal representations throughout the brain and inform mechanistic theories of psychological processes. This ability to "look under the hood" may be especially powerful when studying infant cognition, given the limited behavioral and language abilities of infants. Other neuroscientific techniques such as EEG and fNIRS are more common in infant cognition because of the technical challenges of

infant fMRI, which include that infants move their heads excessively when awake. However, these scalp-based techniques have limited coverage of the brain and insufficient spatial resolution for precisely measuring internal representations. Additionally, although movement is less of an issue during sleep, this precludes many questions about online perception and cognition. Our lab has thus sought to develop data acquisition and analysis methods to make task-based fMRI feasible in awake infants. Here we describe a case study of this technique, about how infants segment continuous experience into discrete events. Such event segmentation is tested in adults by asking them to press a button to parse a continuous stimulus when they feel a break occur. This kind of explicit task cannot be performed by infants. Thus, most research on event cognition in infants uses simplified tasks or vignettes in which adult experimenters pre-segment events. We took a different approach of allowing infants to define event boundaries for themselves, based on their brain activity rather than an explicit task, and with no assumption that these boundaries match those of adults. Namely, we measured fMRI in 24 infants aged 4-12 months while they watched a short, animated movie and used a hidden Markov model to identify abrupt changes in brain states. This resulted in a brain-based segmentation of the movie, indicating the number and placement of these boundaries in different brain regions. This neural approach yielded additional insights into the development of event segmentation not available from infant behavior alone. In adults watching the same movie, we replicated a previous finding that brain regions are organized into a hierarchy of timescales, from shorter events in early visual regions to longer events in later visual and associative regions. In contrast, the infant brain only represented longer events, even in early visual regions, and thus did not show a timescale hierarchy. The boundaries between these events only partially overlapped with events in the adult brain and in adult behavior. These findings suggest that events are segmented differently in infants, with longer timescales and more stable neural patterns, even in sensory regions. This may indicate greater temporal integration or reduced temporal precision during dynamic, naturalistic perception. It also prompts questions about how infant vs. adult events align with the contents of the movie. To address this, we are using computer vision models to extract visual features from the movie and relate them to infant fMRI activity. Overall, our findings support the use of awake, task-based fMRI in infants to better understand the infant mind and open new possibilities for inquiry into aspects of early cognition.

S.27.03: Intrinsic timescales in the brain: similarities and differences between neonates and adults (Truzzi)

Anna Truzzi[1], Rhodri Cusack[1]

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Meaningful information is present in the environment at a range of different timescales and there is evidence that brain mechanisms are tuned to these different timescales. In human adults and other mammals, each brain region has a characteristic intrinsic timescale over which it integrates information, and these timescales follow a hierarchical gradient, from shorter in the sensory-motor regions to longer in the higher order areas. These intrinsic timescales have been found to play a role in input processing and performance on task-related cognitive tests, while atypical timescales have been related to clinical symptoms. However, it remains unclear how timescales develop. Timescales could be adult-like already at birth, preceding a critical learning period, and shape learning by determining at which timescales the input will be encoded in each brain region. Alternatively, the hierarchy of timescales could develop in concert with the learning process and reflect the acquisition of the temporal statistics of the

environment. To differentiate between these possibilities, we measured intrinsic timescales in neonates and compared them with those from adults. We characterized the timescales using resting-state fMRI in low-movement neonates from the developing human connectome project (dHCP, N_infant=267) and low-movement adults from the CamCAN project (N_adult=252). Timescales were calculated for 400 regions-of-interest (ROIs) using an autoregressive model, whose order was selected on a subset of the dHCP data (N_Group1=133) and cross-validated on an independent subset (N_Group2=134). In both infant cohorts, timescales were significantly different across ROIs, however no correlation was found between neonates and adults at the whole brain level. Moreover, timescales in the sensory-motor areas were slower in infants compared to adults. On the other hand, when segregating ROIs by network, a significant correlation was found between neonates and adults for regions belonging to the somatomotor network both in the reference and validation cohorts (Bonferroni corrected alpha=0.004). In conclusion, timescales at birth seem to generally differ from adults, suggesting that timescales are, at least partially, shaped by experience. However, the distribution of timescales in the neonate brain is not uniform nor randomly distributed, suggesting the presence, already shortly after birth, of a structure of timescales which could direct and shape learning by favoring specific timescales of integration. Notably, the sensory-motor regions, when grouped together, show longer timescales compared to sensory-motor regions in adults. This slower integration of incoming sensory information across longer timescales, might help human infants to "take it slow" and to create more regularized, holistic representations of the input which, in turn, could support learning. The specific similarity found between infants and adults in the somatomotor region was unexpected and it remains open to interpretation and further investigation. One possibility is that this similarity could underlie a readiness of this network to interact with the environment for example for feeding or communicating, functions which cannot be delayed or be significantly slowed down. Further research is under way to characterize the development of timescales during the first year of life and to test how they interact with input processing in infancy.

S.27.04: Trajectories of neural functional organization in infancy in relation to the emergence of executive control (Rueda)

Josue Rico-Picó[1], M Carmen Garcia de Soria[1], Sebastian Moyano[1], Angela,Conejero[1], M Angeles Ballesteros[1], M Rosario Rueda[1]

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Patterns of EEG activity at rest in awake individuals has been linked to individual differences in a varied range of psychological and cognitive traits. EEG provides a measure of synchronized firing of neuronal ensembles across a range of oscillatory rhythms (from about 3 to 50Hz). The relative power of particular oscillatory activity, mostly low frequencies (theta: 4-8Hz and alpha: 8-13Hz) in frontal regions has been previously linked to attentional states and cognitive control skills in adults, children and infants. With sufficient recording channels (high-density EEG) and using graph theory we can assess the functional organization of brain activity within particular cortical rhythms. This analysis provides indices of neural functional organization such as clustering (prevalence of clustered connectivity around individual nodes) and path length (shortest connectivity path between all pair of nodes in the network), which speak for the efficiency of information transferring within the brain in different cortical rhythms. For the present study we aimed at tracing the emergence of executive attention abilities in the transition between infancy and toddlerhood and explore the relationship between these skills and patters of oscillatory activity in a large cohort of infants (Initial N=141) who was longitudinally followed from 6 to 9 and 16

months of age. To assess attentional flexibility and inhibitory control babies performed the Early Childhood Inhibitory Touchscreen Task (ECITT) at 9 and 16 months of age. We expected indices of functional organization to indicate more efficient information processing (increasing small-world functional organization) with age. Moreover, we expected to find a link between functional organization in alpha and theta rhythms with individual differences in the emerging trajectory of executive attention. Results show that relative power of alpha (6-9Hz) and gamma (30-50Hz) significantly predict babies? inhibitory control and flexibility of attention both concurrently and longitudinally. In addition, more efficient patterns of functional organization (i.e. small-world index and shorter path length) in particular bands (mostly beta: 13-30Hz and gamma: 30-50Hz) was associated with better executive control as measured at 9 and 16 months of age. Although further investigation is needed to replicate and extend these results, the analysis of functional circuitry in different cortical rhythms at rest with EEG has the potential to provide neural markers of cognitive development from very early on.

S.28: Moving to learn: Sensorimotor influences on early learning

S.28.01: Infants' Motor Actions Create Context Cues for Word Learning (West)

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How do infants learn language amidst the commotion and clutter of everyday life? Infants must somehow connect nouns to the correct referents among a sea of objects, connect verbs to continuously unfolding, ephemeral events, and connect adjectives to perceptually variable features of objects or people. Nonetheless, infants learn words at an astounding rate--up to 9 new words per day by age 2. How do infants accomplish this seemingly daunting task? Previous research shows that context is key. Infants detect patterns among "data sets" of words and the accompanying context, including what infants see, the target's location, and social cues from caregivers (e.g., words about food are often spoken in the kitchen during mealtimes with food in view). Correspondence between words and context facilitates word learning. However, the role that infants themselves play in generating context cues is largely unexamined. We hypothesized that infants' own motor actions yield rich context cues to word meaning.

Here, we present data from three studies of caregivers' language input and infants' actions during naturalistic home observations. Results from all three studies uniformly show that as infants navigate their environments and manipulate objects, they elicit language that is contextually connected to their actions. Study 1 (N = 16) focused on caregivers' noun use. We found that when infants manipulate objects, caregivers respond with relevant nouns pertaining to the target object. For example, if infant held a toy car, caregiver said words like "car" or "wheels"; if infant then reached for a picnic set, caregiver shifted to words like "spoon" or "cup." Study 2 (N = 32) revealed a parallel process for verbs: As infants moved their bodies and acted on objects, caregivers offered relevant verbs for infants' actions (e.g., "climb" or "walk" as infant ascends stairs). Indeed, more than half of caregivers' infant-directed action verbs matched the infants' simultaneous action precisely in time and meaning. Study 3 (N = 53) extended this work to adjectives, using color words as a test case. Indeed, caregivers' color word use corresponded to infants' manual actions with objects. That is, caregiver said words like "red" as infant played with a firetruck, and "yellow" as infant ate a banana.

Collectively, our findings show that infants' own motor behaviors serve as a powerful context for word learning. Through their motor actions, infants actively participate in shaping their language experiences. Testing the role that infants play as active agents in eliciting language input from caregivers is essential to understanding the nature of infant word learning. The mechanisms for language learning are likely different for input that infants passively receive compared to input that infants, in part, self-generate.

S.28.02: Not all looks are equal: Embodied attention scaffolds a unique pathway to word learning (Schroer)

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Infants actively explore their world and social partners can take advantage of this exploration to create learning opportunities. Previous research shows that attending to the right referent at the right moment when hearing a label is necessary for successful learning (e.g., Axelsson, Churchley, & Horst, 2012). One open question though is whether looking alone is sufficient for learning. In everyday activities such as toy play, infant looking behavior is often accompanied by manual actions from both infants and their parents (e.g., Yu & Smith, 2017). Going beyond looking only, the present work examined a causal pathway from manual actions, to infant attention, and to successful word learning.

29 parent-infant dyads (infants 12- to 26-months) wore wireless head-mounted eye trackers while playing in a home-like lab. Dyads played with 10 unfamiliar objects with assigned names and infant learning was assessed after the interaction. We first identified naming utterances as a "hit" when infants were looking at the referent for at least a single frame of the naming utterance (mean=71.2% of the utterance), or a miss. There was a total of 133 successful hits that led to learning and 125 unsuccessful hits across all participants (no association between whether an utterance was a hit and whether the mapping was learned, Yule's Q = 0.031, Figure 1A).

To study the pathways dyads used to create hits, we analyzed infant and parent manipulation of the referent object in the 3 seconds before naming (Figure 1B). We found that both infant (beta=0.652, p=0.007) and parent object manipulation (beta= 0.844, p<0.001) predicted whether the utterance was a hit. Although infant and parent manual activity can make a hit, these two pathways to get infant attention to the referent may not have the same effects on word learning.

To understand why some hits are more successful than others, we then tested whether these self-generated (embodied) and external pathways are equal. We first analyzed the embodied pathway and found that infant object manipulation was significantly higher before successful hits (Welch's t(255.6)=-4.0301, p<0.001, Figure 2A). The external pathway driven by parent object manipulation did not turn hits into successful learning events. In fact, parent object manipulation was significantly higher before unsuccessful hits (Welch's t(252.83)=2.1829, p=0.030, Figure 2B).

Why might infant object manipulation lead to learning? Manipulating and looking at an object creates rich multimodal input and increases the information available to learning. Holding objects may also make objects more salient in the infants' field-of-view. Indeed, we found that infant object manipulation makes the referent bigger in view (small but significant correlation, r= 0.181, p=0.003), but parent object manipulation did not have the same effect (p = 0.564).

Our results suggest that gaze alone cannot predict learning. When we compare successful and unsuccessful hits, we see that only infant object manipulation predicted learning. Further highlighting the importance of embodied input, unsuccessful naming utterances were often characterized by parent manipulating the labeled object. By actively engaging with their world and manipulating objects, infants self-generate information and create word learning opportunities.

S.28.03: Dynamics of the dyad: How mothers and infants co-construct interaction spaces during object play (Schneider)

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Dyadic interactions between infants and caregivers are dynamic. They occur in moment-to-moment exchanges and evolve in form and complexity across development. Interactions are also embodied, contextually bound to real bodies that perform actions while adopting postures and positions in space. Many studies of dyadic interaction emphasize infants' communicative exchanges (e.g., gaze, vocalization) and consequently constrain the physical characteristics of interaction (e.g., infant posture, relative positioning of the dyad). Procedural decisions about the physical arrangements of interaction, however, may inadvertently limit our ability to understand how posture and position shape them.

How do infants and caregivers organize the physical spaces in which they interact? Caregivers may position themselves in ways that facilitate interaction based on their infants' developing postural skills. Reciprocally, infants' propensity to shape dyadic interactions may also increase as their own abilities advance over time. Here we asked how mother-infant dyads co-construct interaction spaces during object play and examined whether and how infant motor development shapes these interactions across the first year of life.

Thirty infants and their mothers were videorecorded at home during play with a standard toy set for five minutes at 3, 6, 9, and 12 months. Each session was divided into sixty 5-second intervals. For each interval, coders identified infants' postures (e.g., sitting, standing) and transitions between postures. Then, we coded dyad's physical orientations in space (i.e., how their bodies were positioned relative to one another), whether dyads changed orientation, and if so, which partner initiated the change. Finally, coders counted the number of objects available for play (e.g., within infants' wingspans) and noted if mothers or infants placed objects within or beyond the interaction space.

Infant posture shifted from predominantly supine and supported sitting at younger ages to independent sitting at later sessions (ps < .001; Figure 1). Moreover, infants were increasingly likely to engage in posture transitions over time ($p < .001$). Dyads switched from predominantly facing one another to orienting themselves at right angles across the first year (Figure 2). We observed an increase in how often dyads transitioned between orientations and a corresponding increase in infants' initiations of orientation transitions (ps < .01). The number of objects available for play also increased substantially between 3 and 12 months. Although mothers were more likely than infants to place objects in and out of interaction spaces, infants were increasingly likely to do so as they got older. Finally, advances in postural development, specifically infants' use of independent sitting in real time, uniquely predicted the time dyads spent at right angles and infants' object placement behaviors above and beyond infant age.

These results demonstrate fundamental differences in how mother-infant dyads create shared interaction spaces during object play across the first year. As new motor skills emerge, infants gain more control over their actions and contribute to interaction space co-construction--they increasingly shape dyadic positioning and determine (along with their mothers) the number of objects available for play. Future work will examine how these embodied properties of interaction relate to dyadic coordination of communicative behaviors

S.28.04: Longitudinal effects of independent walking on postural and object experiences in home life (Franchak)

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Transitioning from crawling to walking changes infants' exploratory abilities. Walking infants travel farther distances and more frequently retrieve distant objects compared with crawlers (Karasik et al., 2011; Adolph & Tamis-LeMonda, 2014). However, differences between crawlers' and walkers' exploratory abilities are typically measured from short, video-recorded sessions. Whether walking changes exploratory experiences requires measuring activity frequencies across the entire day to account for the diversity of tasks (e.g., play, feeding, errands, etc.) that might alter opportunities for exploration. Here, we used ecological momentary assessment--rapid, text-message surveys to probe infants' experiences through caregiver report (Franchak, 2019)--to test whether the transition from crawling to walking changes the time infants spend in different postures and holding objects in daily life.

We tested N = 45 infants longitudinally at 10, 11, 12, and 13 months. Seventeen infants began to walk independently (M onset = 12.17 months), allowing us to disentangle walking experience and chronological age. Each month, caregivers received 40 text message prompts distributed across the waking hours of four days; each prompt asked about infants' current posture (supine, prone, sitting, upright), whether infants were restrained by a caregiver or device (e.g., highchair), and whether infants were holding objects. Time spent in each activity was estimated by summing the number of samples in the activity and dividing by the total number of valid samples for each infant (excluding prompts that caregivers failed to answer and naps).

Walking experience, not age, predicted how much time infants spent prone, sitting, and upright (Figure 1). Linear mixed-effect models for each position with fixed effects of age and months of walking experience (0 for non-walkers) found that walking experience increased time spent upright (beta = 0.066, $p < .001$) but decreased time spent prone (beta = -0.026, $p = .012$) and sitting (beta = -.033, $p = .01$); effects of age were non-significant. In contrast, age predicted less time supine (beta = -.008, $p = .038$) and less time restrained (beta = -0.032, $p = .001$) regardless of walking. Time spent holding objects decreased slightly from 10-13 months (M = 46.9%-42.7%) and was predicted only by age (beta = -0.026, $p = .008$).

Yet, the likelihood of object holding depended on the type of posture and restraint. Across age, infants held objects 50.8% of the time while sitting, 40.4% while upright, 38.8% while prone, and 30.9% while supine, showing that posture moderated object holding (all Holm-corrected pairwise comparisons were significant except upright vs. prone). Similarly, infants held objects more often while unrestrained (48.2%) than when restrained (36.6%). Taken together, these results show that independent walking

may influence object experiences by modifying the time spent in body postures that afford different opportunities for object holding. Age-related changes unrelated to walking (time spent supine and restrained) also vary the likelihood of object holding and might be driven by caregivers' decisions about positioning infants rather than infants' own behavior. Thus, opportunities for manual exploration in daily life develop in the context of changing motoric and non-motoric factors.

S.29: Perinatal sleep and the parent-child dyad: associations to neurodevelopment, attachment, and early sleep health

S.29.01: Prenatal Maternal Sleep and Infant Offspring Neurodevelopment: Focus on Emotion Regulation and ADHD (Lugo-Candelas)

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Introduction: Sleep difficulties are commonly reported in pregnancy. Poor maternal sleep health may be related to a host of negative offspring outcomes. A study of 3,634 mother-offspring dyads documented that offspring of mothers with prenatal sleep disturbances had a 40% increase in ADHD symptoms as preschoolers, compared to mothers without sleep disturbances. These findings require replication, yet offspring of sleep-restricted dams show decreased hippocampal neurogenesis and deficits in self-regulation. As reduced hippocampal volumes and associated difficulties with emotion regulation (ER) in childhood are related to risk for psychopathology, poor maternal sleep may represent a critical mechanism of transmission and a novel focus for interventions. We aimed to elucidate the relationship between prenatal maternal sleep and offspring risk for ER difficulties and symptoms that are precursors to ADHD.

Hypotheses: We hypothesize poor prenatal maternal sleep health will be related to decreased bilateral hippocampal volumes in infants. We explore amygdala volume due to this structure's critical role in ER. Poorer prenatal maternal sleep health will be also related to difficulties with ER and ADHD, as measured by parental reports via the Child Behavior Checklist (CBCL). As studies document infant sex influences the impact of prenatal exposures on offspring neurodevelopment, we hypothesize prenatal maternal sleep for male, relative to female offspring, will be related to greater volumetric alterations and ER difficulties.

Study population: Our sample consists of 114 mother-infant dyads (59 males, 55 females) part of the NIH Environmental Influence on Child Health Outcomes Boricua Youth Study, a two-generation, epidemiological cohort of Puerto Rican families.

Methods: Pregnant women completed self-repots of sleep duration, quality, and disturbances via the Pittsburgh sleep quality index and the ECHO maternal sleep health questionnaires. Sleeping, non-sedated infant underwent MRIs at ~0-4 months of age. The Developing Human Connectome pipeline was used to segment T2 images and estimate sub-cortical volumes. Mothers completed the CBCL when children were 24 months.

Results: Analyses revealed a trend-level interaction between prenatal maternal sleep quality and infant sex in left (L.) hippocampal volumes, (p=0.10). For females (b=-75.55,p=0.04; males=b=3.03,p=0.89), poorer prenatal sleep quality predicted smaller volumes. Worse sleep quality was associated to greater

L. amygdala volume among males only (b=21.91,p=0.03). Worse sleep quality and greater disturbances were associated to greater offspring sleep problems on the CBCL at 24 months (p=.01;p=.02). A significant sex moderation of maternal sleep duration on children's emotional reactivity (p=.05) was also documented, with males showing a trend-level association between shorter sleep duration and greater emotional reactivity (b=-0.20,p=0.10; females=b=0.19,p=0.22).

Prenatal maternal sleep may impact in utero neurodevelopment in sex-specific ways. Although the underlying mechanisms require elucidation, it is possible that males are more affected in ER abilities, which are associated to amygdala structure and function and a significant area of impairment in ADHD. Females may be at greater risk for sleep difficulties, which may carry subsequent risk for negative mental health outcomes later in life, including depression and anxiety. Our study highlights the importance of examining the intergenerational consequences of poor prenatal sleep health, as this modifiable target is ripe for intervention.

S.29.02: Sleep patterns variability in infants and their parents (Pennestri)

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Introduction: Transition to parenthood is a beautiful but challenging period of life. The development of the sleep-wake cycle is one of the major parental concerns during the first months of life. While parents often expect their infants to "sleep through their nights" at around 6 months of age, few studies have variability of infant sleep. Consequently, even if normative data are available, these values represent averages that do not account for both inter-individual variability (between different infants of the same age) and intra-individual variability (from night-to-night within the same infant). Moreover, parental sleep patterns variability also remains to be documented.

Hypotheses: There will be a high inter-individual and intra-individual variability in infant and parental sleep patterns.

Study population: As part of this symposium, results of two studies conducted in two different samples of typically developing infants will be presented (Maternal Adversity, Vulnerability, and Neurodevelopment (MAVAN) and Once upon a night; N = 388 and 44), in order to describe the sleep consolidation variability in infancy and in parents (at 6 months postpartum).

Methods: The sleep of 6-month-old infants was measured by questionnaires (During the night, how many consecutive hours does your child sleep without waking up) or sleep diaries (during a period of two weeks) from mothers, fathers and infants. This presentation will address 3 different themes relating to sleep variability: 1) the proportion of infants who "sleep through their nights" at 6 months of age, using two different criteria (6 or 8 hours of consecutive sleep), 2) the intra-individual variability in the sleep consolidation process of 6-month-old infants over a two-week period, and 3) the intra-individual variability of parental sleep fragmentation.

Results: The following results will be presented and discussed: 1) At 6 months, about one third of infants did not generally sleep during 6 consecutive hours and about a half of them did not sleep during 8 consecutive hours; 2) When studied over a two-week period, 6-month-old infants slept through the

night only about 2 or 3 nights per week; 3) Great variability (as manifested by high coefficients of variation) was observed for parental sleep fragmentation; 4) Mothers' subjective sleep was more fragmented compared to fathers. Thus, a large proportion of healthy infants do not sleep through the night at 6 months, and there is great night-to-night sleep patterns variability both in infants and parents. New parents and health professionals should be aware of this information in order to develop more realistic expectations about newborn's sleep, since this situation will also impact parental sleep patterns.

S.29.03: Maternal Sleep Affects Mother-Infant Bond At 6-8 Weeks Postparutm (Lucchini)

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Introduction: Sleep studies in adults have shown a negative impact of poor sleep health on physical, cognitive, social, and emotional functioning. New mothers typically experience poor sleep, which could have negative effects on maternal mental and physical health, the mother-child relationship, and offspring neurodevelopment. Previous research mostly focused on mothers with depressive symptoms, finding significant associations between sleep and attachment. Attachment is defined as the emotional bond experienced by the parent towards the infant. Attachment and its quality play a primary role in emotional, social and cognitive development of a child. This study investigates associations between maternal self-reported sleep health and the mother-newborn attachment in the early postpartum period in a sample of low-risk mothers.

Hypotheses: Worse attachment will be predicted by worse maternal sleep health (shorter duration, lower quality, longer latency and less efficiency).

Study population: The sample consists of low-risk, highly educated women with full-term infants (N=59) from Prague, Czech Republic. We anticipate that by July 2022 our sample size will reach 100 dyads and will include follow up data at 6 months.

Methods: Mothers completed the Pittsburgh Sleep Quality Index (PSQI) and Maternal Postnatal Attachment Scale (MPAS) at 6-8 weeks postpartum. The PSQI is an 18-item self-report questionnaire which measures the following sleep domains over the preceding month: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. The MPAS is a 19 item self-report questionnaire that is used to assess mother-to-infant attachment, composed by 3 subscales: quality of attachment, absence of hostility, leisure in interaction. Multiple regression analyses were conducted to assess associations between sleep parameters and MPAS overall score and subscales, adjusting for significant psychosocial and demographic covariates (perceived stress (PSS), state trait anxiety (STAI), perceived social support (PSSS), infant sex, maternal education, age, breastfeeding) Results: Maternal age was 32.0±4, 78% of women received college education or above, mean values of PSS, STAI and PSSS were 13.5±5.5, 9.7±2.2 and 75.8±7.6 respectively. 75% of the women fully/partially breastfed and 52% of the infants were female. The overall MPAS score was predicted by subjective sleep quality and sleep duration, but only subjective sleep quality significant after adjusting for age, PSS, social support and breastfeeding (β=-4.0± 1.7 p= 0.03). Quality of attachment score was predicted by subjective sleep quality and daytime

dysfunction, but only subjective sleep quality significant after adjusting for age, PSS, social support, anxiety, and breastfeeding. Absence of hostility was predicted by subjective sleep quality but not significant after adjusting for social support and breastfeeding. Pleasure of interaction was predicted by subjective sleep quality and sleep latency, but only sleep latency significant after adjusting for perceived stress, social support and breastfeeding (β=1.8±0.8 p=0.03).

In summary, worse subjective sleep quality was associated with poorer attachment and lower quality of interaction, while longer sleep latency was associated with more pleasure on interaction. These results highlight the importance of expanding our knowledge on the relationship between maternal sleep health and mother-to-child bond which is a significant determinant of child neurodevelopment.

S.30: The development of referential communication: lessons from preverbal infants and apes

S.30.01: Ontogeny of Cognitive Reference Comprehension (Liszkowski)

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Using words meaningfully requires understanding speakers' referential intentions. Experimental studies have provided evidence for a preverbal cognitive fundament of reference comprehension around 12 months of age, when infants comprehend and produce gestural reference to occluded and absent entities. Surprisingly little, however, is known about the ontogenetic emergence of this cognitive infrastructure in the first year of life. I will present recent and new findings from our lab on the emergence of cognitive reference comprehension. Contrary to nativism views, which suggest that preverbal cognitive reference comprehension is 'just there', I argue for a gradual developmental emergence from a social-constructivist perspective. I present developmental evidence that foundational skills of cognitive reference comprehension at 12 months are absent at 8 months; continue to refine after 12 months; and are predicted by social-interactional experiences in the first year of life. Relevant findings derive from experimental studies of interactions, eye-movements, and pupil dilation, which all employed the same paradigmatic logic: By separating perception and cognition through occlusion events we distinguished simple cueing associations and attention following from cognitive expectations of referents. Infants watched an actress point to occluded sites, and we then measured their expectations for a referent object. In a recent pupillometric study, we found that 12- but not 8-months-olds had larger pupils when a referred-to site was unexpectedly empty than when a not referred-to site was empty. Following up on the age differences, in a new cueing paradigm, infants watched an actress in profile point behind one of two occluders positioned at her front and back. When occluders were lowered, 14-months-olds, but not 8-month-olds, looked longer at the referred-to but empty site than at the not referred-to empty site. When the actress did not point and was only still oriented to one side, the effect was absent at 14 months, but present at 36 months, suggesting that expectations about others' attentional contents outside communication develop later than communication-induced expectations. Using the communicative condition of the same paradigm in a new longitudinal study monthly from 8 to 12 months (N=47), we found sound evidence for object expectations following referential pointing at 12 months, but not earlier. Further, in an interaction-based paradigm, infants followed an adult's gestural reference to manually search for an object which was hidden in one of two locations above chance only from 11 months on (in another of our longitudinal studies from 12 months on). Our new longitudinal findings further revealed that following a point to a visible target emerged

about a month earlier than the referential expectation for an occluded object. Finally, longitudinal findings revealed that both parents' and infants' pointing - taken as a proxy to triadic interactional experiences - predicted infants' comprehension of reference to occluded objects - but not vice versa. Findings reveal that preverbal cognitive reference comprehension is as much a foundation for subsequent communicative development as it is an outcome of triadic experiences in the first year of life. Social constructivist theories may account for the ontogenetic emergence of cognitive reference comprehension.

S.30.02: Reference in the gestures of children and great apes (Cartmill)

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Children gesture before they can speak, and children's referential abilities rely more strongly on gesture than speech well into their second year of life. When children are at the one-word or two-word stage of language development, gestures will often fill in communicative gaps, allowing children to communicate more complex concepts than they are able to in speech alone. While speech eventually takes over as the dominant communicative modality, gesture does not become redundant. The gestures adults produce enrich and add to their speech, often revealing information absent from speech. In humans, gesture and speech together seem to form a unified communicative act--they are integrated both semantically and temporally. Gesture also forms a large part of the communicative repertoires of non-human great apes, but it is rarely produced alongside vocalizations. In this way, great ape gesture resembles the gestures of young human children, but even in the absence of speech, the ways apes and children use gesture to reference the world around them differ. In this talk, I compare the gestures of pre-verbal and barely-verbal children, adults, and great apes. I use human gesture data drawn from a longitudinal video corpus of parents and children interacting spontaneously at home collected over the first five years of children's lives by researchers at the University of Chicago. My ape gesture data is drawn from a corpora of zoo-housed orangutans and chimpanzees in North America and Europe. Apes use gesture in sophisticated, intentional ways: demonstrating persistence, flexibility, and elaboration and paying attention to the visual attention of their recipients. The sophisticated ways apes gesture supports the theory that gesture may have played a critical role in the evolution of language, possibly being the modality within which linguistic structure first emerged. I argue, however, that even before children can speak, they use gesture to create referential acts in ways that differ from great apes. Very young children use gesture to refer to distant entities and even to reference things outside their perceptual environment. They can incorporate different viewpoints into their gestures and can co-create referential gestural frames with others. These features reflect the unique cognitive building blocks of human language, even in preverbal children.

S.30.03: A milestone in the development of verbal reference: learning words for unseen objects (Luchkina)

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A fundamental feature of human languages is that they enable us to learn about objects, events, and ideas that we cannot witness directly (past events, imaginary characters). This capacity for referential

communication rests upon a three-way link between words, referents, and mental representations of those referents (Luchkina & Waxman, 2021; Luchkina & Xu, 2021). When does this link emerge and how does it develop in the first years of life? By about 12-14 months, infants understand verbal reference to recently removed objects (e.g., Osina et al., 2013) and produce referential communicative behaviors, such as pointing, towards their former locations (e.g., Liszkowski, 2009; Saylor & Baldwin, 2004). By 16 months, infants use language to update their representations of recently shown objects (e.g., "Now the dog goes on the table"; Ganea et al., 2016). This evidence indicates that infants begin to retrieve existing representations based on language input and produce preverbal reference in the first half of the second year of life. An open question is when and how this link between words, referents, and mental representations becomes sufficiently robust to support learning entirely new information from language. To address this question we investigated how and when infants develop the ability to establish a representation of something they cannot see, based on language input. In a novel experimental paradigm, we leveraged infants' sensitivity to semantic priming and evaluated their ability to learn the names of objects that are not shown at the time of learning. In Experiment 1, 15-month-olds watched an actor who first named three familiar visible objects and then ostensibly looked toward and labeled a non-visible object ("A modi!"). In the Priming condition (N=24) all familiar objects were from the same semantic neighborhood (e.g., fruits). During test, a novel object from the same neighborhood and a semantically distant object were presented. Infants were prompted to look to the object corresponding to the newly learned word ("modi"). In the No Priming condition (N=24) all familiar objects were semantically distant from each other. Only in the Priming condition, the presentation of familiar word-object pairs enabled infants to constrain the range of possible referents of the novel word to items in the same semantic neighborhood. This suggests that 15-month-olds can create novel representations based on language input and map words those representations. Given the extant evidence, it is possible that even 12-month-olds can establish new representations based on language input. However, a challenge with testing infants this young is that their vocabulary may be too limited to support the priming procedure used in Experiment 1. Thus, we included an additional element in the design of Experiment 2 - a digital picture book containing all words used in the priming phase of Experiment 1. We asked parents to read for several days before testing infants' comprehension of those words and then conducting the same procedure as in Experiment 1. We expect to complete data collection and analyses for Experiment 2 by April 2022. Experimental design, stimuli, and pre-registered analyses are available in a registered report (Luchkina & Waxman, 2021). Together, the results of Experiments 1 and 2 will help establish the earliest evidence of infants forming novel representations based on language and will contribute to our knowledge of the development of referential communication.

S.31: The role of phonology in early bilingual vocabulary

S.31.01: Speech Perception Development in Bilingual Infants' First Year of Life (Kalashnikova)

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During their first year of life, infants undergo a process of perceptual learning and acquire specialized knowledge about the phonetic properties of their native language(s). This is typically manifested in an increase or maintenance of sensitivity to native phonetic contrasts and a simultaneous decline in sensitivity to most non-native contrasts. The process of perceptual learning is supported by the quality

of linguistic input that infants receive in interactions with their caregivers. In the case of monolingual infants, individual native speech perception abilities are significantly correlated with the phonetic qualities (the degree of vowel hyperarticulation) in maternal infant-directed speech (IDS) (Liu, Kuhl, & Tsao, 2003). This relation has not been documented for bilingual infants who face the additional challenge of extracting the phonetic properties for each of their languages from more complex and varied linguistic input.

This study investigated the relation between bilingual infants' developing native and non-native speech perception abilities and the phonetic properties of their caregivers' IDS. This was studied in infants acquiring Spanish and Basque, two typologically distinct languages with highly different grammatical and lexical structures, but largely overlapping phonological inventories. Five- and nine-month-old monolingual Spanish or Basque and bilingual Spanish-Basque infants and their mothers participated (N = 131). Infants completed a behavioral visual preference habituation task that assessed their ability to discriminate a consonant contrast native to both Spanish and Basque and a contrast non-native to the two languages. In addition, maternal speech was recorded during a natural play session with their infant (IDS) and an interview with an experimenter (adult-directed speech, ADS), completed in monolingual infants' one language or bilingual infants' two languages. Vowel hyperarticulation in maternal speech was measured, indexed by the degree of expansion of the acoustic space of the triangle encompassed by the three corner vowels /i/, /u/, /a/ in IDS relative to ADS.

Monolingual and bilingual five-month-olds showed successful discrimination of the native and non-native consonant contrasts, but a decrease in the ability to discriminate the non-native contrast was observed in the nine-month-old group (Figure 1). These results indicate that when bilingual infants acquire two languages with largely overlapping phonological inventories, they follow a similar developmental trajectory of native and non-native speech perception to their monolingual peers.

Mothers of monolingual and bilingual infants produced significant vowel hyperarticulation in IDS in Spanish ($M = 2.100$, $SD = 2.45$), $t(64) = 3.626$, $p < .001$, and Basque, ($M = 1.636$, $SD = 1.642$), $t(88) = 3.655$, $p < .001$, and this did not differ when they addressed bilingual infants in their dominant and non-dominant language. Critically, in both language groups, vowel hyperarticulation in IDS was significantly related to speech perception skills for nine-month-olds, but not for five-month-olds. Mothers who hyperarticulated vowels to a greater extent in IDS had infants who exhibited reduced sensitivity to the non-native speech contrast ($r = -.30$). These findings suggest that bilingual and monolingual caregivers provide their infants with speech input that assists their task of learning the phonological inventory of one or two languages.

S.31.02: A longitudinal exploration of bilingual toddler's processing of cognates (Garcia-Castro)

Gonzalo Garcia-Castro[1], Serene Siow[2], Nuria Sebastian-Galles[1], Kim Plunkett[2]

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Previous studies have provided evidence that lexical access is language non-selective in bilinguals: recognising and producing words in one language activates lexical representations of words in the other language (e.g., Costa et al., 2000; Thierry & Wu, 2007). It has been suggested that this parallel activation is already present during toddlerhood (Jardak & Byers-Heinlein, 2019; Von Holzen & Mani, 2012), but it is unclear how it impacts the developing lexicon. In the present study, we tested Catalan-Spanish and

English-Spanish bilinguals in a word recognition task, in which they were presented with words in their dominant language exclusively. In each trial, two pictures were presented side-by-side and one of them was named (target picture). Participants' visual preference for the named picture was taken as an indicator of word recognition. Each pair of pictures was preceded by the presentation of a silent image (prime picture). We designed three types of trials: (1) cognate trials in which prime and target labels shared phonological onset and the prime label was a cognate (e.g., flower-flor / fork), (2) non-cognate trials, in which prime and target labels shared phonological onset but the prime label was a non-cognate (e.g., frog-rana / fork), and (3) unrelated trials, in which prime and target labels did not share phonological onset (unrelated trials; car-coche / fork).

In line with previous studies, we expected participants to generate implicit labels for the prime pictures, which should interfere with target word recognition when both words share phonological onset (e.g., Mani & Plunkett, 2011). Additionally, under the hypothesis that bilingual participants would activate labels for the prime pictures in both languages, we predicted that interference would be stronger after cognate primes (labels from both languages share phonological overlap with target word recognition) than after non-cognate primes (only the label in the target language share phonological overlap with target word recognition). We tested bilinguals (n = 46) and same-aged monolingual controls, n = 123) at three age points (21, 25, and 30 months) to investigate how any cross-language priming effect emerged or changed across these ages.

Preliminary results (data collection is ongoing) from a Bayesian Growth Curve Analysis suggest that bilinguals' proportion target looking (PTL) did not differ across the cognate (58.32%, 95% HPD = [51.15, 64.37]), non-cognate (57.85%, 95% HPD = [51.22, 64.29]), or unrelated (59.62%, 95% HPD = [54.41, 64.97]) priming conditions. Surprisingly, monolinguals' preference for the target picture was stronger after non-cognate primes (63.46%, 95% HPD = [59.08, 67.91]) and unrelated primes (63.59%, 95% HPD = [59.87, 67.08]) compared to cognate primes (59.73%, 95% HPD = [51.15, 64.37]). This suggests that contrary to our predictions, monolinguals were sensitive to both phonological priming and cognateness. This effect survived after adjusting for potential confounders such as lexical frequency, age of acquisition or object animacy. We present these results along with exploratory analyses addressing the puzzling pattern of results we observed.

S.31.03: Cross-linguistic similarity between words facilitates bilingual infants' vocabulary trajectories (Siow)

Serene Siow[1], Irina Lepadatu[1], Nicola Gillen[1], Daniela Avila-Varela[2], Gonzalo Garcia-Castro[2], Nuria Sebastian-Galles[2], Kim Plunkett[1]

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Bilinguals' two languages are intrinsically linked by shared semantic and phonological properties. Word pairs occur across languages that have the same meaning (translation equivalents) and some of these pairs have highly overlapping phonology (cognates). Advantages for cognates over non-cognates have been found for children's performance on receptive vocabulary tasks (Bosma, Blom, Hoekstra, & Versloot, 2019; Pérez, Peña, & Bedore, 2010) and word production tasks (Bosch & Ramon-Casas, 2014). We contribute to this literature by investigating whether cognates affect early vocabulary trajectories, using parent-report questionnaires to measure vocabulary knowledge in both languages. Our sample included 12 to 36-month-old bilingual toddlers (N = 823) growing up with English and one additional

language (AL) (Dutch, French, German, Italian, Polish, Portuguese or Spanish). Bilinguals heard each language at least 25% of the time. We collected 418-word Communicative Development Inventories (CDIs) in English and the AL for each child. Analyses were conducted on 236 words common across all CDIs. To classify translation equivalents as cognates or non-cognates, we calculated the Levenshtein distance between their phonological transcriptions. Levenshtein distance sums the number of edits needed to convert one word to another. We normalised the resulting score to account for different word lengths. We defined cognates as word pairs with a normalised score of 0.6 or less. Dutch and German shared the largest number of cognates with English (30.5% and 27.5% respectively). This was followed by French (11.9%), Italian (11%), Spanish (7.6%), Portuguese (6.3%) and Polish (5.5%). If cognates facilitate vocabulary learning, we expect that cognates would be more likely to be known than non-cognates after accounting for word difficulty. As English was the common language across all participants, we analysed word comprehension for English words in our dataset. We used monolingual age-of-acquisition (AoA) norms obtained from 1720 British English monolingual infants between 12 and 32 months old as a proxy for English word difficulty. To test our hypothesis, we ran a generalised linear mixed effects model with the binary dependent variable of word comprehension (understands or does not understand). The word pair's cognateness was the main predictor. We included child's age in months, percentage of English exposure and word difficulty as covariates. Participant and word were included as random effects. We found that English words that were cognates with their AL translation equivalents were known by more toddlers, even after controlling for age, English exposure and word difficulty ($z = 5.12$, $p < .001$). The inclusion of cognateness as a predictor significantly improved the model (AIC = 139519) over a model without cognateness (AIC = 139523, $p < .001$). These findings complement previous findings that toddlers learning language pairs with many cognates have larger vocabulary sizes and know more translation equivalents than children learning languages with few cognates. Taken together, this supports the hypothesis that even toddlers who are just starting to learn language can make use of similarity between words in their two languages to learn translation equivalents more easily.

S.31.04: Cross-language cognate advantage in bilingual infants' vocabulary acquisition (Tsui)

Rachel Ka-Ying Tsui[1], Lori Mitchell[1], Krista Byers-Heinlein[1]

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Infants growing up in bilingual environments acquire translation equivalents which are cross-language words for one concept. These can be dissimilar-sounding words (e.g., "dog" in English and "chien" in French) or cognates (e.g., "banana" in English and "banane" in French). An advantage for cognates has been reported where bilingual infants leverage phonological overlap across their two languages and produce cognates more readily than non-cognates (Bosch & Ramon-Casas, 2014). Previous literature with bilingual children and adults has shown that relative language exposure impacts the direction of cognate advantage (e.g., Poarch & van Hell, 2012; Robinson Anthony et al., 2020). A cross-language transfer from the dominant language is proposed to facilitate lexical access in the non-dominant language, leading to a stronger cognate advantage in the non-dominant than dominant language. To explore if cognate advantage is modulated by language exposure in bilingual infants' vocabulary development, we examined bilingual infants' production of cognates versus non-cognates in their dominant and non-dominant languages.

Monthly expressive vocabulary data were collected from 47 French-English bilingual infants across the ages of 16-30 months using the French and English versions of MacArthur-Bates Web-Communicative Development Inventories (CDIs; Fenson et al., 2007; Trudeau et al., 1999). This gave us a total of 219 administrations of both languages. We limited our analysis to (1) a full list of 537 translation equivalent pairs (131 cognates, 406 non-cognates) identified across the two CDIs by three proficient French-English bilinguals, and (2) a subset of 81 cognates and 81 non-cognates matched for part of speech, age of acquisition, and word category. The dominant language was determined by the parent-reported language with a greater exposure.

Result is displayed in Figure 1. To normalize the different numbers of words on the full list and the matched subset, the dependent variable was the percentage of words produced rather than raw values. Overall, bilingual infants produced a greater percentage of words in the dominant than the non-dominant language, and a greater percentage of cognates than non-cognates. However, linear mixed-effects models revealed no significant interaction between language and cognate status such that infants produced more cognates than non-cognates regardless of the language, both for the full list (Estimate = 0.52, SE = 0.72, p = 0.47) and the matched subset (Estimate = -0.31, SE = 1.13, p = 0.79).

Contrary to most findings with adults and school-aged children, we found a similar advantage for cognates in both the dominant and non-dominant languages in bilingual infants' vocabulary development. Simultaneous bilingual infants appear to draw on their knowledge in one language to facilitate vocabulary acquisition in the other, such that they make use of form similarity to build the lexicons in both languages, not just unilaterally. Our results suggest that the nature of the cognate advantage could be different for simultaneous/balanced bilinguals compared to second language learners (Poarch & van Hell, 2012) and/or for parent-reported early vocabulary development as opposed to behavioral tasks.

S.32: The use of neuroimaging tools in the study of adversity and predictiveness: A global view

S.32.01: Brain Imaging as a Measure of Future Cognitive Outcomes of Children (BEAN) (Nelson)

Eileen F. Sullivan, Ashley Bach, Wanze Xie, Charles A. Nelson

Exposure to adverse psychosocial and biological events in early life--including caregiver stress, food scarcity, and chronic enteric (micro-organismal based intestinal) disease--has been associated with lifetime risk of major mental and physical illness, such as type 2 diabetes, heart disease, psychiatric illnesses, and deficits in executive functions. For the past 6 years, two cohorts of children, enrolled at 6- and 36-months-of age, growing up in a resource-limited urban neighborhood in Dhaka, Bangladesh, have been intensively followed using a battery of behavioral, metabolic, neurophysiological, and biologically based measures. Here we focus on two specific outcomes: the effects of psychosocial adversity on inhibitory control assessed using event-related potentials (ERPs), and the effects of recurrent systemic inflammation (putatively related to enteric disease) on brain functional connectivity (FC) assessed by electroencephalography (EEG).

In terms of the effects of psychosocial stress on inhibitory control, there is strong evidence that children growing up in homes with higher burdens of psychosocial stress typically evince poorer performance on tests of inhibitory control than those in homes with less psychosocial stress. We examined relations among early adversity, neural correlates of inhibitory control, and cognitive outcomes in 154 five-year-old children of the sample. Participants completed a go/no-go task assessing inhibitory control and their

behavioral and ERP responses were assessed. Cortical source analysis was performed. We collected measures of poverty, malnutrition, maternal mental health, psychosocial adversity, and cognitive skills. Supporting studies in high-income countries, children in this sample exhibited a longer N2 latency and higher P3 amplitude to the no-go versus go trials. Unexpectedly, children had a more pronounced N2 amplitude during go than no-go trials. The N2 latency was related to their behavioral accuracy on the go/no-go task. The P3 mean amplitude, behavioral accuracy, and reaction time during the task were all associated with intelligence-quotient (IQ) scores. Children who experienced higher levels of psychosocial adversity had lower accuracy on the task and lower IQ scores.

In terms of the effects of inflammation on EEG functional connectivity, we examined the associations between recurrent systemic inflammation, defined as C-reactive protein elevation on ≥2 of 4 measurements across the first year of life, EEG FC at 36 months, and composite cognitive outcomes at 3, 4, and 5 years among 122 children in the sample. Recurrent systemic inflammation during the first year of life was significantly negatively associated with cognitive outcomes at 3, 4, and 5 years, after accounting for stunting and family care indicators (a measure of stimulation in the home environment). Recurrent systemic inflammation was significantly positively associated with parietal-occipital FC in the Beta band at 36 months, which in turn was significantly negatively associated with composite cognitive scores at 3 and 4 years. However, FC did not mediate the relationship between recurrent systemic inflammation and cognitive outcomes. Overall, our study strengthens the evidence that exposure to both psychosocial and biological adversity in the first years of life is associated with changes in brain circuitry associated with inhibitory control and with changes in FC as inferred from EEG.

S.32.02: Stunting in the first year of life is associated with asymmetric activation of dorsal and ventral attention networks (Spencer)

John P. Spencer, Sobanawartiny Wijeakumar, Samuel H. Forbes, Vincent A. Magnotta, Vinay P. Singh, Aarti Kumar

Stunting impacts over 162 million children worldwide affecting cognitive outcomes and influencing health and well-being; however, little is known about how stunting impacts neurocognition in the first year of life. Here we examined how stunting affects the functional brain networks underlying visual cognition in infancy. A large sample (N = 240) of 6- and 9-month-old infants were recruited from Shivgarh, a rural community in Uttar Pradesh, India. Infants were presented with a preferential looking task with flashing displays of unchanging coloured squares on one side and changing coloured squares on another. We varied the working memory load over trials from a low load (1 item on each display) to a medium (2 items) and a high load (3 items). We recorded functional brain activity using fNIRS with sensors placed over bilateral frontal, parietal, and temporo-parietal regions.

Infants' preference to reliably look longer to the changing display declined with the memory load as reported in Western samples. Infants' change preference also varied with physical growth, with stunted infants showing chance-level looking at both displays even in the low load condition. This suggests stunted infants have poorer working memory abilities.

Consistent with this, stunted infants showed less activation in the left intraparietal sulcus (l-IPS), a key part of the dorsal attention network involved in working memory maintenance. This is shown in Figure 1a, which shows the average hemodynamic response in l-IPS (see yellow cluster) from trial onset (0 s) to 10 s after the end of the 10 s trial (i.e., 20 s). Oxygenated haemoglobin (HbO) is shown in red; de-

oxygenated haemoglobin (HbR) in blue. Normal height infants showed a canonical brain response, while stunted infants showed a suppression of activation in l-IPS.

Interestingly the reverse pattern was observed in the right temporo-parietal junction (r-TPJ), a key part of the ventral attention network involved in shifting attention. Here, stunted children showed robust activation, rather than the suppressed activation typical of normal height infants. Notably, these patterns of brain activity in l-IPS and r-TPJ varied systematically with the memory load (Figure 1b), suggesting a role in working memory. Consistent with this, r-TPJ activation was associated with task performance: normal height infants who showed suppression of r-TPJ did better in the task (i.e., higher change preference scores; Figure 1c), while stunted infants who showed suppression of r-TPJ did poorly.

Finally, we asked if these findings were related to cognitive outcomes one year later. Stunted infants had generally poor outcomes as measured by the problem-solving score from the Ages-and-Stages Questionnaire (ASQ) completed at 18 and 21 months. By contrast, normal height infants with more positive linear growth showed higher cognitive scores. Interestingly, normal height infants with poorer linear growth showed lower ASQ scores unless they performed well in the visual cognition task in infancy; thus, good working memory in infancy may be protective of infants at risk for cognitive delays. Functional brain activity in infancy was also related to ASQ scores: normal heigh infants with greater l-IPS activation showed higher problem-solving scores one year later.

S.32.03: The BRIGHT Project: A longitudinal study of brain and cognitive development from 0 - 5 year of life in The Gambia. (Lloyd-Fox)

Sarah-Lloyd-Fox, Chiara Bulgarelli, Bosiljka Milosavljevic, Ebrima Mbye, Ebou Touray, Samantha McCann, Laura Katus, Tijan Fadera, Fabakary Njai, Giulia Ghillia, Anna Blasi, Sophie E. Moore, Clare E. Elwell, The BRIGHT Project Team

The first 1000 days of life (from conception to two years of age) are a critical window of vulnerability to exposure to socio-economic and health challenges (i.e. poverty/undernutrition). While only a fraction of our lifespan, it is characterised by prodigious physiological, psychological and physical change. Studies suggest that the presence of these risk factors in infancy has a lasting impact throughout the life course, however almost nothing is known about the neural bases of these early deficits. We have established a prospective longitudinal study (The Brain Imaging for Global Health Project: www.globalfnirs.org) to chart early neurocognitive trajectories of brain development and behaviour in 204 families living in rural Gambia. During the first two years of life, infants partook in a series of neurocognitive functional Near Infrared Spectroscopy (fNIRS), electroencephalography (EEG), eye-tracking and behavioural assessments. Families are seen during pregnancy, then following the birth, the infant is seen when they reach 7-14 days, then at 1, 5, 8, 12, 18 and 24 months of life. Participants are currently being followed up with a pre-school assessment at 3-5 years called BRIGHT-Kids. Participating families also take part in a battery of assessments of mental health, family environment, growth and biological measures.

In this talk I will highlight some of the emerging fNIRS findings (focusing on measurement of neural responses to social stimuli, habituation to repeated stimuli, novelty detection and functional connectivity), and how these associate with (i) early indicators of adversity (i.e.. psychosocial factors including maternal mental health), (ii) concurrent measures of neurocognition (relation to EEG correlates), and (iii) later measures of cognitive development (i.e. Mullen Scales of Early Learning). For example, in one analysis we find that psychosocial factors, including antenatal maternal mental health,

associate with later specialisation of the social brain network at 18 months of age. In a second, we find that frontal interhemispheric functional connectivity markers (fNIRS) at 5 months associate with cognitive performance at 18 months of age. These findings suggest that we can see the impact of both risk factors (e.g. maternal mental health difficulties) and early signs of neural differences in response before they are observable behaviourally. We are also currently exploring how these associations are further mediated by factors such as growth faltering, iron status and sex differences, and how they map onto pre-school outcomes.

S.33: Communication includes much more than speech: Everyday, multimodal contexts of infant learning

33.01: Proximity to Caregivers and the Language Environment (Salo)

Virginia C. Salo[1], Pat Pannuto[2], William Hedgecock[3], Hannah A. Piersiak[3], Kathryn L. Humphreys[3]

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The types of interactions that support infant learning and development (e.g., language input) take place in moments of close physical contact with caregivers. However, we know little about the patterns of real-life interactions between infants/young children and their caregivers. In this pilot study of two families observed in their daily lives, we examine whether and how differences in physical proximity with caregivers is associated with the children's language environment. Specifically, we present data collected over two (12-hour) days each from a family of four (30-month-old son, 61-month-old daughter, 37-year-old father, 37-year-old mother) and a family of three (12-month-old daughter, 35-year-old-father, 33-year-old mother). Participants wore "TotTags," novel, wearable devices that dynamically and unobtrusively measure second-by-second physical proximity between device wearers without constraints on their location (i.e., infrastructure free). Each child also wore a wearable audio recording device (LENA) to collect time-synced measurement of the language environment.

Our previous analyses (Salo et al., 2021) revealed wide variability in the amount of time children spent in proximity to their caregivers, and that variations in proximity are associated with the quantity of a child's exposure to adult language. In the current analyses we took a broader look at the child's language environment in relation to caregiver proximity. Greater exposure to TV/electronic noise is associated with poorer language outcomes, possibly through decreased interaction with caregivers (Christakis et al, 2009). We thus explored whether time spent physically close to a caregiver was associated with reduced exposure to TV/electronic noise. In contrast to the idea that caregivers may be using TV/electronic games as a caregiving substitute, we found that the times children were in closer proximity to a caregiver were also times that tended to have greater exposure to TV/electronic noise, $r(862)=.17$, $p<.001$, 95% CI [.10, .23]. These findings suggest that perhaps caregivers were the operator of these devices and/or may be engaged jointly with children. We also explored the association between time spent proximal to a caregiver and the amount of silence in the child's environment, and found that proximity to at least one caregiver was also positively associated with the amount of silence a child experienced, $r(862)=.07$, $p<.040$, 95% CI [.003, .14]. Further research is needed to determine whether these were times characterized by sleep, rest, or other quiet activities. We will also discuss differences in

the association between exposure to TV or silence and caregiver proximity when considering proximity to a child's mother versus father.

As children may receive different types of input from physical and linguistic interactions, it is important to consider how these different domains operate in concert or uniquely in shaping the child's early environment. These findings suggest that variations in proximity are linked to--though, critically, not synonymous with--aspects of the child's language environment previously documented to be associated with language development. Observing patterns of caregiver-child proximity as they unfold in real time, in a family's natural context provides a novel perspective on the early caregiving environment, filling an important gap in our understanding of children's early experiences.

S.33.02: Infant-Directed Communication: Examining the many overlapping dimensions of communication beyond speech (Kosie)

Jessica E. Kosie[1], Casey Lew-Williams[1]

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Everyday caregiver-infant interactions are dynamic and multimodal. However, the quality and quantity of infant-directed speech (IDS) has received primary focus in much existing research on infants' natural interactions with caregivers. While speech is a ubiquitous and important feature of caregiver-infant interactions, focusing on speech alone undercuts the full richness of infants' everyday learning environment. The goal of the current study is to augment research on IDS by investigating "infant-directed communication" (IDC): the suite of communicative signals from caregivers to infants including speech, action, gesture, emotion, and touch. Understanding how and when caregivers use these five signals in interactions with infants has the potential to redefine how developmental scientists conceive of infants' early learning environments, and enhance our understanding of relations between caregiver input and early learning.

Infant-directed modifications in speech, action, gesture, emotion, and touch have independently been shown to promote infants' engagement and learning (e.g., Brand et al., 2002; Iverson et al., 1999; Chong et al., 2013; Stack & Muir, 1990). However, prior research has not investigated the dynamics of caregiver-infant interactions, integrating across all of these domains. To investigate IDC, we invited caregivers and their 18- to 24-month-old infants to engage in 10 minutes of natural play while being recorded on Zoom. Videos from our sample of 44 predominantly white, middle-class caregiver-infant dyads in the United States were coded for IDC using extensively detailed, pre-established methods.

We found that multiple, overlapping dimensions of infant-directed communication occurred throughout the entire 10-minute interaction. In fact, significantly more than half of the speech that infants heard (M = 64%, SD = 12%) was accompanied by one or more non-speech dimensions of IDC, $p < .001$ (Fig.1). This finding suggests that focusing on speech alone underestimates the complexity of infants' early communicative environment. We also found substantial variation in the use of IDC, both across dimensions and across caregivers (Fig.2). While one might expect caregivers to simply be high or low across all dimensions of IDC, this was not the case. Instead, individual caregivers differed substantially in which dimensions of IDC they used relatively more or less frequently (e.g., the caregivers who used the most gesture were not the same caregivers who used the most emotion).

Finally, we explored relations between infants' language skill (via the MacArthur-Bates Communicative Development Inventory; MCDI), the amount of caregiver speech alone, and caregivers' use of IDC. Interestingly, speech alone was not predictive of vocabulary size (p = .35), but IDC was (p = .003). Caregivers used more IDC when interacting with infants who had smaller vocabularies, suggesting that caregivers may tailor their use of IDC to their child's abilities, perhaps in a way that enhances learning.

Harnessing variability in multidimensional caregiver input provides important new insights into the true richness of infants' everyday social interactions. This work sets the stage for future investigations into when and how caregivers use IDC (e.g., comparing use of IDC with novel versus familiar words/objects), how IDC varies across the SES spectrum and across world cultures, and how brain-to-behavior coupling emerges between caregivers and infants across development.

S.33.03: Eating in Synch: An investigation of parent-infant behaviour coordination during feeding interactions (Vacaru)

Stefania V. Vacaru[1], Shuang Ma[1], Hein T. van Schie[1], Sabine Hunnius[1]

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Face-to-face interactions between parents and their infants are often seen as the cradle of social development, as they offer numerous opportunities to engage in playful imitations and emotional exchange. During feeding interactions with their infants, parents have been described to move their mouth as if they were eating themselves. This phenomenon provides an example of parent-infant behavioral synchrony, as it entails the coordination of matching behaviours within lags of just seconds. To date, however, the function of these synchronous eating-like mouth movements by the parents remains unexplored. To address this question, we examined two competing hypotheses. The instructional hypothesis suggests that parents' eating-like mouth movements during feeding interactions might serve the purpose of guiding infants' eating behaviours. For instance, by opening their own mouth just before the spoon reaches the infant's mouth, parents indicate that the infant has to do the same. If parents' eating-like actions are instructional, the parents' mouth movements should precede the infants' mouth movements. Alternatively, the mimicry hypothesis proposes that parents' eating-like mouth movements during feeding interactions might be an imitation of their child's actions. Facial mimicry is the spontaneous tendency to copy others' facial expressions and is thought to have an affiliative function that increases liking and the smoothness of the social interactions between individuals.

To test these hypotheses, we examined the temporal dependencies between parents' and infants' mouth movements. We reasoned that parents' mouth movements would occur before their infants' if they serve an instructional purpose, but that they would happen after, if parents mimic their infants. Additionally, we expected that parents' matching mouth movements would be more likely when their infants looked at them in both cases. Fifteen caregivers (13 mothers, 2 fathers) were observed as they were spoon feeding their six-month-old infants (Mage=189.57 days, SDage=8.51; 8 girls). Time-window sequential analysis was conducted to quantify how likely parents were to display mouth opening and closing before or after their infants did. Accordingly, we calculated four Yule's Q scores per parent-infant dyad, with scores reflecting the different combinations of mouth movement (mouth opening and mouth closing) and time-window (parent-first and parent-follow). In addition, infant gaze was defined as looking at the parent and looking elsewhere.

The results from paired samples t-tests revealed that parents' mouth movements were more likely to follow infants' movements, both for open mouth (t(14)=2.36, p=0.034) and close mouth movements (t(14)=4.47, p<0.001), thus in line with the mimicry hypothesis. Moreover, the results from the ANOVA analyses, which also included gaze, indicated that mouth movements of parents were independent of infant's gaze. One possible explanation is that infants did not look at their parents face very often in general but they may have looked at the spoon, which was coded as elsewhere.

In conclusion, our study provides support for the mimicry hypothesis of parents' eating-like mouth movements during feeding interactions, but also opens new research avenues to investigate further the intricacy of parent-infant face-to-face interactions.

S.33.04: Capturing daylong object handling patterns in two small-scale communities (Casey)

Kennedy Casey[1], Mary Elliot[2], Elizabeth Mickiewicz[1], Kimberly Shorter[1], Marisa Casillas[1]

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Infants learn words through multimodal, spontaneous interactions at home. For example, the word 'banana' is likely to be accompanied by both sensory (e.g., look, taste) and contextual information (e.g., association with mealtime, general talk about fruits) that add semantic depth to their budding BANANA concept (e.g., Bruner, 1985; Roy et al., 2015; Tamis-LeMonda et al., 2019). One way to probe children's multimodal engagement in these interactions is to examine what objects they are handling. Visual attention to handled objects leads to coordinated child-caregiver interaction, even without mutual gaze (Yu et al., 2013), and children's first-person holding experiences may further amplify the perceptual and functional properties of objects in ways that support their learning. Prior work has focused on children's object handling during selective slivers of the day, but little is known about object handling patterns over the course of whole waking days.

We examined 83 daylong photo streams from child-worn cameras with children under 48 months of age (M = 21.6 months) in two rural, small-scale communities (Rossel Papuan and Tseltal Mayan) to determine how often children and their caregivers handle objects (Study 1) and what types of objects they handle (Study 2) in the first four years.

Study 1 investigated the prevalence of child and (child-relevant) interactant object handling in over 110k photos. Object handling increased with age (b = 0.003, t = 2.80, p < 0.01), and from about 12 months children handled objects relatively frequently (15%+ of their time), doing so in bursts and lulls across the day (M Goh and Barabási's (2008) B = 0.45). Tseltal children's increase in object handling with age was significantly larger than Rossel children's (b = 0.004, t = 2.32, p < 0.05), likely due to differences in infant carrying practices, daily activities, and available objects. Finally, children's interactants rarely handled child-relevant objects (M< 2% of the time).

Study 2 explored the rate, distribution, and cross-cultural similarities/differences in the types of objects that children hold. To date, 49 of the 77 daylong photo streams with child object handling have been annotated. Children engaged with 21 unique types of objects, on average, per day (range = 1 - 59), including food, tools (e.g., for mealtime or cleaning), toys, large or immovable objects (e.g., housing or furniture), and other natural or synthetic objects (Fig.1A). The number of different object types handled by children increased with age (b = 0.58, t = 4.27, p < 0.01; Fig.1B). The exact objects available to children varied within and across communities. Within each community, a given object was handled by a

relatively small percentage of children, on average (Rossel: M = 11.7%, range = 4.4 - 60.9%; Tseltal: M = 9.2%, range = 4.0 - 56.0%). Only 21.5% of objects were present in both communities, but several of these shared objects were among the most frequently handled by children in both contexts (Fig.2).

These cross-cultural data demonstrate that child age and local context substantially impact the frequency and targets of everyday object handling and thus differentially shape children's opportunities to learn about objects' perceptual properties, functions, and related words

S.34: Deferred Imitation: Individual Differences and Environmental Influences

S.34.01: The two functions of imitation and their developmental course in the second year of life - a longitudinal study (Sieber)

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Children's imitative behavior serves two functions (Over & Carpenter, 2013): A cognitive function to learn new skills and a social function to interact with others. Uzgiris (1981) suggested that 12-month-olds imitate mainly for cognitive reasons, whereas the social function becomes increasingly important during the second year of life. The two functions of imitation are mirrored in young infants' temperament, namely their attention and effortful control - as a prerequisite of learning - and their social orientation. We investigated these links between temperament and imitation in a large longitudinal study using standardized tests. Based on Uzgiris hypothesis, we predicted that attentional aspects of temperament would be associated with their imitative behavior during the entire second year of life, whereas the association between social aspects of temperament and imitation becomes larger during the second year of life. Further, we assumed, that social aspects of temperament with 12 months predicts imitative behavior with 18 and 24 months. We assessed 12-, 18- and 24-months-olds longitudinally (N=136 at T1). To assess deferred imitation, the Frankfurt Imitation Test for each respective age point was used (Goertz et al., 2006; Goertz et al., 2008). The test consists of two phases. In a baseline phase, infants received the different objects without any prior demonstration of the target behavior. Immediately afterwards, the experimenter demonstrated the respective target behaviors. After a 15-min delay, in the imitation phase, the participants received the objects again and their imitative behavior was assessed. Infants' temperament was assessed via questionnaires (IBQ-R, Gartstein & Rothbart, 2003, with 12 months; ECBQ, Putnam et al., 2006, with 18 and 24 months). To test for infants' and toddlers' social orientation, we additionally developed a sociability scale based on the IBQ-R (Cronbach's alpha: .79), whereas the ECBQ already contains the scale Sociability. Infants' temperament was also assessed via two observational tasks at the laboratory (Puppet Game & Task Orientation, LabTAB, Goldsmith & Rothbart, 1999). We controlled for infants' cognitive development status via Bayley Scales (BSID-III, Bayley, 2006). Hierarchical regressions were conducted cross-sectionally with the imitation score (FIT) as depended variable and the baseline score (FIT) and cognitive development status as control variables. At 12 months, the sociability scale from the IBQ-R and the duration of orienting scale predicted imitative behavior, adjusted R^2 =.45, $F(5,130)=23.08$, $p<.001$. At 18 months, the imitative behavior was predicted by the Task Orientation Baseline state, Puppet Game Positive Motor Activity, ECBQ Sociability scale and ECBQ High Pleasure scale, adjusted R^2 =.105, $F(6,92)=2.908$, $p=.01$. The Surgency and the Effortful Control factor of the ECBQ predicted imitative behavior with 24 months, adjusted R^2 =.236, $F(4,102)= 121.77$, $p<.001$ (Table 1). No correlations

appeared between social dimensions of temperament with 12 months and later imitative behavior (Table 2). To sum up, we did not find consistent evidence of the relation between attention/effortful control and imitation, but we did find evidence of the relation between a social orientation and imitation throughout the entire second year of life. This finding suggests that imitation serves a social function from early on.

S.34.02: Memories in times of stress: Toddlers' retention of neutral and negative information during the Covid-19 pandemic (Seehagen)

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Living through the global Covid-19 pandemic has been an unprecedented situation for humans across the lifespan. Stress exposure early in life can have long-lasting consequences for development and well-being (Pechtel & Pizzagalli, 2011). Yet, the short-term effects of stress on early cognition are poorly understood. Given the high plasticity in early development, it is possible that toddlers become quickly attuned to negative information in times of high environmental stress (Pollak & Kistler, 2002), resulting in preferential retention of such information. We assessed retention of negative and neutral information in toddlers during the pandemic. We predicted that higher levels of caregiver-perceived threat and lower levels of caregiver mental health would be associated with increased retention of negative information. In a between-subject design, we assessed 24- to 27-month-old German toddlers' memory for neutral and negative information at three different times characterized by varying infection rates and countermeasures (Fig. 1). Caregivers received all materials to conduct deferred imitation tasks with their toddlers in their own homes (enrolled: n = 40 per measurement point; last measurement ongoing). Toddlers watched two videos showing a 6-year-old girl perform three target actions with two sets of stimuli, one rattle and one animal (modelled after Herbert & Hayne, 2000). In each video, a female adult joined the model after two demonstrations and observed a third demonstration. In one video, she reacted emotionally neutrally to the model's actions. In the other video, she reacted angrily (cf. Repacholi et al., 2008). At test 24 hours later, toddlers received the stimuli, one set after the other, and were allowed to freely interact with them for 60s. Caregivers video-recorded their child during video watching and test. Retention was inferred by the number of target actions performed at test. Caregivers provided information on their own positive mental health (Lukat et al., 2016), perceived threat of the pandemic, and on the general situation of the family via online questionnaire. There were three key findings. First, toddlers' memory for the target actions overall varied as a function of measurement point, such that performance was highest in Autumn 2020 (Fig. 2), $F(2,75) = 3.506$, $p = .035$, $\eta\rho^2 = .085$. Second, there was no significant difference in the retention of neutral versus emotional information $F(1,75) < 1$. Third, although parental well-being declined from before the pandemic to the time during the pandemic, there were no significant relationships between caregivers' mental health, perceived threat, perceived family situation, and retention (all $r < .10$). In sum, memory performance varied during times of environmental stress. However, these variations were not due to differential recall of negative versus neutral information, and they were not associated with self-reported parental mental well-being.

S.34.03: Toddler's memory and media - picture book reading and digital media use are associated with memory development at two years of age (Koch)

Felix-Sebastian Koch[1], Annette Sundqvist[1], Ulrika Birberg Thornberg[1], Rachel Barr[2], Mikael Heimann[1]

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It has been shown that young children can learn from picture books as well as video content by transferring the 2-dimensional material shown into 3-dimensional real-world actions. However, most studies have looked at group level performance and thus do not take individual differences into account. Experience with video content, e.g. watching television or clips on YouTube, could affect the ability to memorize 2-dimensional as well as 3-dimensional material as could experience with picture book reading. The current study examines whether individual differences in 2-year-olds memory performance is related to watching video content and/or book reading. The sample consist of 89 two-year-olds and their parents. A within participant design was used where two-year-olds memory was assessed for screen presented and live presented events with deferred imitation tasks. Specifically, four tasks were presented on a screen with prerecorded videos (screen condition) and four tasks were presented live by an experimenter (live condition). Tasks are based on the Frankfurt imitation Test (Kolling & Knopf, 2015). After a delay of about 30 min the children were presented with the objects of the tasks and given the opportunity to produce the target actions. The target actions for each condition were summed to create total imitation scores for each condition. A multivariant ANOVA was then run entering, watching video content (4 categories) x reading picture books (3 categories) as predictors and memory scores for the screen and live conditions as the dependent variables with repeated measures across memory scores. As shown in Figure 1, watching video content, $F(4, 134) = 4.06$, Wilk's $\Lambda = .80$, $p = .004$, partial $\eta^2 = .11$, and picture book reading, $F(2, 67) = 4.85$, Wilk's $\Lambda = .87$, $p = .011$, partial $\eta^2 = .13$, were significant but the interaction was not, $p = .31$. However, relations were different for the two conditions. Watching video content was significant for the screen condition, $F(2, 73) = 7.38$, $p = .001$, partial $\eta^2 = .18$, but not the live condition, $p = .11$ (Figure 1). Whereas, picture book reading was significant for the live condition, $F(1, 73) = 9.23$, $p = .003$, partial $\eta^2 = .12$, but not for the screen condition, $p = .79$ (Figure 2). The result indicates that children who watch more than 1 hour of video content a day imitated less from screen presented material. A lot of experience of video content seem to hamper children's imitation of target action for events presented on screens, but not events presented live. Picture book reading is unrelated to how much video content the child watches daily, but reading 30 min to 1 hour yields significant better imitation of target action for live presented events than less the 30 min daily. Possibly, picture book reading supports symbolic understanding in such a way that memory abilities increase for day-to-day activities, whereas digital media does not.

S.35: Emergence, origins, and communicative significance of deictic gestures in the first year of life

S.35.01: The Developmental Origins of Referential Communication: Joint Attention Looks and Showing Gestures (Salter)

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Much research on the ontogeny of referential communication has focused on the pointing gesture. A number of studies have sought to investigate the developmental processes that precede the emergence of conventional pointing gestures (e.g. Carpendale & Carpendale, 2010; Masataka, 2003; O'Madagain et al., 2019). However, if we want to understand the very beginnings of referential communication, we need to investigate other key, earlier-emerging behaviours. Before infants point, they can communicate

referentially in other ways. They coordinate facial expressions and vocalisations with looking behaviour, in what have been called "sharing looks" or "joint attention looks" (Hobson & Hobson, 2007; Jones & Hong, 2001). Additionally, they produce showing gestures, holding up objects so that others can see them. Both joint attention looks and showing gestures typically first emerge before pointing (Bates et al., 1979; Cameron-Faulkner et al., 2015; Carpenter et al., 1998), but have received far less attention in developmental investigations of early referential communication. To address this gap in the literature and to investigate the very beginnings of referential communication, we present data from a longitudinal study of 6- to 10-month-old infants. First, we present data on the origins of communicative joint attention looks from a novel joint attention elicitation procedure. Second, we present data on the developmental processes that precede conventional showing gestures. Twenty-five infants were assessed longitudinally at monthly intervals from 6-10 months using a variety of methods (elicitation procedures, free play observations, maternal interviews), as well as via questionnaires conducted at 11-12 months. Joint attention looks were coded for during three elicitation procedures and free play. Showing gestures were coded for during two elicitation procedures and free play. Along with conventional showing gestures, we also coded for pre-conventional, incipient gestures, behaviours that involved some components of conventional gestures, but lacked other important components. We found that some infants (44%) produced joint attention looks already from 6 months, and 100% of infants had produced at least one joint attention look by 8 months. The consistency with which infants produced joint attention looks (indexed by producing looks in multiple different tasks) increased as infants aged. These results reveal that some infants' capacity to referentially communicate emerges by at least 6 months. A single infant produced a conventional showing gesture at 8 months (4%), with 52% of infants producing a conventional showing gesture by 10 months. Incipient forms were observed as early as 7 months. There was observational evidence that at least some of these incipient behaviours were communicative. We make the case for how conventional showing may emerge gradually in the context of social interactions. We also discuss the influence of maternal interpretations of these early behaviours on their development. Overall, these data provide new insights into the very beginnings of referential communication. We argue that future studies should pay greater attention to the very earliest behaviours infants use to communicate and establish joint attention, before they use pointing.

S.35.02: Show, Give, and Point Gestures Across Infancy Differentially Predict Language Development (Choi)

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Deictic gestures play an important role in children's language development. Pointing, in particular, has been identified as a robust predictor of later language. However, recent evidence suggests that other forms of early gestures, specifically show and give gestures, emerge before pointing and are associated with later pointing. In the present study, we examined the development of show, give, and point gestures in a sample of 47 infants followed longitudinally from 10 to 16 months of age and asked whether there are certain ages during which different gestures are more or less predictive of language skills at 18 months. We also explored whether parents' responses vary as a function of child gesture types. We hypothesized that show and give gestures would emerge before pointing and might predict later language earlier than pointing does. In addition, we predicted that parental responsiveness might differ as a function of child gesture type. Data were drawn from parent-child dyads (N = 47) from diverse

socioeconomic backgrounds in the Northeast US. All children had a minimum gestational age of 37 weeks, had no known developmental diagnosis, and were primarily from English-speaking households. At 10, 12, 14, and 16 months, parent-child dyads engaged in 15-minute semi-structured play interactions at home. Parents were asked to play with their child as they normally would and were provided with age appropriate toys. These parent-child interactions were videotaped and later transcribed and coded for child gestures and parent responses. We focused a priori on the following types of child gestures: show (holding up an object in a communicative partner's sight; i.e., "look at this!"), give (holding up an object for a partner to take; i.e., "I want you to take this!"), and point (extending the index finger toward a referent). Parent responses were coded if they occurred within the first two utterances following the child's gesture and categorized as contingent or non-contingent. Child language skills were measured at 18 months using standardized (Mullen Scales of Early Learning) and parent report (MacArthur-Bates Communicative Development Inventory) measures. We found that at 10 months, show+give gestures were a better predictor of 18-month language skills than pointing gestures. Yet, at 14 months, pointing gestures were a better predictor of 18-month language skills than show+give gestures. By 16 months, children's use of speech in the interaction, not gesture, best predicted 18-month language skills. In addition, there was some preliminary evidence indicating that parent responsiveness differed based on child gesture type; at 10 months, parents provided contingent responses to a higher proportion of shows+gives than to points. These results suggest that there seems to be a developmental progression where show+give gestures are predictive of later language skills before pointing gestures are. And once pointing gestures predict language skills, show+give gestures no longer do so. In sum, different types of deictic gestures provide a window into language development at different points across infancy.

S.35.03: How early experience and expression of shyness influence infant pointing (Colonnesi)

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In the first year of life, infants can express their arousal or emotional ambivalence when confronted with novel social situations by displaying positive expressions of shyness, or coy smiles (Colonnesi et al., 2013; 2021; Reddy, 2001). Positive expressions of shyness are stable in the first two years of life (Colonnesi et al., 2021) and they are, unlike negative expressions of shyness (i.e., social withdrawal), recognized as self-regulated and socially adaptive reactions. Positive shyness relates to higher levels of sociability and theory of mind (Colonnesi et al., 2014; MacGowan et al., 2021) as well as to lower levels of attentional bias (Susa-Erdogan et al., 2021) and anxiety (Colonnesi et al., 2014; 2017; Nikolić et al., 2016). However, the impact of positive shyness on social-communicative development in infancy has not yet been examined. In the present study, we investigated whether infants' production of the pointing gesture is affected by infants' tendency to express shyness in novel social situations. The central hypothesis was that infants' who express shyness positively are those who produce more pointing gestures to direct the attention of a social partner to share the attention about socially positive situations. Participants were 80 infants (35 girls; Mage= 13.62; SD= 1.48). Infants' expressions of shyness were coded during a situation of exposure to social attention when the infants entered the lab in their mothers' arms. They were welcomed by an unfamiliar researcher giving enhanced attention and compliments. Infants' positive expressions of shyness (gaze/head aversions during smile) and negative expressions of shyness (gaze/head aversion during neutral or negative facial expressions) were coded

second-by second. Infants' production of pointing was measured with an adapted version of Camaioni et al. (2004)'s declarative task, including the presentation of three stimuli: positively valenced stimulus (moving toy spiral), no valenced stimulus (piece of fabrics), and negatively valenced stimulus (spider snake toys). Pointing gestures were coded second-by-second as frequencies and duration. Three preliminary hierarchical regression analyses were performed to test the predictive value of gender and age as control variables (Model 1), and positive and negative expressions of shyness as predictors (Model 2) on infants' production of pointing gesture during the presentations of positively valenced, no valenced, and negatively valenced stimuli. Results indicate a significant prediction of shyness on the production of the pointing gesture during the positively valenced stimulus, $R2 = .16$, $F = 3.20$, $p = .018$. Infants' expression of positive, but not negative, shyness significantly predicted pointing gestures towards positive valenced stimuli, $\beta = .34$, $t = 3.04$, $p = .003$. The models for pointing gesture during no valenced and negative valenced stimuli were not significant, $R2 = .07$, $F = 1.21$, $p = .315$, and $R2 = .06$, $F = 1.09$, $p = .371$, respectively. Infants who cope with their ambivalent feelings expressing shyness in a positive way are those who also use referential communication to share positive situations. These results suggest that infants' referential communication is connected to infants' sociability and the ability to regulate their self-conscious reactions.

S.35.04: Ontogenetic origins of infant pointing (Liszkowski)

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Infants begin to point around their first birthdays. Experimental research has revealed that infant pointing constitutes a preverbal communicative referential act (Liszkowski, 2018), predictive of later language acquisition (Colonnesi et al., 2010). However, much less is known about the emergence of preverbal referential pointing acts in the first year of life. To fill this gap, we report on two novel longitudinal studies in which we investigated predictors of the emergence of the pointing gestures. In study 1, 31 infants and their mothers were tested monthly from 8 to 13 months in three situations: a standardized point-inducing setting (the 'decorated room', in which parent and infant walk freely around in a room decorated with a set of standardized items and pictures; Liszkowski et al., 2012); a free-play setting (in which parent and infant interact with proximal toys); a point-following task (four trials). We coded index-finger and hand pointing in the decorated room; showing gestures in the free-play setting, and point-following in the experimental task. As outcome variables we determined the age of emergence (AoE) of pointing as the month, in which infants pointed more than once with the index-finger, if they also did so in a consecutive month. We also computed the median month of pointing to dichotomize the sample into pointers and non-pointers (PnP) age-centered at that month. We then computed longitudinal and cross-lagged relations between the caregiver- and child-level variables and the outcome variables. The AoE of pointing patterned between 9- to 13-months, with 11 months as the median age of pointing. Caregiver pointing at 8 months predicted the AoE of pointing ($r(25)= -.475$, $p= .009$), and caregivers who pointed above the median at 8 months had infants who pointed at 11 months ($\varphi (25)= .358$, $p= .028$). On the child-level, AoE of pointing was predicted by hand pointing ($r(25)= -.520$, $p= .001$); point-following ($r(22)= -.415$, $p= .03$); showing ($r(24)= -.415$, $p= .025$). The pattern was similar for PnP at 11 months and confirmed by regression analyses. In study 2 we used a similar longitudinal design from 8-14 months with 46 participants and included home observations at 8 and 10 months. We used a similar coding but also included parents' contingent referential responsiveness when they

gestured to things in the infants' attentional focus, and triadic activity. Main findings were replicating a prediction of the AoE of pointing from parent pointing at 8 months at home (r(36)=-.43, p=.003) and at 9 months in the 'decorated room (r(37)=-.34, p=.015). Ongoing analyses indicate a prediction of the AoE from parents' contingent responsive pointing at 8 months in the decorated room and at 10 months in free-play. Further analyses will focus on concurrent relations and differences between behaviors and settings. I will discuss findings in terms of current theoretical proposals. While social shaping accounts assume that pointing is shaped into meaning via caregivers' responses once it exists; and cognitive accounts assume that pointing rests on a social-motivational infrastructure, I argue that pointing emerges through a continuous developmental process of social co-construction which has identifiable roots in caregiver-infant joint activity.

S.36: Expectancy violations and selective learning: new perspectives from social cognition

S.36.01: Inefficient action toward infants can induce preference and learning (Hirai)

Masahiro Hirai, Yasuhiro Kanakogi, & Ayaka Ikeda

Although the learning mechanisms of infants are gradually being clarified, it is not known how they learn from others, especially from others' actions. A key concept of action that can attract infants' attention and learning is "Motionese" (Brand et al., 2002), defined as an exaggerated and repetitive action. However, it remains unclear which action components of motionese promote infants' preference and learning. We have focused on inefficiency (Gergely & Csibra, 2003; Gergely, Nadasdy, Csibra, & Biro, 1995; Phillips & Wellman, 2005; Skerry, Carey, & Spelke, 2013) and toward-ness of action (Reddy, 2008; Schilbach et al., 2013) in a series of studies. In four visual preference studies on 4-month-old infants, we hypothesized that infants' visual attention could be attracted by inefficient holding-out action toward infants, rather than efficient action and the profile view of the inefficient holding-out action. Moreover, in four novelty preference studies on 10-month-old infants, we hypothesized that infants would encode the object better than in other conditions when observing an inefficient holding-out action of a toy object toward them. In all the visual preference studies on 4-month-old infants (Experiments 1-4) and novelty preference studies on 10-month-old infants (Experiments 5-8), 24 infants were assigned to each experiment. Infants' eye movements were measured using an eye-tracker (Tobii TX-300). For the visual preference studies on 4-month-old infants, two types of actions were displayed simultaneously on each side of the monitor. The combination of the displayed actions was as follows. Experiment 1: indirect holding-out action without an obstacle (inefficient action) vs. direct holding-out action (efficient action); Experiment 2: indirect holding-out action without an obstacle (inefficient action) vs. indirect holding-out action with an obstacle (efficient action); Experiment 3: identical to those in Experiment 1 but presented in the profile view; and Experiment 4: identical to those in Experiment 2 but presented in profile view. In the novelty preference study on 10-month-olds, infants observed the toy object accompanied with either efficient or inefficient actions in the familiarization phase. This was followed by the test phase, in which two toys were displayed bilaterally. One toy was familiar; it had been displayed during the familiarization phase, and the other was a novel toy not appearing in the familiarization phase. We displayed indirect action without an obstacle (inefficient action) in Experiment 5, indirect action with an obstacle (efficient action) in Experiment 6, direct (efficient) action in Experiment 7, and indirect action without an obstacle (inefficient action) from profile view in Experiment 8 during the familiarization phase. We found that inefficient holding-out action attracts 4-month-old infants' attention. It facilitates learning about the identity of the toy object accompanying it in 10-month-old infants, especially when the model directs inefficient actions toward them. These findings indicate that both action efficiency

and toward-ness may be key factors in infant learning. We are now exploring the neural mechanisms underlying infants' observations of inefficient holding-out action.

S.36.02: Should I learn from you? Seeing irrational actions attenuates infants? propensity to learn from others (Colomer)

Marc Colomer, & Amanda Woodward

Most of what infants learn they learn from others. However, not all individuals provide information that is functionally or culturally relevant. Here, we studied how seeing people who perform unexpected actions influences selective social learning. Previous studies found that infants learn more efficiently the properties of a novel object after seeing unexpected (e.g., object passes through a solid wall) rather than expected (e.g., object stops by the wall) events (Stahl & Feigenson, 2015). These findings suggest that infants consider events that violate object behavior as a special opportunity for learning. However, as compared to objects, agents act based on goals and intentions that cannot be directly accessed or explored. Thus, violations of expectation about social entities could hinder rather than induce learning. To address this, we tested infants via Lookit (Scott & Schulz, 2017) on a word learning paradigm after manipulating whether a demonstrator's action was consistent or inconsistent with the principle of rationality -- the expectation that others act efficiently to obtain their goals (Gergely & Csibra, 2003). Eighty 17-to-19-month-olds saw videos of an agent who reached for a novel object either efficiently (N = 39) or inefficiently (N = 41), and then labeled the object with a novel word. To assess whether infants learned the label-object association, they saw the target object paired with a distractor side by side while either the taught label (familiar) or a novel label were played. To assess whether they learned a property of the agent (agent-voice association), the agent was paired with a new person and either the voice of the familiar or the novel agent was played. All test trials began with a baseline in silence, followed by the test window with the audio stimuli. The analysis and hypothesis were pre-registered: https://osf.io/b3j2m. We found a main effect of condition during the baseline of the label trials ($p = .011$): infants in the rational condition, but not in the irrational condition, looked significantly longer at the target toy relative to the distractor. In the test window, there was a marginally significant interaction of condition and audio ($p = .076$). Infants in the rational condition looked longer at the target object when presented with the familiar rather than a novel label ($p = .023$), but infants in the irrational condition showed no evidence of learning. Thus, infants' attention to and learning about the taught object were attenuated if the demonstrator acted irrationally prior to the teaching event. In the voice trials, infants showed no differences based on condition and only a main effect of audio type ($p = .045$). Surprisingly, infants looked longer at the familiar agent when a novel voice was played. The findings suggest that infants' propensity to learn from, but not about others, is influenced by the efficiency of their actions. These results are consistent with the hypothesis that infants use their prior knowledge about agency to navigate the social world: they selectively learn novel information from those who act based on the core principles of agency.

S.36.03: Do infants experience surprise induced-learning in the social domain? (Cao)

Alexis Smith-Flores, Jasmin Perez, Qiong Cao, & Lisa Feigenson

Surprise enhances early learning: infants learn better about objects that defy physical principles, compared to objects that behave in accord with these principles (Stahl & Feigenson, 2015). This learning enhancement can help children revise their understanding of the physical world around them. But

infants also have expectations about non-object entities-- notably, they detect when social agents behave in surprising ways that are inconsistent with the agents' goals, preferences, and knowledge states. Here we asked whether violations of expectations in the social domain also boost infants' learning. First, we sought to replicate the basic finding that surprise enhances learning in the physical object domain, in an online testing format. In Experiment 1, 16-month-old infants (N = 24) saw a video in which a novel object either remained fully supported by a surface (Expected Outcome), or was pushed over the edge and yet remained magically suspended without falling (Unexpected Outcome). In both cases infants were then taught a novel word for the object (e.g., "That's a gaffa!"). Finally, infants' learning was tested by showing them the taught-about object and a novel distractor object, while a hidden experimenter said, "Where's the gaffa?" Infants showed significantly more learning of the novel word after seeing the Unexpected than the Expected Outcome, thereby replicating previous findings in the object domain. Next, in Experiment 2, we asked whether 16-month-old infants (N = 22) would also show enhanced word-learning following a violation of social expectations concerning an agent's goals. Infants saw a person reach repeatedly for one novel object (Object A), rather than another (Object B). Then on the critical test trial, infants saw the person either again reach for Object A (Expected Outcome) or for Object B (Unexpected Outcome) (modeled after Woodward, 1998). After the person had grasped the test object, infants were taught a novel word for the object (e.g., "That's a gaffa!"). As in Experiment 1, infants' learning was tested by showing them the taught- about object and a novel distractor object while a hidden experimenter said, "Where's the gaffa?" In contrast to Experiment 1, infants showed significantly better learning following the Expected Outcome. In Experiment 3 we asked whether 16-month-old infants (N = 20) would show surprise- induced learning following a different type of social violation. Infants saw a person presented with a delicious-looking but novel dessert, versus a novel insect. The person looked at both items, then turned towards the dessert and said either "Yum!" or "Yuck!". A different person then labeled the novel dessert (e.g., "That's a gaffa!"). Learning was tested as in Experiments 1 and 2. We found that, replicating Experiment 2, infants learned better following the Expected Outcome (e.g., "Yum!" rather than "Yuck!" to a dessert). Together, these experiments suggest that whereas infants notice when both people and objects behave in surprising ways, violations of social expectations affect infants' learning differently than violations of physical expectations. Social violations may impair, rather than enhance, infants' learning.

S.37: The dynamics of language switching across communities: What do bilingual infants actually hear?

S.37.01: Language minority caregivers codeswitch into the majority language in speech to their infants (Benitez)

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In the U.S., 22% of children face the challenge of learning a home minority language and the majority (English) language (U.S. Census, 2019). There is large variability in the quantity of each language caregivers from language minority homes speak, directly impacting infant's bilingual skills (Pearson et al., 1997; Place & Hoff, 2011; Song et al., 2012). However, understanding qualitative features of caregivers' speech is also critical (Anderson et al., 2021; Sczepurek & Verhagen, 2021). Bilingual caregivers frequently codeswitch in child-directed speech (Bail et al., 2015; Goodz, 1989; Kremin et al., 2021). Do language minority caregivers incorporate the majority language in speech to their infants?

Here, we examine how Spanish speaking Mexican-American mothers (N=107) from low-income households codeswitch into the majority language, English, during play with their 24-month-old infant.

Participants were part of a longitudinal study examining the mental health of Mexican-American mother-child dyads from low-income households (Luecken et al., 2019). Mothers were born in Mexico and primarily Spanish-speaking; infants were U.S. born. Speech during a five-minute mother-infant free-play task, at infant age 24 months, was transcribed (MacWhinney, 2000). We examined English and Spanish word tokens and utterances, codeswitching within- and between-utterances, and the most frequent English word types used.

Mothers predominantly spoke in Spanish: 95% of word tokens (SD = 8%, range: 52% - 100%) and 94% of utterances (SD = 10%, range: 43% - 100%) were in Spanish. However, a majority of mothers (N = 81) incorporated some English into their speech. Focusing on mothers using English, mothers' speech contained 11.67 English word tokens (SD = 15.99, range: 1 - 99), 4.26 English-only utterances (SD = 6.1, range: 0 - 31) and 3.33 mixed-language utterances (SD = 5.64, range: 0 - 41). The mean length of utterances (MLU) differed across utterance type, with Spanish-only utterances (M = 2.06, SD = 0.34, range: 1.38 - 3.16) having a higher MLU than English-only utterances (M = 1.2, SD = 1, range: 0 - 5.33; $t(79) = 6.92$, $p < 0.001$) but a lower MLU than mixed-language utterances (M = 2.46, SD = 1.83, range: 0 - 9; $t(80) = -2.03$, $p = 0.0457$). Of mothers' total utterances, 3% (SD = 5%, range: 0% - 42%) were within-utterance switches, while 6% (SD = 8%, range: 0% - 43%) were between-utterance switches; these behaviors were significantly different ($t(80) = (-3.07)$, $p = 0.0029$; see Figure 1). Examining the most frequent English word types across the sample revealed that mothers codeswitched to provide toy names (e.g., baby, frequency = 34) and words related to routines (e.g., hello, frequency = 38). In sum, although English composes a small proportion of Spanish-speaking caregivers' speech, mothers provide complex input by codeswitching into English in qualitatively similar ways as bilingual caregivers (Bail et al., 2015). Language minority caregivers from low-income households thus incorporate the majority language in speech to their infants, perhaps setting the foundation for infants' emerging bilingual skills. Currently, we are examining what factors predict caregivers' codeswitching behaviors and how caregivers' codeswitching changes as infants age.

S.37.02: Code-switching and translanguaging in a large corpus of preschool parent-child interactions (Styles)

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How do parents use their different linguistic resources when they communicate with their preschoolers in a diverse multilingual environment? The "Talk Together Study" is a large-scale micro-longitudinal study designed to create a corpus of naturalistic parent-child talk in Singapore, aiming to document patterns of code switching/translanguaging with preschoolers.

A total of 245 families of children aged 0-48 months expressed an interest and consented to take part in the study, and 147 families completed starter surveys and progressed to the recording session. Children ranged from between 8 months and 4 years of age at the start of the study. All families completed language background questionnaires including self-report of language skills for all carers, and an estimate of the mix of languages each carer uses when speaking with the children in the study. The

majority of caregivers reported multilingual language skills, although not all families reported using all of their languages when they talk with their children. Families in the sample report language profiles that are similar to of the range of languages collected in the National census (Census, 2020).

The study began in 2020 when many families were at home with their children. We used an online data collection method (BLIND 2021), in which parents are invited to join a videocall with their child and narrate an onscreen wordless picturebook 'NAME OF BOOK BLINDED' (BLIND 2020). The study had a micro-longitudinal design with three recording sessions taking place over 4-6 months. In total, we recorded 410 parent-child storybook sessions.

The wordless picturebook was designed to allow parents to use any language resources they normally do with their child, so parents whose speech is typically multilingual were able to translanguage freely. Where possible, calls were hosted by a Research Assistant who shares English and a non-English heritage language with the parent on the call (most often Mandarin, Malay and Tamil). Before starting the task, parents were reminded they could share the story in any language, including a mix of languages.

Transcriptions are conducted by a team of trained research assistants using the BELA transcription conventions (BLIND, 2021) in ELAN, which include manual annotation of language labels to facilitate automated analysis. All transcriptions are transcribed and annotated fully once, and checked in detail by a more experienced transcriber. Members of the transcription team meet regularly to refine the transcription and language labelling conventions. The BELA dashboard allows further checking for possible transcription errors, and automated computation of language mix estimates.

At the time of abstract submission, 189 transcriptions have been completed, with a further 107 in progress (including complete, ready for checking). Transcriptions expected to be complete by Autumn 2022. Figure 1 illustrates the BELA processing pipeline, with an example of 10 parent-child conversations, labelled for language.

The current paper will present the first overview of language mixing behaviour in the cohort. Particular attention will be drawn to how different models of multilingual language use have an impact on how language behaviour is quantified (Figure 2)

S.37.03: Code-switching in parent-child interactions while sharing bilingual versus monolingual books (Weisleder)

Adriana Weisleder[1], Lauren Miller[1], Milton Guendica[2], Anele Villanueva[1]

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Shared reading has long been recognized as a powerful context for supporting early language and literacy. However, there is limited research on the ways bilingual families use their entire linguistic repertoire during shared reading. Studies with school-aged children suggest that bilingual parents modify their language during shared reading to match their child's language ability and to support both home and school literacy (Delgado-Gaitan, 1992; Moody, Matthews, & Eslami, 2021). However, little is known about how bilingual parents of infants use both languages when booksharing. Moreover, we have little understanding of how the book itself shapes the language(s) used during shared reading. This study investigates the use of code-switching - combining languages during an interaction - as a window into bilingual families' shared reading practices. In particular, we compare parent-child code-switching

while sharing a bilingual and a monolingual children's book and examine relations to child vocabulary and family language practices.

Parent-child dyads were enrolled in a larger study of early literacy in Latinx families when infants were 1-3 years old (M = 22 months). At enrollment, information was collected about parents' language and bookreading practices and child vocabulary in English and Spanish using the CDI. A subset of parent-child dyads (n = 15) participated in a booksharing observation over Zoom when children were 3-4 years old in which they shared two children's books that we provided: one monolingual (English-only) and one bilingual (English-Spanish). We used two different commercially available books, each with a monolingual and bilingual version. Books and book order were counterbalanced across participants. Observations were coded for code-switches that occurred during extra-textual talk (i.e., not when reading the book text itself). Four types of code-switches were analyzed: 1) intra-sentential switches, 2) inter-sentential switches, 3) inter-speaker switches, and 4) reading-to-talk switches (i.e., switching languages between reading and talking about the book).

Based on parent report, 33% of parents were Spanish-dominant, 20% were English-dominant, and 47% used English and Spanish equally with their child. Code-switching occurred in 86% of observations with the bilingual book and in 57% of observations with the monolingual book ($p<.05$). Intra-sentential code-switches (e.g., Mira el dinosaur) were the most common type of code-switch overall and differed significantly between the bilingual and monolingual book (Figure 1). There was also a significant interaction between book type and the direction of code switching: when reading the bilingual book, parents switched more often from Spanish to English; when reading the English-only book, they switched more often from English to Spanish (Figure 2). Finally, code-switching was correlated across books: dyads who code-switched more with the bilingual book also code-switched more with the monolingual book. However, code-switching frequency was not correlated with child vocabulary concurrently or at 22 months.

These results suggest that Latinx, Spanish-English bilingual parents in the U.S. use both languages when sharing books with their infants, even when sharing a monolingual book. In addition, the type of book (bilingual vs monolingual) influences bilingual booksharing practices. Findings will be discussed in the context of how code-switching during booksharing may support vocabulary learning across languages.

S.37.04: Infant's exposure to language switching in bilingual homes across two communities (Kosie)

Jessica E Kosie[1], Laia Fibla[2], Rachel KY Tsui[2], Taylor Martinez[1], Andrea Sander[2], Christine Potter[3], Krista Byers-Heinlein[2], Casey, Lew-Williams[1]

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What does it mean for an infant to grow up bilingual? There are likely as many answers to this question as there are bilingual infants. For example, estimates of language switching - a key characteristic of bilingual environments - vary widely. In the few studies that have examined switching, some suggest that switching occurs often (Bail et al., 2015), while others find that switching is overall infrequent (Kremin et al., 2021). These studies differ in key features, however, including the bilingual community studied, and the context of interaction (in-lab play with a primary caregiver vs. full-day home recordings with multiple household members). In this cross-community investigation, we quantify variability in

switching across two bilingual contexts to describe diversity in young bilingual's everyday language input and use of their two languages.

Data from forty 18-35-month-old infants from Spanish-English bilingual homes in the United States (N=12) and French-English bilingual homes in Canada (N=14) were analyzed. We recorded infants (via Zoom) in their homes during two 10-minute play sessions, which yielded natural samples of input (Bergelson et al., 2019; Tamis-LeMonda et al., 2017). On the first day, infants played with only their primary caregiver. On the second day, additional household members were present (e.g., other parents, siblings, nannies). We coded onsets and offsets of all utterances and tagged each for speaker identity and language. To quantify switching, we calculated per-minute values of: a) any switches that occurred, b) within-speaker switches, and c) across-speaker switches.

We first compared switching across Day 1 (one speaker present) and Day 2 (additional household members). As expected, the number of switches-per-minute (spm) increased from Day 1 (M = 2.99spm, SD = 2.67spm) to Day 2 (M = 7.64spm, SD = 3.84spm) for both communities, p = .01. On Day 2, we found variability in the type of switching that occurred. French-English infants experienced more across-speaker (M = 6.23spm, SD = 4.18spm) than within-speaker switches (M = 1.77spm, SD = 1.02spm), p = .003. However, there was no significant difference in across- (M=4.36spm, SD=3.76spm) versus within-speaker (M = 2.87spm, SD = 2.00spm) switching in Spanish-English families, p = .30. Closer examination of switching revealed that a primary source of variation - across communities and days - was in individual differences across families (Figure 1). We also found some evidence that switching decreased with infant age, but this relationship depended on both the bilingual community and type of switching.

In ongoing research, we are examining the role of the infant in the dynamics of switching across communities. One direction, for example, is to investigate whether infants' use of two languages mirrors patterns of caregivers' language use. Other ongoing research examines how infants may be actively shaping caregivers' use of two languages.

In sum, this study is the first to compare the patterns of switching that infants experience across two bilingual communities. In addition to providing insight into naturalistic variation in the number and type of switching that bilingual infants encounter, our findings highlight the diversity of bilingual infant's language experience.

S.38: The impact of COVID-19 restrictions on early cognitive development across the world

S.38.01: The impacts of COVID-19 pandemic restrictions on infant's development of face perception (Kim)

Kate Kim[1], Wei Fang[1], Naiqi Xiao[1]

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Since the coronavirus disease (COVID-19) pandemic was declared in March 2020, the safety regulations have substantially restricted interpersonal interactions in various ways (e.g., wearing masks, and keeping social distance). Although these restrictions were essential in slowing the spread of COVID-19, the breadth of the impact is largely unexamined. Thus, this study focused on how such changes in the living experiences have affected infants' face perception abilities.

Face experiences play a crucial role in shaping the development of face processing in infancy. For example, the characteristics of commonly seen faces (e.g., gender, and race) give rise to a specialized face processing capacity in the first year of life. While the pandemic has been limiting social interactions that allow infants to obtain face experiences, masks also have been covering most faces, making important facial information inaccessible. Because the development of face processing relies on the access of facial information, the COVID-19 restrictions might have delayed, altered, or even impaired this crucial cognitive capacity in infants. To this end, this study examined the effects of the COVID-19 restrictions on infants' face discrimination ability.

We used familiarization and visual pair comparison paradigm to probe face discrimination in infants between 6 and 14 months of age. All infants participated in the study via online experiment platform (Pavlovia.org) between February 2021 and June 2021 amid COVID-19 pandemic. 96.55% parents of the participants reported significantly reduced interactions with others upon their participation. We used Zoom to record infants' looking behaviors. Their looking time was coded offline by two researchers.

Experiment 1 examined infants' discrimination of unmasked own-race female faces, where infants learned faces in frontal view and tested with faces in ¾ view (Figure 1). The results showed a significant novelty preference in young infants (n = 17, 7.78 months, 58.59%, p = 0.02), replicating previous findings. However, older infants (n = 16, 12.51 months) failed to show significant preference (53.81%, p = 0.49, Figure 2). These results suggest that with limited interactions with individuals outside of their families, infants could have developed overly specialized face processing ability, where they failed to differentiate stranger's faces.

Experiment 2 investigated how experiences with faces covered by masks affected the development of face discrimination. Experiment 2 used identical design as Experiment 1 with the test faces covered by face masks. Younger infants exhibited no significant visual preference (n = 14, 8.00 months, 57.81%, p = 0.14). In contrast, older infants (n = 13, 12.32 months) showed a significant familiarity preference (54.13%, p = 0.04), indicating they could discriminate the two masked test faces. These results suggest that the experiences with masked faces during the pandemic give rise to the ability to discriminate faces covered by masks.

Overall, these findings demonstrate that the COVID-19 restrictions affect infants' perceptual development, where infants' face processing abilities already adapted to the current norms. Given the foundational role of face processing in human cognitive, the current study implies a broader impact of COVID-19's restrictions, which may lead to lasting effects on our cognitive capacities.

S.38.02: The impact of COVID-19 outbreak on infant?s processing of the mother's face (Kobayashi)

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We have a significant ability to process mother's faces from a very early age. Even newborns prefer and recognize their mothers' faces to those of strangers (e.g., Pascalis et al., 1995), and the tolerance of image transformation and holistic processing (e.g., Kobayashi et al., 2020) in the perception of their mother's face develops at around 6-7 months of age.

COVID-19, however, has modified numerous aspects of infants' social environments. First, people wear face masks to prevent the spread and infection. Especially in Japan, although the country is recording only about a hundred new COVID-19 cases a day, the impact might be more significant because everyone in public spaces is still wearing masks all the time (Inada, 2021: https://www.wsj.com/articles/when-wearing-a-mask-covers-up-a-social-anxiety-problem-11635678000). Second, there may also be regional differences in face experience within a country due to their cultures and COVID-19 restrictions. As an example, in Tokyo, the capital and largest metropolitan area in Japan, people have been under the state of emergency, which includes long term stay-at-home requests. By contrast, in Aichi, the third-largest metropolitan area in Japan, the restriction period was shorter than Tokyo. Thus, these face experiences under COVID-19 would affect the development of mother's face processing.

We examined these effects of COVID-19 on the development of familiar faces processing in 6- to 8-month-old infants, born and raised in two different cities of Japan (Aichi and Tokyo), by assessing infants' visual preference toward their mother's face over a female stranger's face. First, we tested a preference toward the mother's face in infants in Tokyo who participated in the experiment before (2015-2016) and amid COVID-19 (2021). As a result, infants who participated before COVID-19 significantly preferred the mother's face, whereas infants who participated amid COVID-19 did not (Figure 1). Second, we examined the mother's face preference in infants born and raised in Aichi and Tokyo amid COVID-19 (Figure 2). When the faces were intact (no-masks), infants in Aichi preferred their mother's face to the stranger's face, whereas infants in Tokyo did not. When the faces wore face masks, infants in both sites looked significantly longer to the mother's face than the stranger's face. These results imply that, as we expected, face experiences during COVID-19 would modulate the early development of processing of familiar faces.

In addition, we will show the development of infants' representation of their mother's face during COVID-19 by assessing the caricature effect. The caricature effect refers to better recognition performance for familiar faces in caricatures than veridical depictions and anti-caricatures (Rhodes et al., 1987), suggesting the representation of familiar faces as distinctive feature deviations from a norm. We found that 9-month-old infants partially showed the caricature effect in recognition of their mother's face, with a significantly higher preference for the mother's face in the veridical depiction and the caricature than in the anti-caricature. These results suggest that the adult-like representation of familiar faces would develop at 9 months of age.

S.38.03: The impact of face masks on infants' attention to and learning of faces (DeBolt)

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Infants use information conveyed from the faces in their environment to learn about emotions, gender, language, and more. Therefore, it is not surprising that decades of research have demonstrated that infants have precocious abilities to remember and discriminate faces. Moreover, infants also prioritize different regions of the face, for example, looking more at eyes than at other facial regions. In addition, the facial regions infants prioritize change across development, with increasing attention to the mouth and lower facial region across the first year. One consequence of the coronavirus (COVID-19) pandemic is that face masks have become a part of daily life for many Americans. As a result, infants' daily

experience with faces differs from before the pandemic. In particular, infants' exposure to the lower regions of faces is greatly reduced by the use of face masks, which may impact how infants look, process, and remember faces. In the present pre-registered study, we examined how infants process and remember faces wearing masks.

We used the online platform Lookit (Scott & Schulz, 2017) to examine facial memory in infants 4 to 12 months of age. At present, we have tested 115 infants, and we are in the process of analyzing the data. Each infant was tested in a series of four visual paired comparison trials. On each trial, infants were familiarized with one woman's face and then were tested with the now familiar woman's face paired with a novel face. We varied whether or not the women were wearing a mask during familiarization, test, or both. For example, during familiarization, the women may be unmasked, and during the test, both the women were wearing a mask (e.g., Fig 1B, Condition A). On other trials, the inverse was presented (e.g., Fig 1B, condition B). Finally, infants received trials where the women were masked or unmasked during both familiarization and test. This design allowed us to ask not only how masks influence infants' learning and memory for faces, but also how infants generalize their learning about an individual face between the masked and unmasked condition.

We have conducted preliminary analyses on 85 infants, and have observed a significant effect of trial type, $F(1, 288) = 4.61$, $p = .004$. In general, the group of infants showed the most robust novelty preference when the face was masked during familiarization and subsequently unmasked during the test phase (Fig. 1B, condition B). When the faces were masked during both familiarization and test, infants exhibited a familiarity preference (Fig. 1B, condition C), suggesting that infants showed memory for the familiar face but perhaps required additional time to continue processing that masked face. Interestingly, when the face was unmasked during familiarization, the novelty preference was at chance ($M = .50$). Thus, these preliminary results suggest that infants' recognition memory for faces is sensitive to whether or not the face is masked or unmasked. Our final analyses will examine how these effects vary as a function of infant age and other variables.

S.38.04: Effects of face coverings on early word recognition in bilingual children (Singh)

Leher Singh[1], Paul Quinn[2]

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The impact of face coverings on language development in children remains largely unknown. There has been speculation that clear masks (i.e., face shields) may be better for young children by providing access to greater visual information than opaque coverings (e.g., surgical masks). However, Singh, Tan, and Quinn (2021) demonstrated that 2-year-old monolingual English learners were successful at word comprehension without a face covering as well as with opaque face coverings, but unsuccessful with a clear mask. In the present study, a similar question was investigated in bilingual children.

Twenty Mandarin-English bilingual children were tested on word recognition both in Mandarin and English. Children were tested at 3 years of age. Language exposure, vocabulary size, and stimulus familiarity were obtained for each language. A preferential looking paradigm was used where infants were presented with a series of trials, each containing an image of a target and distractor presented to the left and right lower quadrants of the screen. The center of the screen presented speaker who labelled the target (e.g., "Look! It's a bird!). The experiment was comprised of three blocks: 1) the

speaker wore no mask; 2) the speaker wore an opaque mask; and 3) the speaker wore a clear mask (Figure 1). The order of the blocks was counter-balanced across participants. Fixation to the target (e.g., bird) relative to the distractor (e.g., pen) was coded prior to the label (i.e., pre-naming) and after the label (i.e., post-naming). A significant difference in target fixation between phases (i.e., a naming effect) indicates successful word recognition. Naming effects are displayed in Figure 2.

Analyses focused on the effects of phase (pre-/post-naming), condition (no mask/clear shield/surgical mask) and language of testing (English/Mandarin) on proportional fixation to target. In both English and Mandarin, there was a main effect of phase (English: $F[1, 19] = 15.70$, $p<.0001$), Mandarin $F[1, 19] = 16.52$, $p<.0001$), with higher fixation to targets during post- versus pre-naming phases. Individual comparisons of naming effects to zero revealed successful word recognition in English for no mask and opaque mask conditions (no mask: $t[19] = 2.65$, $p=.03$, opaque mask: $t[19] = 3.04$, $p=.007$), but not for clear masks ($t[19] = 1.31$, $p=.21$), replicating what Singh et al. (2021) reported for English monolingual children. In Mandarin, children demonstrated successful word recognition in all three conditions (no mask: $t[19] = 2.07$, $p=.05$, opaque mask: $t[19] = 2.71$, $p=.01$, clear mask: $t[19] = 3.62$, $p=.002$).

Despite demonstrating greater word recovery through face coverings in Mandarin, children in this study had larger English vocabularies (English [mean]: 468 words vs. Mandarin [mean]: 229 words), had greater exposure to English than Mandarin (English [mean]: 53% vs. Mandarin [mean]: 47%), and knew more stimulus items in English than Mandarin (English [mean]: 17/18 words vs. Mandarin [mean]: 13/18 words. However, correlational analyses indicated no relations between language exposure and recovery (all rs ns). These findings suggest that with bilingual children, word recognition through face coverings may be unequal across languages and may be unrelated to proficiency in each language.

S.39: The physical contexts of developmental cascades: How features of the environment shape infant play and learning

S.39.01: Everyday environments for infant locomotion: How physical aspects of the home shape infant cruising (Schneider)

Joshua Schneider[1], Owen Marty[1], Jana Iverson[1]

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Before infants learn to walk, they rely on surfaces for support during upright locomotion. Infants can cruise along stationary objects (e.g., couches and coffee tables) or engage in supported walking by holding a caregiver's hand. Opportunities to generate such pre-walking behaviors, however, rely on the presence and availability of surfaces of support that afford these actions. Infants' homes provide the natural affordances--surfaces to hold on to and flooring to traverse--that enable practice with upright movement. Little is known about what features of the environment infants use when they move. Thus, we created the first catalog of infants' home spaces to document and categorize which aspects of the home pre-walking infants encounter as they travel in everyday environments via supported upright locomotion.

Thirty infants were videorecorded at home during everyday activities with their caregivers for 45 minutes. We anchored infants' observations to the onset of cruising (i.e., 5 steps while holding on to furniture) and coded the session representing cruise onset ($M = 9.69$, $SD = 1.27$) and one month later. Coders identified all bouts of cruising (along stationary support surfaces) and supported walking (with

mobile support surfaces). Then, for each bout, we categorized the physical aspects of the home environment to identify: (1) the surfaces of support infants used for locomotion, (2) the textures of each surface, and (3) the types of the flooring underfoot.

On average, pre-walkers generated 51.53 bouts (SD = 31.18) of upright locomotion, and this did not change between sessions ($p > .05$). Infants' hands contacted five predominant surfaces while moving (Figure 1a). Locomotion was most likely to occur with the aid of household furniture and caregivers' hands, and to a lesser extent, infant furniture, locomotor toys, and structural components of homes like walls ($ps < .01$). Notably, infants encountered 23 unique combinations of surfaces during their travels (e.g., using a couch for an entire bout vs. a couch and then a locomotor toy). We identified three main surface textures (Figure 1b), and of these, rigid surfaces were most prevalent ($ps < .001$). The variety of flooring was immense: infants moved over 12 different types of flooring (see Figure 2 for a subset), but the most common was carpeting. Perhaps most striking, infants accumulated 41 unique combinations of flooring types during their bouts. Put differently, whereas some bouts were confined to a single type of flooring, others took infants across numerous types of terrain (e.g., a bout containing steps on a wood floor, plastic toy, and metal door stopper). Finally, there was no evidence of developmental change for any measure of the physical environment. That is, everyday home environments (and infants' use of them) remained largely stable as infants consolidated early cruising experience.

Taken together, these results suggest that infants' homes are brimming with natural affordances that enable upright locomotion before the onset of walking. Moreover, these data underscore the importance of studying motor behavior in real-world settings and taking the physical aspects of infants' environments into account when constructing theories about infant development.

S.39.02: Use of space and objects in center-based childcare during free play time: What does it tell us? (Oudgenoeg-Paz)

Ine van Liempd[1], Ora Oudgenoeg-Paz[1], Paul Leseman[1]

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Center-based childcare is an important context in young children's life. However, studies into the relation between children's play and exploration behavior and the physical environment of childcare are scarce (Van Liempd et al., 2020). The present study addressed a related research question: Are types of play behaviors (i.e., solitary, social and parallel play) related to children's use of spatial components in the childcare environment and the complexity of children's object exploration?

Participants were 61 Dutch children aged 11-48 months attending ten mixed-age groups in ten childcare centers. All participants could engage in self-locomotion (crawling or walking). Children were filmed during four episodes of five minutes free play, spread over two days. Films were coded for children's use of spatial components, such as an activity-center and the free floor-space. Play behaviors were coded using Rubin's scale (Rubin, 2001). The complexity of object exploration was coded as either: no object use; simple manipulation including manipulation of a single object (e.g., throwing, carrying) and simple combinations (e.g., banging); complex manipulation including more complex combinations (e.g., stacking, compiling using puzzles, Lego). Coding was done by dividing each 5-minute episode in 10-seconds intervals (N=6419).

A previous study using these data has shown that, during free unguided play, children mostly used the free floor-space, activity-centers (e.g., for construction, dramatic play) and tables. Therefore, the analysis focused on these spatial components. First, MANOVA was used to test for differences in object exploration during different types of play. Results (see Figure 1) show no significant differences in exploration during social play. During both parallel and solitary play simple manipulations were significantly more frequent than no object use and complex manipulations were more frequent than simple ones. Second, multilevel analysis (level 1-intervals, level 2-child) was conducted, with the use of spatial components and the complexity of object exploration as predictors of the types of play while controlling for age. Results show that younger children engaged in social play mostly in the activity centers while engaging in simple object manipulation. Older children more often engaged in social play without using objects. Solitary play was predicted by the use of simple and complex manipulations in all three locations (main effects). An interaction effect showed that solitary play was also predicted by the use of complex manipulations in the activity centers. Parallel play occurred mostly at the table while engaged in complex manipulations. Complex use of play materials at the floor and in the activity center also predicted parallel play but occurred less frequently.

Thus, children's play in the childcare context is predicted by a dynamic interplay between components in the physical environment, child characteristics and children's exploration. These findings stress the importance of paying extra attention to the way childcare spaces are constructed and how this affects child behavior and development.

During the presentation we will further discuss the meaning of these findings and reflect on methods to further investigate children's use of the physical space in childcare centers.

S.39.03: Embodied and embedded: Features of the environment shape infants' motor actions and caregiver language (West)

Kelsey West[1], Catherine Tamis-LeMonda[1], Karen Adolph[1]

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Infants learn verbs in the context of their own actions, as they move about and play with toys and household objects. Notably, caregivers are sensitive responders to infant actions, providing relevant verbs precisely as infants perform the target action (e.g., "are you building a tower?" as infant stacks Lego blocks; West et al., 2021). In two experiments, we tested the causal connections between the objects of infant play, infants' motor actions, and caregivers' verb use. We hypothesize that features of the environment offer different opportunities for infant play, and that different types of infant play in turn elicit distinct verb inputs from caregivers.

In Study 1, 32 infant-caregiver dyads played together in a "locomotor toy" condition with toys designed to elicit locomotion (stroller, broom, balls, etc.) and in a "manual toy" condition with toys designed to elicit manual actions (shape sorter, xylophone, blocks, etc.). Infants played differently in the two conditions. Infants locomoted more often during play with locomotor toys compared to manual toys, and reciprocally, infants played from a stationary position more often with manual toys than with the locomotor toys. Correspondingly, caregivers produced more locomotor verbs like "walk," "come," and "bring" when infants played with locomotor toys compared to infants' play with manual toys (Figure 1A). And caregivers produced more manual verbs like "press," "open," and "pull" when infants played with

manual toys compared to locomotor toys (Figure 1B). Thus, experimentally changing infants' real-time actions (via object affordances) prompted a shift in caregiver language.

In Study 2, we focused on the physical layout of toys, rather than on features of toys. Infant-caregiver dyads played together with two sets of matched toys (each set of 12 toys included both "locomotor" and "manual" toys), but in different physical layouts. In one condition, toys were dispersed throughout a large laboratory playroom, and in another condition, toys were piled in the center of the room. Preliminary data from N = 10 dyads indicates that infants played differently in the two conditions. Infants locomoted more often when toys were dispersed , and they played from a stationary position more often when toys were within arms' reach. Again, caregivers' language input corresponded to infants' play: caregivers produced more locomotor verbs when toys were dispersed (and infants were on the move) compared to when toys were in a pile (and infants played in place). Likewise, caregivers produced more manual verbs when toys were in a pile compared to when toys were dispersed.

Findings converge to show that features of the environment, including the toys available for play and the physical layout of materials, have immediate consequences for infants' moment-to-moment behavior, and as a result, the specific types of language inputs that infants receive from caregivers. Thus, language learning is both embodied--shaped by infants' developing motor abilities and behavior--and embedded within a physical context that offers different affordances for action, language input, and ultimately, word learning.

S.39.04: Transforming Play and Learning in Early Childhood Through Playful Learning Landscapes (Fletcher)

Katelyn Fletcher[1], Hailey Gibbs[1], Rachael Todaro[1], Annelise Pesch[1], Kathryn Hirsh-Pasek[1]

[1]Temple University

Playful Learning Landscapes (PLL) merges the science of playful learning with public spaces to create learning opportunities for children and communities. Using a community-based approach, PLL sites are co-constructed by community members, designers, and researchers through an equity-based, culturally relevant process that embeds scientific principles of children's learning. As a result, PLL sites increase social interactions known to support strong language, literacy, and STEM skills for infants and children ages 0-8. For instance, a bus stop infused with puzzles prompts children's math talk more than a traditional bus stop (Hassinger-Das et al., 2019). When trained facilitators lead playful learning activities for young children, children use more learning-focused language, engage in more social interactions, and exhibit more 21st-century skills than they do without playful learning activities (Schlesinger et al., 2020). PLL installations have been linked to enhanced social interactions in parks, community centers, grocery stores, libraries, and more (Bustamante et al., 2019). Given prior success in a wide array of public spaces, we examine how this work might bear out in schools. How can PLL sites transform learning opportunities for society's youngest members--infants and young children--in the setting of early childcare centers?

Using participatory research methods (Collins et al, 2018), we apply a human-centered design approach to reimagine physical spaces within Bright Horizons early childhood centers. Bright Horizons is an international provider of early childhood education, with over 1,000 centers in the United States and Europe, serving children ages three- to five. We describe an innovative ongoing community-research

partnership fostered through a series of co-design workshops, in which teachers, community members, designers, and researchers collaborate to create new PLL sites. The six centers currently involved in this partnership serve hundreds of children and families in urban Philadelphia and its surrounding suburbs across socioeconomic status, race and ethnicity, and religion. Deep, authentic community engagement occurs throughout the process--from conceptualization to modification and installation.

In the present work, key characteristics of co-design are discussed, including local ownership and sustainability of installations, intuitive and evidence-based designs, and consideration of communities' cultural and historical contexts. As such this work opens a new vista for research with young children and their caregivers that is in situ and culturally-inclusive. We discuss implications for community-level shifts in teachers' beliefs around play and learning and children's educational outcomes.

The PLL initiative provides an innovative model for childcare centers, communities, and cities to design and build learning spaces that place children and playful learning at their core. By doing so, PLL sites transform everyday, physical environments to create bespoke and culturally-relevant playful opportunities to support children's development of critical 21st-century skills. Through extending a human-centered design approach--a successful hallmark of PLL research more generally--to early childcare centers, communities can enhance learning opportunities for all infants and children, even prior to school entry.

S.40: Ecological dynamics of mother-infant social engagement

S.40.01: The Neural Processing of Multisensory Integration Between Tactile-Visual and Interoceptive Information in Infancy (Myowa)

Masako Myowa[1], Yukari Tanaka[2]

[1]Kyoto University, [2]Kansai University

Parents and infants share visual (facial), auditory (speech), and tactile (touch) sensory information in their daily interactions. The simultaneous experiences of multimodal information processing promote multisensory integration in the infant's brain. For example, we demonstrated that perception of novel speech words (auditory) accompanied by touch (tactile) stimuli enhances infants' neural activity related to auditory-tactile integration (Tanaka et al., 2018). Among several types of touch, C-tactile-mediated' affective touch' (i.e., a light touch at a speed of 3 cm/second) is thought to play a crucial role in regulating infants' interoception (cardiac activity) and integrating interoceptive and exteroceptive sensory signals (Atzil et al., 2018). It remains unclear, however, whether and how affective touch modulates infants' neural processing of multisensory integration. Using electroencephalography (EEG), we examined infants' neural activities during affective touch while looking at a stranger's face to examine integration processing between exteroception (visual) and interoception (cardiac).

Method: Participants were 35 infants (age: 4- to 9-month-olds). Visual stimuli were photographs of two female strangers with gaze averted. One face was assigned to the "Touch" and the other to the "No-Touch" condition. Infants wore the 64chls EEG cap and the 3chls ECG electrodes. In the Exposure phase, two women's faces were presented alternately for five seconds each. In Touch condition, another experimenter (out of infants' visual range) stroked the infant's legs. In the No-Touch condition, the experimenter did not touch infants' legs. The stimuli were presented five times, making a total of 10 presentations. In the Test phase, infants looked at the same pictures of the two women alternately as in

the exposure phase during EEG and ECG measurement. The test phase continued until the infant either became fussy or started crying or completed 80 trials for each condition. We conducted a band-pass filter (0.1-40Hz) and segmented data based on the presentation of visual stimuli. We compared ERPs during the presentation of visual stimuli between conditions. We also analyzed heart-beat evoked potentials (HEP), which is an indicator of interoception. The onset was the R-peak of ECG during the presentation of test stimuli. We compared HEPs between the two conditions.

Results: Regarding ERPs of face stimuli, we found greater positive amplitude in the Touch than in the No-Touch condition during 300-450 msec from stimulus onset in Pz region ($F(34,1) = 6.52$, $p = .01$, $\eta 2=.19$, Figure 1). We also found a significantly greater positive HEP amplitude in the Touch than in the No-Touch condition in the right frontal region during 100-230 msec from R-peak onset ($F(34,1) = 4.99$, $p = .03$, $\eta 2=.18$, Figure 2).

Discussion: We found the perception of touch modulated the infants' ERP activity in the parietal region. The parietal sulci and lobes are core regions of visual-tactile integration (e.g., Tal & Amedi, 2009). The simultaneous experiences of tactile (touch) and visual (face) stimuli may integrate in neural processing in infants' brains. We also confirmed that perception of affective touch affected infants' HEP, which reflects infants' interoceptive cortical activity. The perceptual experience of multimodal information, including affective touch, may modulate integration between exteroceptive and interoceptive information in infancy.

S.40.02: Looking into My Eyes: Understanding Social Engagement in Young Infants Using the Interplay of Autonomic and Motor Responses (Lipschits)

Or Lipschits[1], Ronny Geva[1]

[1]Bar-Ilan University

In the first weeks after gestation, before the onset of the "social smile", little is known about infants' emotional perception, cognitive processing, and social engagement (Kret, 2015). We explore the mechanisms behind early social engagement as they change and influence infants' social development over the first year. Post-birth brainstem networks enable regulation of autonomic arousal and motor responses supporting social engagement (Geva et al., 2017). Inter-relations between infant's gaze orienting, pupil reactivity, and blinking develop during the first year of life in ways that may support social engagement and social development. We hypothesized that 1) infants at 6-weeks would show sensitivity towards their caregivers' emotions evident by suppressed pupil dilation (PD). 2) Infants' maturing gaze orienting abilities would enable directing/averting gaze to self-regulate arousal. 3) Infants' blinking in response to social stimuli at 6 weeks would predict social development at 9-months.

Method: Using a longitudinal repeated-measures approach, we examined infants (Ns=57) at 6-weeks when the parent-infant dyad has already formed, yet before the emergence of an explicit social smile; and at 9-months after infants develop a representation of their caregiver and indicate a stranger- and separation anxiety. Infants performed a computerized novelty task, examining gaze (mean AOI looking time, AOI change across time), PD (mean, change across time), and blinking (rate) to familiarity (mother, stranger) and emotion (happy, neutral). At 9-months, a social-developmental assessment was also performed using The Griffiths Mental Development Scales-ER.

Results: Both in 6-weeks and 9-months, PD response to neutral mother (M=0.231±0.043) was greater than a happy mother (M=0.1±0.041) [$F(1,41)=8.268$, $p<0.01$, partial $\eta^2=0.174$], where a stranger's change in affect did not yield a difference in PD (see Fig.1, Panel A). Already at 6-weeks, results showed significant PD changes across time in response to novelty (transition between happy mother to happy stranger / neutral mother), resulting in dilation to a stranger and a suppression to neutral mother (see Fig.1, Panel B). Findings suggest a different age-dependent mechanism for self-regulation: At 6 weeks, aversion from novelty (% of time in familiar AOI) predicted lower PD [$F(1,22)=23.1$, $p<0.001$], $R2=0.512$. By 9 months, the development of orientation enabled more frequent transitions between mother and stranger, helping infants regulate PD arousal and explore novelty (See Fig.2). Finally, supporting the third hypothesis, at 6-weeks, blinking rate to neutral affect (mother and stranger) predicted social development at 9-months [$F(4,31)=4.38$, $p=0.006$], $R2=0.361$.

Discussion: Results delineate a developmental trajectory enabling young infants to engage socially while regulating arousal when confronted with challenging novel or emotional events and highlight the different age-dependent mechanisms serving self-regulation. Findings provide evidence for early parental affect representation already at 6-weeks of age and underscore the importance of these early milestones to social development through the first year of life. The inner workings of the mechanisms are still elusive, nevertheless given the neurobiological systems regulating PD and blinking behaviors at infancy, findings may indicate the role of noradrenergic networks in social engagement and social development. Findings call for future studies exploring infants' autonomic communicative abilities as a marker for typical social development.

S.40.03: Nurturing the Epigenome: Targeting Early Caregiving and Molecular Mechanisms Underlying Social Behavior (Krol)

Kathleen Krol[1]

[1]University of Virginia

Infancy is one of the most dynamic, environmentally malleable stages of human life and a point when many foundational social skills are established and tuned. Though the concept that caregiver behavior can profoundly impact infant physiology, neurodevelopment, and behavior is unrefuted, far less is understood regarding the underlying mechanisms by which this occurs. One system sensitive to early parental care is endogenous oxytocin, known to be a crucial regulator of human social behavior and cognition. The combination of plasticity and sensitivity makes infancy an informative time to investigate the development of the oxytocin system, which has the capacity to aid the establishment of early social perceptual and cognitive processes as well as set trajectories for the emergence of complex social behaviors. The actions of oxytocin are dependent on its receptor, encoded by the oxytocin receptor gene (OXTR). A naturally varying epigenetic mark on OXTR has been identified at which levels are significantly higher in autistic (ASD) individuals than in age-/sex-matched controls. Heightened DNA methylation of OXTR (OXTRm) has been associated with reduced expression of the gene in human adult, infant, and animal models, suggesting reduced availability of oxytocin receptors. This presentation will highlight recent work in which we've investigated the potential impact of early caregiving experience on the developing infant oxytocin system, namely OXTRm. In the current study, we assessed OXTRm in infant-mother dyads at 5 months of age and again at 18 months of age. In addition to epigenetic analyses, we video-recorded a free play interaction between mother and child at the 5-month visit. First, we find that OXTRm is more dynamic in infancy than in early motherhood, suggesting infancy may be a

sensitive period in which the system is more malleable. Second, we found that elements of maternal engagement during free play - namely, proximity and vocalization frequency - significantly predicted infants' OXTRm over time. Specifically, higher levels of maternal engagement reduced infants' OXTRm, suggesting an upregulation of the child's oxytocin system. Last, we report a positive association between infants' OXTRm and parent-reported discomfort (Figure 1). Taken together, these findings posit epigenetics as a molecular mechanism by which early caregiving can "get under the skin" to facilitate social development. Future directions and methods will be discussed, including the use of objective, ecologically valid measurements of maternal proximity and vocalizations toward her infant using wearable Bluetooth sensing and recording technology (Figure 2). Here we leverage cutting-edge engineering technology with innovative molecular biology techniques to target specific aspects of parental care and examine their impact on a specific, dynamic molecular mechanism (OXTRm), harnessing the potential to inform us when and how foundational social skills are established.

S.40.04: Interdependencies between Vocal Behaviour and Interpersonal Arousal Coupling in Caregiver-Infant Dyads (Wass)

Sam Wass,[1] Emily Phillips[1], Celia Smith[2], E Fatimehin[1], Louise Goupil[1]

[1]University of East London, [2]King's College Infants explore their vocal tracts from birth, producing vocalisations that are on a continuum from cries to speech-like vocalisations, or protophones. This pre-linguistic vocal exploration is thought to be crucial for the emergence of speech: it could serve as a base for selection mechanisms whereby caregivers' differential responses to their infants' vocal outputs (e.g., different responses to cries versus protophones) progressively lead to the prioritisation of speech signals for communication. Offering temporal contingencies could constitute especially important information for infants, allowing them to realize through repeated interactions that some sounds are privileged communicative signals that are particularly efficient to engage their social partners in conversation.

But what determines when infant vocalisations occur, and what their acoustic characteristics are? We know that, by 3-months, infants can produce speech-like vocalisations in conjunction with both positive and negative facial displays, which suggests that their vocal explorations are functionally flexible - i.e. not bound to specific affective states, at least in terms of valence. Less well understood, however, is how endogenous factors (i.e. internal to the infant) influence when early vocalisations occur. One factor that may be important is autonomic arousal, mediated by the Autonomic Nervous System (ANS). Research with marmoset monkeys has shown that vocalisation likelihood is driven by rhythmic fluctuations in the autonomic nervous system (ANS) across multiple temporal scales (Zhang & Ghazanfar, 2020), but we currently understand little about how autonomic arousal influences early vocal development in humans.

To examine this, we used wearable microphones and autonomic sensors to collect day-long recordings (mean (sd) duration: 7.3 (1.4) hours) from N=74 12-month-olds and their caregivers (see Figure 1). We present four analyses: first, we examine how vocalisations are clustered together in time. Second, we examine caregivers' and infants' arousal levels around vocalisations, using three different measures: 1) average arousal levels around vocalisations; 2) vocalisation likelihood around arousal peaks; and 3) Receiver Operator Characteristic (ROC) curves. Third, we examine arousal stability, and infant-caregiver arousal coupling, around vocalisations. Fourth, we examine arousal around vocalisations subdivided by the partner's arousal at the time of the vocalisation.

Overall our results suggest that clusters of vocalisations occur during elevated infant and caregiver arousal (see Figure 2). This relationship is stronger in infants than caregivers: caregivers show greater functional flexibility, and their vocal production is more influenced by the infant's arousal than their own. Cries occur following reduced infant arousal stability and lead to increased child-caregiver arousal coupling, and decreased infant arousal. Speech-like vocalisations also occur at elevated arousal, but lead to longer-lasting increases in arousal, and elicit more parental verbal responses. Our results suggest that vocal development is more dependent on selective reinforcement operating through interpersonal arousal coupling across caregiver-infant dyads than previously thought.

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S.41: Infants' behavior regulates their immediate learning environment

S.41.01: What infants' active exploration of a multi-modal contingency can tell us about language development (Cox)

Christopher Cox[1], Tamar Keren-Portnoy[2], Helena Daffern[2], Rory DePaolis[3], Ken Brown[4], Florence Oxley[4], Mona Kanaan[4]

[1]Aarhus University, [2]University of York, [3]James Madison University, [4]University of York

Infants learn about the world by stumbling through developmental cascades of behaviors and exploring contingencies between their own actions and resultant events. These processes of exploration allow infants to learn to predict the outcomes of their own actions and to repeat them at will with predictable consequences. Within the domain of vocal development, for example, infants learn the contingencies between the motoric, proprioceptive, and auditory characteristics of different actions of the vocal apparatus.

In this talk, we present results from a recent study investigating whether infants' tendency to engage in active exploration applies in the context of vocal development. We allowed infants to interact with a digital interface that produced colorful shapes on a screen in response to infants' voiced vocalizations. The duration of the shapes on the screen persisted throughout the duration of infants' vocalizations, and the size of the shapes corresponded to the amplitude of the vocalizations, as shown in Figure 1 below. This experimental setup allowed infants to engage in free, active exploration of a cross-modal contingency, where the appearance of visual shapes on a screen depends on their self-initiated vocalizations.

By recording infants' vocalizations to the digital interface in a single five-minute session, infants were shown to increase the rate of their vocalizations, as compared with yoked infants in a control group interacting with a non-contingent tablet, as depicted in Figure 2. We interpret this finding as suggesting that infants can explore and learn a self-initiated, cross-modal contingency based on their own vocal behavior at an early point in development (i.e., 6.5 months of age).

This increase in the rate of vocalizations in response to contingent visual rewards suggests that infants can form expectations about the contingent outcomes of their own vocalizations. In this talk, we frame these results within a Bayesian construal of the infant as an active learner and further discuss how this framework can provide conceptual tools to enable investigation of infant language development.

S.41.02: The temporal dynamics of exploration in play (Anderson)

Erin Anderson[1], Hadar Raz[1], Linda Smith[1]

[1]Indiana University

Play is often conceptualized as a form of exploration and seen as a critical and domain-general mechanism in human learning (Gopnik, 2020; Muentener et al., 2018), one that is especially important in early childhood. Theoretical analyses suggest that exploration is driven by a learner's quest to increase their understanding of novel - but not too novel - stimuli (e.g., Twomey & Westermann, 2018), which may result in a balance of exploration and exploitation in different contexts. Laboratory studies designed to understand these processes have used extremely short exploration periods (typically < 2 minutes) and small pre-selected set of objects for exploration (typically 2 items at a time). These

contexts are unlike play and the exploratory activities of everyday life, which are characterized by access to many objects at each moment and by repeated experiences with many of the same objects (Clerkin et al., 2017).

We bridge the gap between experimental and everyday settings by examining the structure of exploration in the context of natural play. Data was collected at a tent at a county fair and in a playroom at the university, with parents and children determining the duration and character of the play period. The play area contained a set of 33 toys (vehicles, animals, containers, tools). Children (n = 60) wore a head-mounted camera while they played and ranged in age (1 to 4 years, M = 2.5 years) and in the total duration of their play (3 to 32 minutes, median = 10.6 min).

We found that children only played with M = 10.4 out of the 33 toys, interacting with individual toys across multiple events (M= 2.7 interactions per toy over 10 minutes). These interactions decreased somewhat in duration: 1st event M = 27.67 s, 2nd event M = 18.54 s, 3rd event M = 22.74 s. Because children's play centered around a small subset of toys (see Figure1), we next focused on their most frequently played with toys. The time spent with children's top three toys made up 58% of their total play. In line with this, children's most-played-with toy was marked by more interactions than average (M = 5 total) and longer events (1st event M = 52.75 s; 2nd event M = 54.12 s; 3rd event M= 69 s). The top toy differed by child (e.g., a truck for one child or a horse for another), suggesting that this relationship was not dependent on a particular object.

Despite access to many objects over time, we see repeated interactions with children's top toys, interspersed with fewer interactions with secondary toys. This pattern of repeated bursts of experience with a few focal objects is similar to the visual statistics of infants' everyday life (Clerkin et al., 2017). By examining the dynamic of natural play, we see how children's balance of exploration and exploitation structures the input they receive from a more variable environment.

S.41.03: Immature vocalizations amplify the learnability of adult speech across multiple languages (Elmlinger)

Steven Elmlinger[1], Jacob Levy[1], Michael Goldstein[1]

[1]Cornell University

What are the features of parent-child interaction that facilitate the learnability of speech? Infants' immature vocalizations function to elicit linguistically simplified caregiver speech, which enhances language learnability (Elmlinger, Schwade, & Goldstein, 2019). This effect has only been shown in English-speaking participants. To investigate the cross-linguistic robustness of this effect, the present work examines the extent to which caregivers simplify their responses across 14 different languages. Our goal was to determine if the linguistic simplification pattern is a stable feature of language learnability.

We investigated transcripts of parent-child interaction across 14 languages using the CHILDES database (MacWhinney, 2000). Only transcripts with utterance timestamps were included. 10 minutes of transcription were randomly sampled from each transcript. If less than 10 minutes were available, then the transcript was excluded from analysis. In total, we analyzed 1,690 transcripts where children were between 5 and 30 months of age (M= 18.67; SD = 6.83). Utterances from parents (either the mother or the father) were categorized as contingent if they occurred within 3 seconds of the onset of children's

vocalization; all other parent utterances were categorized as non-contingent. The lexical diversity of parental speech was measured by counting the number of unique words parents spoke. To assess the syntactic complexity of parents' speech we calculated the mean length of their utterances in words and the proportion of their utterances which contained only a single word.

We found that parents in most languages simplified the speech they produce in response to their child's vocalizations compared to non-contingent speech (Figure 1). Parents' speech was less lexically diverse when organized around immature child vocalizations in 9/14 languages. Contingent speech was significantly shorter in utterance length than non-contingent speech in 11/14 languages, and contained a higher proportion of single-word utterances in 10/14 languages. In most of the cases where significance was not reached (10/12), languages had less than 30 transcripts under analysis.

To understand the specificity of the simplification effect, we conducted the same linguistic complexity measures as above on responses to infants' pointing to or touching of objects during free play. Using a dataset where linguistic simplification to infants' babbling was previously found (Elmlinger, Schwade, & Goldstein, 2019), we coded 10-minute samples of twenty-nine infants' (M infant age = 9.68 months) play for touching of or pointing at objects or caregivers. We found the linguistic complexity of caregiver responses to infants' non-vocal behavior did not show the same simplification signature as responses to immature vocalizations (Figure 2). Only the number of unique words spoken contingent on infants' manual behavior was significantly simplified compared to non-contingent speech.

Our findings suggest that infants and young children's immature vocalizations function to elicit changes in the structure of parents' speech, creating favorable moments for learning. We suggest that the cross-linguistic stability of this effect points to a common strategy enabling efficient language learnability for children first breaking into the structure of their ambient language.

S.42: Let's read! Parent-infant book sharing in low-income families from Brazil, Chile, and the U.S.

S.42.01: Factors contributing to parent-infant booksharing among U.S. Latino families (Weisleder)

Adriana Weisleder[1], Laura Pabalan[2], Alejandra Reinoso[1], Murielle Standley[1], Mariana Glusman[3]

[1]Northwestern University, [2]Rush University Medical Center, [3]Lurie Children's Hospital

Parent-child bookreading is believed to be a key context for promoting language development and early literacy. Past research suggests that low-income Latino families have fewer books in their homes and read less frequently to their children than middle-class European-American families (Boyce et al., 2004; Flores et al., 2005; Raikes et al., 2006). However, the reasons for these differences are not well understood. Explanatory models of parent-child reading developed for European American families suggest that maternal literacy, parental attitudes about reading with children, and availability of books help explain differences in the quantity and quality of shared reading with young children (DeBaryshe, 1995; Green et al., 2009). Here, we examine the extent to which these factors contribute to differences in shared bookreading among Latino families with infants. We also expand on this explanatory model by investigating the influence that parents' beliefs about bilingualism and proficiency in both English and Spanish have on shared book reading. Participants were 106 parents (95 mothers, 11 fathers) of children between 1-3 years of age who were recruited from the waiting room of a pediatric clinic serving low-income families. All participants identified as Hispanic or Latino. Parents were asked about their beliefs

about bilingualism (Bilingual Attitudes Survey), their beliefs about reading with children (Parental Reading Beliefs Inventory) and their shared reading practices (StimQ), as well as family sociodemographic characteristics and self-reported proficiency in English and Spanish. A subset of families also participated in a shared bookreading observation with their infant. The majority of parents (74%) reported they had started reading with their children, and 53% spontaneously mentioned bookreading among their three favorite activities to do with their child. Of parents who had started reading with their child, the majority read 1-3 days per week. As in previous studies, parental level of education was associated with more frequent parent-child shared bookreading ($r=.37$, $p<.001$). Self-reported proficiency in English was associated with shared reading practices ($r=.21$ $p<.05$), while proficiency in Spanish was not ($r=-.16$, $p=.12$). Parental beliefs about reading with young children were also associated with shared reading practices ($r=.30$, $p<.01$), yet this association was present only for mothers with higher levels of education (Fig. 1). In addition, parents who endorsed higher concerns about bilingualism (e.g., "Hearing two languages can be confusing and difficult for children.") read with their children less often than those who endorsed fewer concerns ($r=.21$, $p<.05$), and this relationship was stronger for parents with higher English and lower Spanish proficiency (Fig. 2). Importantly, while parental education and reading beliefs were associated with home reading practices, these were not associated with the observed quality of shared reading. These findings demonstrate substantial heterogeneity in shared reading practices among Latino families with infants and suggest that demographic characteristics are more strongly associated with the frequency of reading practices than with the quality of shared reading interactions. Better understanding factors that contribute to literacy practices in Latino families is important for supporting early literacy in Latino children.

S.42.02: Mothers' and fathers' shared reading with infants in low-income, ethnically diverse families (Chen)

Yu Chen[1], Natasha Cabrera[1], Charlotte Sudduth[2], Edwin Duran[3], Stephanie Reich[3]

[1]University of Maryland, [2]University of Edinburgh, [3]University of California

Introduction. Shared reading is an essential activity through which parents provide a rich language environment by introducing new words, elaborating the story, making connections with the child, and asking questions (Wasik et al., 2016). Past research has consistently associated shared reading with children's language and literacy skills (Mol & Bus, 2011). By kindergarten entry, children from low-income backgrounds on average have lower reading scores than those from middle-income families (Reardon & Portilla, 2016). Therefore, understanding how parents from disadvantaged backgrounds read with their children is pivotal for reducing the language gap and preparing children for success in school. However, the literature has primarily focused on shared reading between preschoolers and their mothers. Little is known about how parents read with infants (Muhinyi & Rowe, 2019), especially fathers who tend to use more challenging language than mothers (e.g., Duursma, 2016) and uniquely contribute to early language development (Cabrera et al., 2017). Lastly, it is important to understand the mechanism through which shared reading relates to language outcomes (Malin et al., 2014).
Hypotheses. To address these gaps, we ask: (1) What strategies do mothers and fathers use when reading with their infants at 9 months? (2) Are mothers' and fathers' reading strategies at 9 months uniquely associated with children's receptive and expressive language skills at 18 months? (3) Are these associations mediated by children's attention during shared reading at 9 months? We hypothesize a significant association between reading quality and language outcomes mediated by children's

attention. Methods. We use data (n=280) from a longitudinal intervention that includes low-income, ethnically diverse mothers and fathers. We videotaped parent-child shared reading and transcribed parent and child speech. Parents' utterances were coded into eight reading strategies (Table 1). Infants' attention was rated on a 5-point scale representing how long they attended to the book. Standardized receptive and expressive language scores were obtained using the Preschool Language Scale, 4th edition (Zimmerman et al., 2002). Parents also reported how often they read to their infant (Farver et al., 2006). We controlled for home literacy environment, highest parental education, and intervention condition. Results. Mothers and fathers did not differ significantly in their use of reading strategies, but mothers read to the child more often than fathers ($t=4.22$, $p<0.01$). Reading book text and labeling were the most frequent strategies, whereas elaboration and wh-questions were the least frequent (Table 1). Fathers' use of close-ended questions ($r=0.17$, $p<0.05$) and reading frequency ($r=0.17$, $p<0.05$) were significantly correlated with receptive scores. Structural equation modeling revealed that home literacy engagement was significantly associated with receptive scores ($\beta=0.23$, $p<0.05$; Figure 1). Infants' attention did not mediate the associations between reading quality and frequency and language outcomes. These findings suggest that it may be more beneficial for parents to engage children in various literacy activities rather than just reading to them at 9 months and that including both mothers and fathers is crucial for understanding children's early language environment.

S.42.03: Does child's engagement during shared reading mediate the effect of a personalized book giveaway intervention on child's interest in books? (Mendive)

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This intervention aimed to find a less time-consuming modality to promote parental beliefs that toddlers are indeed interested in books, in response to findings that i) early exposure to books benefits the development of oral and written language (Sénéchal, 2017), ii) in low-SES populations children are less frequently exposed to books compared to their peers from higher-SES households (Strasser & Lissi, 2009), iii) parents in low-SES households increase their children's exposure to reading when they perceive an interest in books (Authors, 2019), iv) a common barrier in family literacy interventions is the scarcity of parental time to attend workshops (Whittaker & Cowley, 2012), and v) the high engagement and enjoyment of a parent-child dyad when jointly reading a personalized book (where the child is the protagonist, carrying out his/her favorite activities) (Kucirkova, et al., 2013). After providing families (n=81) with a personalized book, encouraging repeated reading of it for two weeks, and with a video recommending interactive reading, we experimentally confirmed that parents from low-SES households reported that children given personalized books had higher odds of having a favorite book than the odds of the comparison (n=63) and control (n=57) groups. Families from the personalized group showed a higher relative risk of mentioning the title of the personalized book than the comparison group (Authors, under review). Children and caregiver engagement were measured through automated (# words, clauses, and ratio of word quantity per clause), and manual codes (laughter, expressions of enjoyment, questions, comments, identification with the character, positive appraisal of the book, among others) from the first audio-recorded reading sent by 114 parents from personalized and comparison groups. Linear regression models showed that children exposed to the personalized book used on average 16.15 more words (d=0.45) and 0.42 more words per clause (d=0.53) than the comparison group. Poisson regression models showed that for children and parents, being in the personalized group significantly

increased the expected number of joy expressions, laughs, and identification with the story, the number of questions from children, and evaluations from adults (Table 1). The current work extends prior research by evaluating the mechanistic effects of the intervention. Using Path Analysis, we aim to test the intervention's theory of change, namely that child engagement during shared readings of the personalized book will predict caregiver engagement which in turn would predict the number of readings of the personalized book, and thus caregivers' perceptions of their child having a favorite book (Fig. 1). Children and caregiver engagement were assessed using the number of laughs, enjoyment expressions, questions/evaluations, identification with the story, numbers of words and of words per clause. Preliminary results suggest the existence of direct effects of children's engagement on caregivers' perception of child's interest in books after the intervention, and also the existence of mediation effects of caregivers' engagement on their perceptions of child's interest in books. We discuss our results, highlighting the potential of personalized books to drive change in parents' perception of children's interest in books in a low-burden way.

S.42.04: Can a reading aloud intervention buffer impacts of the pandemic on parent-child reading? An experimental study in Brazil (Piccolo)

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Background: Promotion of positive parenting and cognitive stimulation through parent-child reading and play has been considered a key strategy to buffer children's development from impacts of poverty-related stressors (e.g., food insecurity, reduced income). The COVID-19 pandemic may compound pre-existing stressors, impact parent-child relationship and parenting, and exacerbate disparities in early childhood development, particularly in low- and middle-income countries (LMICs). Recent evidence suggests that parent-child book reading during the pandemic may ameliorate disparities in early childhood learning. However, there is limited evidence on whether pre-pandemic participation in reading programs that promote cognitive stimulation may buffer COVID-19 impacts on parent-child book reading and parenting during the pandemic. We sought to address these gaps by investigating 1) whether participation in a parent-child reading aloud program prior to the COVID-19 pandemic can support parenting and parent-child book reading during the pandemic for low-income families in Northeast Brazil, 2) whether cognitive stimulation in the home mediates effects of a reading aloud program conducted before the pandemic on parenting and parent-child book reading during the pandemic, and 3) whether participation in a reading aloud program prior to the pandemic buffers effects of COVID-19-related distress level on parenting and parent-child book reading during the pandemic. Method: This is a secondary analysis of a randomized controlled trial (RCT) of a parenting program, called Universidade do Bebê (UBB), implemented from August 2019 to March 2020 in Northeast Brazil prior to the pandemic's onset. In the RCT, n=400 low-income third-trimester pregnant women and families with children 0-24 months were randomized to UBB (n=200) or control groups. UBB consisted of monthly parent workshops focusing on parent-child book reading complemented by a lending library. Participants were evaluated pre-pandemic (June 2019) families' sociodemographics, psychosocial characteristics, and cognitive stimulation in the home. Re-assessment of cognitive stimulation in April 2020 has shown significant impacts on reading aloud and parenting practices. Follow up data following pandemic onset was obtained for 133 families (n=69 UBB; sociodemographics comparable to the full sample), including COVID-19-related distress level, as well as parenting practices

to manage children's social, educational and emotional needs and parent-child book reading during the pandemic (October 2020), when children were mean(sd) 24.9 (8.1) months. Results: Overall, participation in UBB prior to the pandemic was directly associated with parent-child book reading (β=0.19, p=0.04), but not parenting (β=0.01, p=0.33), during the pandemic. Indirect effects of UBB through cognitive stimulation were observed for both parenting and parent-child book reading during the pandemic (Fig 1). Participation in UBB moderated associations between COVID-19-related distress level and parenting/parent-child reading (Fig 2): such associations were not significant for the UBB group (parenting: β =-0.03, p=0.84; parent-child reading: β=-0.06, p=0.64) but were significant for families in the control group (parenting: β=-0.30, p=0.04; parent-child reading: β=-0.43, p=0.001). Conclusion: Novel empirical evidence suggests that promotion of cognitive stimulation prior the pandemic may buffer impacts on positive parenting and parent-child book reading following onset in LMICs. Findings likely have implications beyond the COVID-19 pandemic for disasters generally, and provide important new support for implementation of effective programs.

S.43: Multi-level dyadic pathways influence infants' emotion regulation across prenatal and postnatal development

S.43.01: Changes in maternal depressive symptom during pregnancy and infant cortisol reactivity: Mediation by placental corticotropin-releasing hormone (Rinne)

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Maternal depression is a leading pregnancy complication with established risks for maternal health as well as offspring health and well-being (Davis et al., 2018; Gavin et al., 2005; Rogers et al., 2020). Maternal prenatal depressive symptoms may influence offspring health over the lifespan through programming of the fetal hypothalamic-pituitary-adrenal axis (HPA axis). However, the biological mechanisms explaining the association between maternal prenatal depressive symptoms and offspring HPA axis regulation are unclear. Placental corticotropin-releasing hormone (CRH), a stress hormone of fetal-placental origin, is an indicator of fetal response to maternal stress (Sandman, 2018) and is integral to the development of the fetal HPA axis (Howland et al., 2017). Studies have yet to test whether pCRH explains the association between maternal depressive symptoms and infant cortisol reactivity. The current study addresses this research gap and examines whether patterns maternal depressive symptoms over pregnancy are associated with infant cortisol reactivity via changes in placental corticotropin-releasing hormone (pCRH) from early to late pregnancy. A sample of 174 pregnant women completed prenatal assessments in early, mid, and late pregnancy, including standard measures of depressive symptoms in interviews and blood sample collection for pCRH. Infant cortisol reactivity to a heel stick blood draw and the Still Face paradigm was assessed at one month (M age = 1.26 months, SD = 1.13) and six months of age (M age = 5.62 months, SD = 1.01), respectively. A structural equation model was conducted to model changes in pCRH and evaluate the effect of patterns of maternal depressive symptoms on infant cortisol reactivity via changes in pCRH. Exploratory analyses tested whether associations differed by offspring sex. Greater increases in maternal depressive symptoms over pregnancy were associated with higher infant cortisol reactivity at one month and six months of age. Additionally, the indirect effects of increases in maternal depressive symptoms on infant cortisol

reactivity mediated by increases in pCRH from early to late pregnancy were statistically significant. These effects were independent of relevant confounds and did not differ by offspring sex. Changes in maternal depressive symptoms and pCRH over pregnancy appear to influence offspring cortisol reactivity in the first six months of life across two stressful tasks independently of other confounding variables. These results have implications for offspring health and development given associations of cortisol reactivity with susceptibility to mental and physical health problems across the lifespan (Heim et al., 2000; Luby et al., 2003; McEwen, 2009). In sum, the current study elucidates the prenatal biopsychosocial factors that influence offspring HPA axis regulation and adds to growing literature indicating the importance of modeling changes in maternal psychological states and physiology over the course of pregnancy.

S.43.02: Physiological Correlates of Mother-Infant Emotional Communication (Dasilva)

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Physiological regulation is an important component of sensitive caregiving that supports engagement in synchronous social interactions and facilitates the development of infants' biobehavioral regulation (e.g. Moore & Calkins, 2004, Feldman, 2012). One measure of this regulation is associated with changes in vagal activity and is typically assessed by respiratory sinus arrhythmia (RSA) -- an index of cardiac activity related to respiratory function and general parasympathetic nervous system activity (PNS). Currently, there is limited evidence on the relation between mothers' PNS functioning and infants' emotion regulation, and critically the results are not consistent. One individual difference factor that may contribute to these inconsistencies involves caregiver-infant emotional communication. It is well established that infants differ in how they utilize 'social bids'-- gazing at the mother, vocalizing, or smiling - to re-engage her during periods of maternal unavailability. Social bidding is positively correlated with maternal responsiveness suggesting that infants expect that their mothers will contingently respond to them. In previous research, we demonstrated that infants with less-developed PNS regulation required greater co-regulation from their mothers in the form of RSA synchrony. Our goal in the current study is to extend this inquiry to investigate how maternal PNS regulation contributes to infants' emotion regulation following a stressor, and whether social bidding interacts with this co-regulation. To test these questions, 4- to 6-month-old infants (N = 127) and their mothers participated in the Face-to-Face Still Face Paradigm (FFSF) consisting of three 2-minute phases (play, still-face, reunion). ECG was recorded from infants and mothers across the FFSF. Facial expressions, vocalizations, and gaze direction were coded continuously for both infants' and mothers'; composite scores of negative and positive affect were computed every 30s, which provided 12 total indices of emotion regulation throughout the three FFSF phases. A median split was used to classify infants as demonstrating high vs. low social bidding during the still-face episode based upon their gaze at mother, smiling, and vocalizing. The difference score in mother's RSA between still-face and reunion was used to calculate RSA withdrawal as an index of maternal physiological regulation. Mothers of high social-bidding infants showed significant RSA withdrawal from still-face to reunion, $F(1, 58)= 5.97$, $p= 0.02$, but mothers of low-bidding infants did not, $p= 0.37$ (see Figure 1). In addition, high-bidding infants displayed lower negative affect during reunion than low-bidding infants, $F(1, 135)= 5.56$, $p= 0.02$. These results indicate that infants' emotion regulation during reunion was associated with mothers' physiological regulation and moderated by infants' social bidding. Although mothers are frequently the initiators of social

communication with their infants, this is not the case during the still-face episode when infants attempt to re-engage their mothers via social bidding. One reason that mothers' physiological regulation was moderated by social bidding is that high-bidding infants were more capable of affectively communicating their needs and expectations during the still-face episode, which contributed to those mothers expending greater physiological effort (i.e., RSA withdrawal) to co-regulate their infants' distress during the reunion. Converging evidence for this interpretation will be discussed in the presentation.

S.43.03: Real-time Associations between Maternal Affective Engagement and Infant Behavioral and Physiological Responses to a Stressor (Hu)

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Positive maternal engagement during face-to-face interactions may facilitate infant emotion regulation at both the behavioral and physiological levels. Studies that have employed the Still-Face Paradigm (SFP) to assess such associations report that maternal engagement and positive affect predict more infant positive affect and active engagement behaviors during the reunion episode (e.g., Rosenblum et al., 2002). Positive maternal behaviors have also been linked to infants' better parasympathetic recovery in the reunion, although findings are not consistent (see Jones-Mason et al., 2018). Prior studies typically use global measures of behavior and psychophysiology, and less is known about the temporal dynamics of mother-infant coregulation. For instance, infant behavioral and physiological responses may fluctuate in tandem with real-time changes in maternal engagement. Further, with the rapid development of socioemotional abilities, mother-infant coregulatory processes may change considerably during the first year. In this study, we examined real-time fluctuations of infant affective engagement and physiology (i.e., respiratory sinus arrhythmia [RSA]) in relation to real-time fluctuations in maternal affective engagement during the SFP reunion episode at 3, 6, and 9 months. Participants were 102 mother-infant dyads (45 girls; mothers were 71% European American). At 3, 6, and 9 months, mothers and infants were observed during the SFP, which included three 2-min episodes (play, still-face, and reunion). Using frame-by-frame coding of mothers' and infants' facial expressions, vocalizations, and gaze, infants' and mothers' affective engagement during the reunion were computed on a 5-point scale (1 = negative engagement to 5 = positive engagement) and were then aggregated into 15-s epochs. Infants wore a 3-lead wireless ECG monitor, and RSA during the reunion were calculated in 15-s epochs. At each time point, two-level autoregressive models predicting infant affective engagement and RSA, respectively, were fitted. As shown in Table 1, the autoregressive relations at Level 1 were significant, indicating stability in infant engagement and RSA across epochs. Using epoch as a predictor, only infant RSA at 6 months showed significant increase over the course of the reunion. For the model predicting infant engagement, at 3, 6 and 9 months, infants showed more positive engagement in a given 15-s epoch when their mother was more positively engaged compared to the mother's own mean level. This Level-1 association complemented the Level-2 association between the mean levels of maternal and infant engagement. For the model predicting infant RSA, higher maternal positive engagement predicted higher infant RSA in the same 15-s epoch only at 9 months; this association was nonsignificant at 3 months and approached significance at 6 months. This study extends the literature by illuminating the real-time dynamics between maternal affective engagement and infant behavioral and parasympathetic responses to a stressor over the first year of life. Specifically, maternal positive engagement appears to

predict real-time infant engagement during the reunion at all ages, and this association appears to become stronger over time. Real-time infant physiological responses, however, were only coupled with maternal engagement toward the end of the first year, suggesting that older infants are better able to physiologically benefit from mothers' real-time support.

S.43.04: Physiological Measures of Attention and Arousal During Dyadic Interactions as Predictors of Social Communication and ASD Symptoms (Bradshaw)

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Dyadic interactions between infant and a caregiver are critical for the development of language and social competence. In early infancy, social interactions are supported by sustained attention to the caregiver and effective physiological regulation (Calkins et al., 1998; Moore & Calkins, 2004; Pratt et al., 2015). For infants who go on to experience social-communication challenges, such as those with autism spectrum disorder (ASD), these early interactions may be even more important for social learning. This study examines how physiological and attentional regulation during early dyadic interactions predict later social-communication skills and ASD features in a group of infants at elevated and low likelihood for ASD. Participants included 21 infants (11 female, 10 male) determined to be at low and high familial likelihood for ASD. Between 3-4 months of age, infants and mothers participated in a 5-minute dyadic interaction. Infants wore wireless electrocardiogram (ECG) recorders and the interaction was filmed for later coding of infant attention to the caregiver's face. Infant respiratory sinus arrhythmia (RSA) during the interaction was used to further index physiological regulation. Autonomic regulation of social attention was indexed using (1) overall time in heart rate-defined sustained attention to caregiver and (2) heart rate deceleration during sustained attention (Bradshaw & Abney, 2021). Maternal social anxiety (Liebowitz Social Anxiety Scale) and parent-reported temperament (IBQ-R) were also collected at 3 months. At 24 months, social-communication skills (Communication and Symbolic Behavior Scales) and autism symptoms (Autism Diagnostic Observation Schedule) were assessed. Overall RSA during the dyadic interaction was significantly associated with social-communication skills at 24 months ($r=.56$, $p<.05$) and heart rate-defined sustained attention deceleration was moderately associated with ASD symptoms ($r=.54$, $p=.09$). Maternal social anxiety was associated with sustained attention heart rate deceleration ($r=-0.66$, $p<.05$) and moderately with RSA ($r=-.46$, $p=.09$), but not developmental outcomes. Finally, the only temperamental construct to predict developmental outcomes was Surgency for predicting social communication ($r=.58$, $p<.05$). A multiple regression revealed a significant interaction between surgency and RSA for predicting social communication ($F=8.63$, $p<.05$). This study extends previous research and suggests that physiological measures of reactivity and attention during infant dyadic interactions are important for developmental outcomes and may be early indicators of atypical developmental pathways. Higher parent-reported surgency and higher RSA during a dyadic interaction at 3-4 months of age significantly predicted social-communication at 24 months. Importantly, surgency was more predictive of social communication for those with lower RSA. For those with higher RSA during the interaction, surgency made very little impact on outcomes. Regarding maternal factors, maternal anxiety significantly impacted infant heart-defined sustained attention, but long-term effects on social communication outcomes were not apparent. While RSA was predictive of social skills at 2 years, autism symptomatology was more related to autonomic regulation of attention. Data collection is ongoing, but these results suggest that autonomic regulation and social attention during dyadic interactions in

infancy is an important predictor of social outcomes and may be useful as an early indicator of ASD symptoms, especially in infants at elevated familial likelihood.

S.44: New perspectives on the cognitive bilingual advantage in infancy

S.44.01: Exploring whether a bilingual advantage exists for 8-to-36-month-old infants in the UK (Gibson)

Shannon Gibson[1], Alexandra Hendry[2], Catherine Davies[3], Nayeli Gonzalez-Gomez[1]

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This paper tested whether multilingual 23-month-olds out-perform monolinguals (N=81) on response inhibition, attentional flexibility, and regulation measured with a parental questionnaire. Additionally, individuals with greater non-dominant language exposure and a higher translation equivalent (TE) proportion were expected to have stronger EF. Parents completed the Early Executive Functions Questionnaire (EEFQ; Hendry & Holmboe, 2021) and a productive vocabulary checklist that measured TEs. Multilingual toddlers and individuals with greater non-dominant language exposure had significantly stronger response inhibition skills. No significant findings were noted for TEs. Indirect measurement of EF might be more appropriate in testing the cognitive advantage among young bilinguals.

S.44.02: Examining and re-examining the bilingual cognitive advantage in infancy: Extending Dal Ben et al.'s analyses to new data (Tsui)

Angeline Sin Mei Tsui[1], Christopher Fennell[1]

[1]University of Ottawa

In this Paper, forty-one bilingual 8-to-36-month-old infants were matched with monolingual participants on age, gender, and SES. Their parents completed the EEFQ. When a 20% L2 exposure criterion was used, there was no significant difference between monolingual and bilingual participants on overall EF ability; however, bilingual participants scored significantly higher than monolingual participants on inhibitory control. A second study (N=72) with a minimum of 25% second language exposure threshold suggests that there are no significant differences between bilingual and monolingual participants' global EF ability. Analyses comparing monolingual and bilingual participants on the separate sub-components of inhibitory control, flexibility and working memory were not conducted with the second sample as no subcomponents were dissociable above the preregistered threshold.

S.44.03: Testing the Bilingual Cognitive Advantage with the Early Executive Functions Questionnaire (Beaudin)

Kayla Beaudin[1], Diane Poulin-Dubois[1]

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The authors of this Paper replicated the seminal study by Kovacs and Mehler (2009), but with slightly older infants. Twenty-four monolingual English and 23 bilingual French-English infants of 9.5 months were first trained to predict a reward on the right based on a tone-shape rule structure (AAB pattern). Infants were then trained to predict a different reward on the left based on a new rule structure (ABB pattern). Infants' success was marked by correct anticipation of reward locations in each trial. Bilinguals

and monolinguals performed similarly at test, showing no evidence of enhanced EF. More fine-grained analyses of the data are planned, as including total anticipatory looking using whole-trial values may mask subtler differences between monolinguals and bilinguals .

Oral Presentations

O.01: Bilingualism

O.01.01 Bilingualism affects infant cognition: Insights from new and open data (Dal Ben)

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Bilingualism has been hypothesized to shape domain-general cognitive abilities across the lifespan. In their seminal 2009 study, Kovács and Mehler showed monolingual-bilingual cognitive differences in 7-month-old infants. However, subsequent replication attempts have reported mixed findings (D'Souza et al., 2020; Ibánez-Lillo et al. 2010; Molnar et al., 2014; Tsui & Fennell, 2019). We further tested these differences by collecting new data from 7- and 20-month-olds and reanalyzing three open datasets (D'Souza et al., 2020; Kalashnikova et al., 2020; 2021). Infants from all studies (combined N = 222) were tested in an anticipatory eye movement paradigm. Training trials began with a visual and/or auditory cue in the center of the screen, flanked by two white squares. After 2 seconds, the cue disappeared and a one-second anticipatory period began, with only the squares remaining on the screen. Finally, an audiovisual reward appeared consistently on one side of the screen. After 9 Training trials, Test trials began. Test trials had the same sequence, but the reward was presented on the opposite side of the screen. To correctly anticipate the reward at Test, infants had to update their previously learned behavior. Kovács and Mehler (2009) reported a block-level analysis, where the 9 trials in each phase were grouped into 3 blocks, yielding up to 6 data points per infant (2 phases x 3 blocks). We, however, modelled performance within and across trials using mixed-effects logistic regression. This strategy yielded greater statistical power with 80 data points per infant, providing more fine-grained insights about our data and also revealing new trends in the reanalyzed data. Results from our newly collected data are shown in Figures 1 and 2 (7- and 20-month-olds). At 7-9 months, an analysis of infants' anticipations both within and across trials showed that in 3 out of 4 studies (newly collected data; D'Souza et al., 2020; Kalashnikova et al, 2020; 2021, Visual condition), bilinguals were better able than monolinguals to update their previously-learned response at Test. Importantly, in these three studies, bilinguals also showed weaker anticipations during the Training phase. In the fourth study (Kalashnikova et al, 2020; 2021, Auditory condition) the opposite pattern was found, whereby monolinguals showed better performance than bilinguals at Test, but worse performance during Training. At 20 months, bilinguals performed better at Test, although groups showed similar performance during the Training phase. Overall, these results show that bilingualism affects how infants process both new and updated information. Surprisingly, the patterns we observed imply a tradeoff between performance during Training and performance at Test. In studies of 7-9-month-olds that used visual cues, bilinguals were always less accurate during Training, but outperformed monolinguals at Test. In the only study to use a purely linguistic cue, the reverse was true: monolinguals performed worse during Training but better at Test. Perhaps for linguistic stimuli, bilinguals are faster at initially encoding information, whereas for visual stimuli they are slower. Our study also shows the potential of open science, especially open data and code, to advance our understanding of language development.

O.01.02 Habla conmigo, papá: Fathers? language input in bilingual Latinx families (Ferjan Ramirez)

Naja Ferjan Ramirez[1], Daniel Hippe[2], Lili Correa[1], Josephine Andert[1], Melissa Baralt[3]

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Although understudied, fathers have a unique and critical contribution to their children's language development (Pancsofar, 2013; Tamis-LeMonda et al., 2013). This study examines the language environments of bilingually raised Latinx infants (n=37; age: 4-22 months) in mother-father families of diverse socioeconomic (SES) backgrounds, with a focus on paternal speech and parentese, a speaking style distinguished by higher pitch, slower tempo, and exaggerated intonation (Fernald et al., 1989). We ask how much paternal speech and paternal parentese Latinx infants hear, and whether paternal language input relates to infant language production. Further, we seek to identify relations between fathers' responsibilities in childcare, fathers' knowledge around child language development, and fathers' language input. Using Language ENvironment Analysis (LENA), we collected 2 daylong audio recordings from each family on weekends when both parents were home. Child vocalization counts (CVC) and male and female adult words counts (MAN, FAN) were provided through LENA's automatic annotation, while conversational turn count (CTCs), parentese, and language (Spanish/English) were manually annotated, following the previously described procedures (Ramírez-Esparza et al., 2014; Ferjan Ramírez et al., 2021). Paternal Parental Responsibilities (PPR) scores and Paternal Language Development Knowledge (PLDK) scores were calculated from questionnaires administered to fathers. Using linear mixed-effects models, we compared male and female word counts (MAN, FAN), paternal and maternal parentese, and their ratio between fathers and mothers while accounting for demographic variables (SES, infant age, and infant sex). Linear regression models were used to evaluate the associations of the PPR and PLDK scores with MAN and paternal parentese, as well as the associations of paternal and maternal speech and parentese with CVC, CTC. Most infants experienced Spanish and English within child-directed speech, and language mixing was common in fathers and mothers. Adjusting for demographic variables, infants heard 50.4% less talk from men compared to women (p<.001), and 43.4% less parentese from fathers compared to mothers (p<.001). However, when controlling for overall speech amount using the parentese-to-word-count ratio, the rate of parentese use did not differ significantly between mothers and fathers (p=.36), demonstrating that, contrary to the stereotype, fathers in Latinx families adjust their speech in verbal interactions with their infants. An asymmetry emerged where paternal parentese was associated with greater paternal knowledge of child language development (p=.046), but not paternal childcare responsibilities (p=.62); the opposite was true for paternal speech amount (p=.11 for PLDK and p=.042 for PPR). Controlling for maternal contributions and demographic variables, paternal parentese was predictive of increased concurrent turn-taking (CTC; p=.030) and marginally predictive of increased infant language vocalizations (CVC; p=.086), demonstrating its important role in infant language development. These results demonstrate that, although fathers in Latinx families speak less to their infants compared to mothers, they regularly use parentese, which is uniquely predictive of concurrent caregiver-child turn-taking and child language vocalizations. This study has important implications for designing culturally sensitive father-centered language interventions.

O.01.03 Contextualized Language Input during Routine Activities in Multilingual Homes. (Caunt)

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Studying infants' language environments using real-world longform audio recordings (e.g. Bergelson et al., 2019; Casillas et al., 2020) has revolutionised the field of early language development by allowing us to capture the essence of infants' experiences at home. Day-long recordings can be particularly useful for studying bilingual language development: they allow us to estimate exposure to each language (Cychosz et al., 2021), the frequency of code-switching in the input (Kremin et al., 2020), and to test whether those depend on activities and people the infant is engaged with. Throughout the day, infants participate in routine activities that provide them with unique opportunities to receive contextualised language input (Nelson, 1985; e.g., at bath time, infants are more likely to hear 'bubbles' than 'spoon'). Whilst previous research examined monolingual input during daily activities (Tamis-LeMonda & Custode, 2018), input in multilingual homes has received less attention. In a multilingual home, daily activities afford the infant with opportunities to hear different languages from various speakers. For example, a Spanish-speaking mother may be the one who bathes her infant every evening; therefore bath time words would be associated with Spanish only. During a shared family meal, the presence of the English-speaking father will likely expose the infant to food-related words in English and Spanish. Hence, routine activities may expose the multilingual infant to sets of contextualised inputs that can be speaker- and language-specific or include a mix of languages and speakers. The current study aims to examine language input in multilingual homes across various daily activities (e.g. book-reading, feeding) from the beginning, middle and end of the day. We ask whether particular activities are language specific or mixed across two days, and whether activities that involve multiple speakers and languages include evidence of code-switching. Data collection is still ongoing, and our current sample (n=19) includes multilingual families who live in the Greater London area and speak different languages (e.g., Japanese, Greek, Spanish, French). At the time of the study, these families were raising infants between the ages of 6 - 20 months. Families received packages containing small USB recorders and t-shirts (see Figure 1), and were asked to record two full days at home. We are currently annotating the recordings using ELAN (Brugman et al., 2004) following the ACLEW guidelines (Soderstrom et al., 2021). Our annotations capture 2 x 5 minute samples from the beginning, middle and end of each of the two days (total = 30 minutes per day) around a range of activities; e.g., bath time, breakfast etc. The annotations account for mixed, single language utterances, directed speech and the languages used (see Figure 2). Once completed, our annotations will allow us to characterize whether routine activities in a multilingual home include single or mixed language input, and to measure the frequency and features of code-switching during a range of activities throughout the day. These analyses will contribute to our understanding of context-dependent word learning.

O.01.04 Learning two words for the same thing: Bilingual parents? repetitions within and across languages (Moore)

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Children's earliest words often refer to their everyday lives, including social routines, playtime, mealtime, bathtime, and bedtime (Braginsky et al., 2016). In monolingual families, these experiences occur within the context of a single language, while in bilingual families, they occur across two languages. Experimental evidence suggests that the timing of word learning opportunities matters, favouring close repetitions for to-be-learned words (Schwab & Lew-Williams, 2016). Here, we

explore the temporal organisation of repetitions in naturalistic speech to bilingual toddlers, both within the same language (i.e., hearing the word "dog" twice) and across languages (i.e., hearing translation equivalents like English "dog" then French "chien"). We used a collection of transcribed 20-30-minute recordings from 11 French-English bilingual 24-month-olds, who in separate recordings played first with a primary caregiver and second with multiple household members (4 toddlers did not contribute second-session data). For each session, utterances were transcribed and tagged with their language (French or English) and speaker (e.g. Mother). To identify infant-relevant words, we focused on the 610 items that appear on both the English and Canadian French versions of the MCDI (Fenson et al., 1994; Trudeau et al., 2008). Within any given recording, children heard an average of 98 (SD=13) of the 610 eligible CDI items, 71 (SD=13) of which were repeated. Further, 26 (SD=17) of these repetitions occurred across languages, suggesting that on average bilingual infants regularly hear repetitions of the same item in both languages within a short timespan. Repetition frequency scaled with input; toddlers who heard more balanced input across both languages heard more translation equivalents. Unexpectedly, the most balanced input also came from the families who talked most (r=0.61, p<0.006; Fig.1). Looking at the temporal organisation of repetitions, we found that same-language repetitions were significantly closer together in time than translated repetitions overall (t=10.68, p<0.001). Despite this, 32% of translations occurred within 10s. This short interval suggests that, consistent with previous work (Kremin et al., 2020), an important minority of translations may occur pedagogically; parents may attempt to support their children's bilingual development by providing translation equivalents in succession, potentially boosting balanced bilinguals' language exposure. Looking at parents' language choices by lexical class, we found that for nouns and adjectives, same-language repetitions and translated repetitions occurred at equivalent mean intervals. In contrast, verbs' same-language repetitions were significantly closer in time than translated repetitions (Fig.2). This pattern suggests that parents may deliberately translate words from some lexical classes for their children (nouns and adjectives), while only circumstantially providing translations for others (verbs). Taken together, these findings show that bilingual toddlers hear temporally-close translation equivalents for almost a quarter of the early-learned words they hear, and that the distribution of those words differs based on the relative proportions of each language, and lexical class. Further, parents who provide more balanced input also provide more input in our sample, which may help toddlers learn two languages concurrently while monolinguals learn one.

O.02: Emotion

O.02.01 The role of emotional reactivity in Mexican-origin mothers' momentary punitive emotion socialization behaviors (Boyer)

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Parenting is an emotional experience (Dix, 1991). Children's repeated demands and emotional outbursts can evoke a range of parental emotions from anger to sadness to happiness. Parents emotional arousal to child stimuli may determine individual differences in maternal behavioral responses (Gross, 1999; Teti & Cole, 2011). Drawing upon an affective organization of parenting framework, the current study examined Mexican-origin mothers' propensity to use punitive emotion socialization behaviors with their toddlers. Specifically, employing an intensive longitudinal design we examined 1) if increases in mothers' negative emotional reactivity predicted increases in punitive behaviors and 2) if greater child difficult

behaviors (e.g., crying hitting) increase the likelihood that maternal negative emotional reactivity will lead to punitive behaviors. Mothers (n = 59) and their 18-month-old toddlers (Mage = 18.16, SD = 1.97) were recruited to participate in a six-day ecological momentary assessment with surveys at wake-up, evening, and bedtime during which they reported their punitive emotion socialization behaviors (e.g., yelling at the child, spanking the child), negative emotions (e.g., anger, sadness) and percent of which was attributable to their toddler (e.g., "how much of your anger in the last 30 minutes is due to your child?"), and their toddler's difficult behaviors (e.g., crying, hitting). Maternal negative emotional reactivity was derived from the percent negative emotion mothers attributed to their child. Data were analyzed using multilevel modeling with within- and between-person effects separated to account for their unique contributions to the variance in mothers' punitive responses. Results indicated that when mothers' felt more negative emotional reactivity to their child than usual and when toddlers engaged in more difficult behavior than usual, mothers used more punitive responses toward their toddler (table 1). However, a significant between-person emotional reactivity by within-person difficult behavior interaction revealed that the association between mother's emotional reactivity and punitive behavior was dependent upon child difficult behavior. Simple slopes analyses revealed that mothers who had higher overall negative emotional reactivity to their toddler engaged in more punitive behaviors when their toddler engaged in more difficult behaviors than usual compared to mothers who had lower overall negative emotional reactivity (figure 1). These findings highlight the unique role of negative emotions during challenging parenting situations and how these contribute to Mexican-origin mothers' emotion socialization behaviors.

O.02.02 The structure of emotion dynamics from infancy through early childhood (Nencheva)

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Emotions are not isolated events. Instead, the current state depends on how preceding states unfold over time. Adults' emotion dynamics follow predictable patterns, determined in part by valence: positive emotions more often follow positive than negative emotions (Thornton & Tamir 2017;2020). How do children develop emotional experiences that are likewise organized by valence? In three studies, we explored factors that shape young children's emotion dynamics. In Study 1a (N=148, age=0;0-5;0) and its preregistered replication 1b (N=255, age=0;0-7;1), parents were asked to imagine that their child was feeling a given emotion (e.g., happy) and estimate how likely it is that the child would feel a different emotion next (e.g., sad). We quantified the extent to which each child's transitions were organized by valence in a regression model predicting transition likelihood ratings between two emotions from the difference in their valence. For example, we would predict a high transition likelihood for 'sad' and 'irritated', which have similar valence, and low likelihood for 'sad' and 'happy', which have different valence. The extent to which a child's transitions followed these predictions was our metric of valence organization -- the regression coefficient estimated by this model for each child. We found that valence organization significantly increased with age (Fig.1a ; β1a=0.05, p<0.05; β1b=0.03, p<0.05), indicating that, with age, children became increasingly likely to transition between similarly-valenced emotions and less likely to transition between differently-valenced emotions. In Study 2 (N=239, age=0;2-7;0), we tested how the organization of children's emotion transitions interacts with their growing vocabulary and their ability to sustain emotional experiences for longer. Parents reported their child's emotion transitions, the time course of emotion experiences, and emotion vocabulary. Emotions

that children experience for longer or emotions they can name were more likely to transition to other emotions that are similar (vs. dissimilar) in valence (Fig.1b; βhalflife=0.19, p<0.05, βlabel production=0.08, p~0.07). In Study 3 (N=99, age=0;1-4;11), we examined these questions in a large-scale, naturalistic experience sampling paradigm. We assessed the child's emotion time-course and vocabulary. In addition, parents completed experience sampling surveys 6x/day for 10 days in which they reported on which of 10 emotions their child was feeling in the moment. This approach bypassed parents' estimation of child transition likelihoods to quantify the log odds ratio and well as the frequency of each child's actual transitions between each pair of emotions. These real-life measures showed that as children got older, their emotion transitions became increasingly organized by valence (Fig.2a; βfrequency=-0.007, p<0.001; βlog odds ratio=-0.01, p <0.001). Transitions were more organized by valence when the child could name the starting emotion (Fig.2b; βfrequency=-0.3, p<0.001; βlog odds ratio=-0.4, p<0.001), and became more organized by valence with increasing half-life (βfrequency =-0.027, p~0.001). Together, these studies suggest that children's emotion dynamics gradually mature into an adult pattern organized by valence. Further, children's growing abilities to label emotions and sustain emotional experiences may support the development of their emotion dynamics (and vice-versa). This densely-sampled, ecologically-grounded approach to measuring children's everyday emotion dynamics can advance our current understanding of emotion development.

O.02.03 Maternal depression and parenting: Implications for the early development of emotion regulation behaviours (Atkinson)

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The emotion regulation behaviours developed in infancy set the stage for lifelong socioemotional functioning. This development occurs in the context of early parent-infant interactions, and may be impeded by risk factors such as maternal depression (Granat et al., 2017). Depressed mothers tend to be less attuned and responsive to their infants' emotional states, and to engage in more harsh/negative parenting behaviours (Hentges et al, 2021; Priel et al., 2019). Infants of depressed mothers display higher levels of negative emotionality (Feldman et al., 2009); however, little is known about the specific regulatory behaviours used by these infants. The goal of the current study was to examine the association of maternal depression and the emotion regulation behaviours used by infants in two interaction contexts, as well as the moderating effects of maternal sensitivity and hostility. The sample included depressed (n = 13) and non-depressed (n = 28) mothers and their four-month-old infants. Dyads underwent the Still-Face procedure (Tronick et al., 1978), which consists of two two-minute normal interaction periods, in which mothers interact with their infants normally, separated by a two-minute perturbed interaction period, during which mothers maintain a neutral facial expression and refrain from interacting with their infants. Maternal depression was measured using the Centre for Epidemiologic Studies - Depression Scales (Radloff, 1977). Maternal sensitivity and hostility were observationally coded using the Emotional Availability Scales (Biringen et al., 1988; 2014), and infant emotion regulation behaviours were coded using the Infant Self-Regulation Scheme (Jean & Stack, 2012). A series of four two-step multiple regression analyses was carried out. Results indicated that, during the normal period, maternal sensitivity moderated the association between maternal depression and infant bidirectional exchange, such that maternal depression negatively predicted the use of bidirectional exchange, but only for dyads with low maternal sensitivity (Figure 1). During the still-face

period, maternal sensitivity moderated the association between depression and infant gaze aversion, such that maternal depression positively predicted gaze aversion for dyads with high maternal sensitivity and negatively predicted gaze aversion for dyads with low maternal sensitivity (Figure 2). This is consistent with findings that infants respond differently to the still-face when they have prior experience of similar, depressed interactions with their mothers (Graham et al., 2017). Our findings are in line with theories that maternal sensitivity is one mechanism by which maternal depression impacts infant emotion regulation, and suggest that this may occur at the level of individual emotion regulation behaviours. Maternal hostility did not moderate the association between maternal depression and infant emotion regulation behaviours during either the normal or still-face periods. During the still-face period, maternal hostility positively predicted the use of self-comforting and gaze aversion. This increased use of self-soothing may reflect the association between maternal hostility and infant difficulty in regulating distress (Little & Carter, 2005). Taken together, our findings suggest that parenting characteristics are important predictors of the emotion regulation behaviours used by infants in different interaction contexts. These results have implications for the socioemotional development of children of depressed mothers and for early parenting interventions.

O.03: Neuroscience I

O.03.01 Follow the rhythm: Basque-Spanish bilingual infants' cortical tracking of speech after brief exposure to music (Fernández-Merino)

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Music experience and music exposure yield positive transfers to language abilities in adults and children, such as positive impact on their vocabulary skills, phonological awareness, and auditory processing, among others. Music-to-language benefits have also been reported in young infants demonstrating enhanced development of prelinguistic communicative gestures, neural processing of temporal structure, and word segmentation as a result of music exposure. This study investigates the neural processes underlying these transfers, focusing on the effects of exposure to rhythmical cues in music on neural entrainment to speech. For this purpose, we are conducting a study that uses electroencephalography to record neural responses to music sequences and spoken sentences in 6-month-old and 15-month-old Basque-Spanish bilingual infants (expected N = 25 per group). Infants are presented with a task in which they hear 64 Basque and Spanish sentences produced in natural infant-directed speech. Sentences presentation is preceded either by rhythmically regular musical sequences or by rhythmically irregular musical sequences. The regular sequences were constructed to reflect and match the rhythmic structure and the melodic contour of the linguistic stimuli. The irregular sequences were constructed by scrambling note duration and the melodic contour of the regular sequences. Only one type of musical sequence and language is used within a single experimental block. Delta (~2Hz) and theta (~4Hz) frequencies, suggested to follow syllabic language rhythm, were stimulated and of interest in this study. Oscillatory activity in these frequencies in response to the musical sequences and speech are analyzed. Stronger oscillatory activity is expected in rhythmically regular than irregular musical sequences, illustrating facilitated entrainment to regular rhythms. We also expect stronger oscillatory activity and phase coherence in the speech preceded by regular musical cues, which will reflect that rhythmic information in music leads to a processing benefit in subsequent speech. Regarding

entrainment to the musical sequences, preliminary analyses on a subset of data from the 6-month-old group (n=7) suggest that neural entrainment to rhythmically regular musical sequences was higher than to irregular sequences across frequencies in both Spanish and Basque (see Figure 1). Additionally, neural entrainment to speech (see Figure 2) was higher when preceded by rhythmically regular musical sequences compared to irregular musical sequences in the delta but not theta band in the case of Spanish and Basque. These preliminary analyses point to a positive influence of brief musical stimuli on infants' cortical tracking of speech. The addition of more participants from both age groups will enable us to examine the differences in cortical tracking of speech and music throughout development. In addition, the inclusion of bilingual infants will enable us to assess the effects of individual language experience on this relation by comparing neural responses to infants' dominant and non-dominant language stimuli.

O.03.02 A meta-analysis of fNIRS studies on infants' detection of repetition- and diversity-based regularities in speech (Gemignani)

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Introduction. The replicability of scientific discoveries is a pressing concern in the research community. Meta-analytic studies are key to assessing the robustness of reported effects. Yet very few exist in the NIRS literature, especially with infant populations. Using this approach, we investigate infants' abilities to extract two types of regularities from speech: (1) repetition-based regularities (AAB: mumuba, ABA: mubamu), (2) and diversity-based regularities (ABC: mubage). Individual studies suggest that infants show significant hemodynamic responses to repetitions, but not to diversity-based structures at birth, but by 6 months, they also encode diversity (de la Cruz-Pavía & Gervain 2021). Here we conduct a meta-analysis to evaluate the developmental trajectory of the processing of these structures in the existing infant NIRS literature. Methodology. We gathered all published and unpublished studies (k=19) testing NIRS responses to repetition- and diversity-based regularities implemented with speech stimuli (16), tones (1), sign (1), or visual stimuli (1) in newborns (k = 12) and 6-9-month-old infants (k = 7). We calculated variance-weighted effect sizes for oxyHb concentration in response to repetition- and diversity-based regularities as compared to a silent baseline in the left temporal lobe, known to functionally support auditory processing in infants, using random-effects models with the R package metafor (Viechtbauer, 2010). Results. Meta-analytic effect sizes over all ages pooled together were 0.26 for repetition-based structures (CI [0.13, 0.39]) and 0.19 for diversity-based structures (CI [0.04, 0.34], see Figure 1). When analyzing speech-only stimuli (16 studies), responses to repetition-based structures had numerically similar meta-analytic effect sizes at birth and in the 6-9-month-old group (birth: 0.29, CI [0.14, 0.45]; 6-9 mo: 0.28, CI [-0.02, 0.58]). In turn, responses to diversity-based structures were larger in the 6-9-month-old group (0.26, CI [-0.04, 0.56]) than at birth (0.14, CI [-0.06, 0.35]). These results thus confirm that infants detect repetition from birth, reflected in an effect size that remains constant through the first few months of development, while the effect size of the responses to diversity-based structures, moderate at birth, increases with age, and by six months of age becomes similar to that of repetition-based structures. Analysis of potential moderators (e.g. native language, etc.) is currently undergoing. Discussion. Our findings quantify, for the first time, the effect sizes of young infants' brain responses to repetition- and diversity-based sequences in the left temporal areas. The meta-analysis

indicates differential developmental trajectories for the two patterns. This may be related to the different roles they play in development, e.g. encoding structures based on diverse syllables becomes more important as infants start learning words starting at 6 months.

O.03.03 Peak selection and latency jitter correction in infant event-related potentials (Guy)

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Researchers frequently select time windows for event-related potential (ERP) analyses based on previous literature or visual review of the data, however, use of a data-driven strategy, accounting for trial-by-trial variability within individual participants' data may yield more accurate results. Variability in component latency within an individual's data (i.e., latency jitter) may blur the average ERP, misleading interpretation of neural mechanisms. The ReSync MATLAB toolbox (Ouyang, 2020) has been made available for correction of latency jitter. In this study, we illustrate how ReSync can be adapted for infant ERP research. Participants completed an ERP study including visual presentations of intact and scrambled face and toy stimuli. For each participant's data, a semi-automated peak detection program estimated time windows for the P1, N290, and P400 components (Conte et al., 2020; Guy et al., 2016; 2018). A custom MATLAB script was used to identify the point of greatest amplitude for each stimulus condition at specific electrodes within a predetermined time window. Each peak was inspected after detection and misidentified peaks were adjusted. This has helped to overcome weaknesses of a "one size fits all" approach to peak selection, however it does not account for variability due to latency jitter within a participant's data. ReSync was used to determine whether component latency jitter was present in individual trials at electrodes of interest, correct for jitter, and then average jitter-corrected trials. We hypothesized that greater variability in latency would be observed for the N290 and P400 than for the P1. The ReSync toolbox was effective in the identification of component peaks within individual trials. As shown in Figure 1, use of ReSync led to enhanced ERP component presentation, at the individual and group levels, indicating that components were impacted by latency jitter. Figure 2 presents the peak latency at each trial for the P1, N290, and P400. Greater variability is observed in the N290 and P400 than the P1. Bootstrap analyses were performed on corrected and uncorrected datasets to test whether the procedure improved data quality. Reduced error was observed in the measurement of peak latency of the infant P1, N290, and P400 following ReSync. While the implementation of these procedures led to more precise peak selection in components characterized by distinct peaks (e.g, the P1, N290), they may be unsuitable for examination of ERP components characterized by broader, less precise peaks (e.g., the Nc). In general, data processing procedures that promote accurate, study-specific component selection and reduce trial-by-trial asynchrony strengthen developmental ERP research by decreasing noise included in analyses and improving the representation of the neural response.

O.03.04 Secondary Engagement at 12 and 24 Weeks: Window on Neuro-Cognitive Developmen (Gin)

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Joint attention interactions - also known as secondary engagement - are catalysts for learning (e.g., Bruner, 1983; Tomasello, 1999). Within such interactions, learners can anchor information caregivers offer - about language, emotions, object functions, and the like - to the object of joint focus. Given the power of secondary engagement for learning, and thus neuro-cognitive development, it is surprising that these interactions are rarely harnessed for clinical assessment of neuro-cognitive development. This study investigates the value of a new task - the Secondary Engagement Task (SET) - for assessing neuro-cognitive development. We report here on preliminary analyses aimed at basic validation of the SET. The research was conducted as part of a double-blind, randomized, controlled trial in Cambodia examining possible benefits of maternal thiamine (vitamin B1) supplementation for breastfed infants' neuro-cognitive development (Measelle, et al., 2021). The larger clinical trial involved 335 breastfeeding mother-infant pairs receiving thiamine supplementation from 2-24 weeks postpartum. Dyads participated in the SET when infants were both 12 and 24 weeks old. We report here on results for 99 dyads. In the SET, caregivers were asked to establish and sustain their infant's interest in a novel object over the course of five 30-second epochs; they were prompted to add and then subsequently remove cues to secondary engagement (e.g., line-of-regard, voice and gesture) as these epochs unfolded (Figure 1). We rated infants' secondary engagement behavior via a 1-6 Likert scale adapted from Bakeman and Adamson's (1984) classic investigation into early joint engagement skills (e.g., 1 = no engagement with either object or mother; 3 = engagement with one or the other but not both; 6 = clear signs of conscious joint engagement with both mother and object). We predicted that secondary engagement ratings would a) display a quadratic pattern over the course of the SET as mothers first added and then removed cues to secondary engagement across epochs, and b) increase from 12- to 24-week timepoints. Preliminary analyses confirmed both predictions, revealing a significant quadratic trend across epochs, $F(1,98) = 103.0$, $p = .000$, and a significant main effect of timepoint, $F(1,98) = 129.0$, $p = .000$ (Figure 2). A significant epoch X timepoint interaction also emerged, $F(4,392) = 3.02$, $p = .018$, with a linear decline in ratings across epochs apparent at 12 weeks disappearing at 24 weeks. Together, these findings offer initial validation of the SET for measuring infants' involvement in secondary engagement at 12 and 24 weeks. As Cambodian mothers increased and then decreased their efforts to engage infants jointly with a novel object, infants responded with parallel changes in their attention on a joint engagement scale. When the full dataset is available, analyses will examine relations between mothers' and infants' behavior in the SET, as well as the degree to which infants' responsiveness was associated with other aspects of their neuro-cognitive development. Also of interest will be the extent to which maternal thiamine supplementation influenced infants' involvement in secondary engagement. Collectively, such findings hold potential to document the SET as an innovative instrument for assessing early neuro-cognitive development.

O.04: Social Interactions I

O.04.01 Interpersonal synchrony modulates infants' reactions to changes in caregiver-infant interactions (Markova)

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A vast amount of research impressively demonstrates that very young infants are sensitive to the lack of social communication during the so-called still-face (Tronick et al., 1978), and their responses to these situations predict various outcomes ranging from attachment security to better learning (Mesman et al.,

2009). However, perturbations of social interactions are rarely as dramatic as suspending all communication. For example, caregivers may look at their infants while speaking to another person on the phone, which results in a communicative situation that is strange yet not unusual for children. Social interactions naturally contain uncertainties and thus hold many possibilities for disruptions and interactive mistakes (e.g., Mayo & Gordon, 2020). Although these disruptions and mistakes are more subtle, infants are well capable of recognizing them (e.g., Markova & Legerstee, 2006; Murray & Trevarthen, 1985). However, we have no clear understanding of the mechanisms that (1) facilitate their recognition of such instances and (2) explain their affective responses to disruptions and interactive mistakes. Accordingly, the goal of the present study was to examine 4-month-old infants' reactions to a modified interactive condition, where mothers communicate but do not adjust to their infants' social signals. A total of 40 mother-infant dyads were observed during two conditions: a natural interaction, and a modified interaction where mothers delivered an emotionless speech about facts, while continually looking at, but refraining from engaging with the infant. During the natural interaction we observed behavioural synchrony. We also used changes in infant salivary oxytocin from before to after the natural interaction as a measure of infant reactivity to naturally synchronous interactions with their mothers. During the modified interaction we measured infant social gaze, positive, and negative behaviours as indices of interest, approach, and regulation, respectively. Results showed that higher gaze synchrony during the natural interaction was associated with infant social interest (p < .001; Figure 1A) and regulative behaviours (p < .001; Figure 2A) during the modified interaction. Higher affect synchrony was, in turn, related to infant approach during the modified interaction (p = .016; Figure 1B). Interestingly, infant-initiated (IM) synchrony facilitated infants' regulatory capabilities (p = .002; Figure 2B). Infant oxytocin was positively associated with infant social gaze (p = .015), but not related to their regulative nor approach behaviours during the modified interaction. These findings suggest that synchrony experiences with caregivers, possibly in combination with the oxytocin system, allow infants to notice changes in regular interaction patterns and contribute to the development of early regulatory capacities. The combined experience of synchronized interactions as well as interactive mistakes and, maybe even more importantly, the repairs thereof may be vital for the development of early regulatory capacities. As caregivers help infants to understand variability in their interactional environment, infants learn to anticipate and bridge those instances by themselves - taking an important step towards emotional independence.

O.04.02 Is maternal negative affectivity related to psychosocial behavior of preterm and term-born toddlers through mother-child interaction? (Krijnen)

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Introduction: Children born moderately-to-late preterm (MLP) are prone to developmental difficulties, but little is known regarding the effect of maternal personality traits and interaction style on their psychosocial outcomes. Negative affectivity (NA) is a relatively stable trait characterized by the tendency to experience negative thoughts, feelings and emotions. Maternal NA has been related to less favorable psychosocial outcomes in their offspring. Furthermore, mothers with high levels of NA have been associated with more negative parenting practices during mother-child interactions. Negative interactions have been related to less optimal psychosocial outcomes, especially in children at risk for developmental difficulties. This relationship has not been studied yet for MLP children despite their

vulnerability. The current study investigated whether maternal NA predicted child's psychosocial outcomes, whether mother-child interaction mediated this relationship and if these associations differed between MLP and term-born children. Methods: The sample consisted of 108 MLP and 92 term-born children and their mothers. At 18 months corrected age, the subscale Negative Affectivity of the Type D Scale (Denollet, 2005) measured maternal NA. Mother-child interaction was videotaped during a structured task and coded using the Coding Interactive Behavior scheme (Feldman, 1998). Five subscales of mother-child interaction were assessed: negative interaction, reciprocal engagement, emotional support, maternal stimulation and mother-led interaction. At 24 months corrected age, three psychosocial outcomes were measured: Social-emotional difficulties with the Ages and Stages Questionnaire-Social Emotional (Squires et al., 2002), and internalizing and externalizing problems using the Child Behaviour Checklist 1½-5 (Achenbach & Rescorla, 2001). Results: Results are depicted in Figure 1 (MLP group) and Figure 2 (term-born group). For MLP children, the moderated mediation model revealed that maternal NA directly, positively, predicted social-emotional difficulties (b = 0.57) and internalizing problems (b = 0.45). For term-born children, no direct effect was found, but maternal NA negatively predicted negative interaction (b = -0.13) and mother-led interaction (b = -0.16). For term-born children, reciprocal engagement negatively predicted social-emotional difficulties (b = -0.98) and mother-led interaction negatively predicted internalizing (b = -0.75) and externalizing problems (b = -0.77). A mediation effect was found for term-born children through mother-led interaction on internalizing (ab path: b = 0.12) and externalizing problems (ab path: b = 0.13). The differences in effect between the relationships within the MLP group and the term-born group were non-significant. Discussion: For MLP children, maternal NA is a direct risk factor for their psychosocial development. MLP children may be more sensitive for the NA trait in the mother, though other mediators or a genetic component may also play a role. For term-born children, maternal NA influences interaction styles, and maternal NA only indirectly predicts problem behavior through mother-led interaction. Additionally, more active and engaged interaction styles had a positive effect on psychosocial outcomes in term-born children only. For clinical practice, it is recommended to pay attention to maternal NA traits when the child is MLP born and to active interaction styles for term-born children.

O.04.03 Maternal parenting and RSA dynamics during an infant simulator task in pregnant women with opioid use disorder (Hamill)

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Introduction: The current epidemic of opioid use in the United States impacts many parents and children. The increase in opioid use is particularly relevant to women using opioids during pregnancy since infants with prenatal opioid exposure are at risk for biological dysregulation after birth. Maternal opioid dependence may disrupt mothers' capacities to provide sensitive care to their infants, placing their infants at increased risk. However, sensitive parenting has been found to buffer the negative influence of prenatal opioid exposure on infant biological and behavioral regulation. Sensitive parenting requires parents' effective regulation of their own emotions and physiologies to better attend to infants' distress. Respiratory sinus arrhythmia (RSA) is a physiological indicator of emotion regulation. This study examines the association between parenting (measured using parental report of self-efficacy and observed nurturance behaviors) and maternal RSA during an infant simulator task among pregnant women with opioid use disorder. Method: The sample included 62 women who received medication-

assisted treatment for opioid dependence during pregnancy. They enrolled in the study either during their third trimester or within one month postpartum. They were on average 29.78 (SD = 4.15) years old, with 77.4% reporting being White, 17.7% African American or Black, and 4.8% Multiracial/Other. All but one were non-Latina/x. RSA data were recorded during a resting baseline, an infant simulator task where women interact with a crying baby doll, and a recovery task with average RSA values calculated for each task. Maternal nurturance was coded based on appropriateness, latency, and proportion of distress cues women responded to during infant distress. The Maternal Self-Efficacy Scale was used to measure maternal parenting efficacy. Multilevel models were specified within Hierarchical Linear Modeling software to examine the impact of maternal parenting efficacy and nurturance behaviors (analyzed in separate models) on RSA changes across the three tasks. Both linear and quadratic coefficients of time were estimated in the models. Results: Greater self-reported efficacy was associated with higher resting RSA. On average, the RSA trajectory was a parabola, characterized by initial RSA withdrawal followed by RSA augmentation. The relationship between maternal efficacy and RSA was quadratic ($\beta = 2.27$, $p = .025$), with higher efficacy associated with greater RSA withdrawal during the infant simulator task followed by greater augmentation during the recovery period than lower efficacy. An analogous association was found between nurturance and RSA ($\beta = 2.06$, $p = .041$). Discussion: The results indicate that women who reported greater self-efficacy or exhibited more nurturing behaviors had greater parasympathetic reactivity and recovery during an infant simulator than mothers with less reported self-efficacy or observed nurturance. Decreases in RSA during a stressful task may represent optimal functioning, given that RSA withdrawal has been linked to better emotion regulation. Findings of the present study highlight the link between parenting behaviors and physiological reactivity among women with opioid use disorder. Future research should investigate whether changes in parental sensitivity predict changes in maternal physiological regulation and infant regulation outcomes in longitudinal studies.

O.04.04 The association between maternal-child interaction, maternal depression and early child development: an observational sub-study in rural Zimbabwe (Ooi)

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Johns Hopkins Bloomb Maternal responsiveness, defined as the mother's ability to perceive their infant's behaviour and respond promptly and appropriately, may impact early child development. The quality of maternal responsiveness may also be reduced by maternal depression. This sub-study of the Sanitation Hygiene Infant Nutrition Efficacy (SHINE) trial in rural Zimbabwe aims to evaluate the relationship between maternal-child interaction, maternal depression and early child development (ECD) using validated tools in the low-middle income setting. Pregnant women from two rural districts of Zimbabwe were enrolled in a cluster randomised trial between 2012 and 2015 and followed until children were 18 months old; a subgroup had ECD assessments at 24 months. Maternal depression was measured using the Edinburgh Postnatal Depression Scale (EPDS) at baseline and 24 months

postpartum. A cut-off of EPDS ≥12 at either timepoint was used to indicate depression. Maternal-child interaction was measured using the Observed Mother-Child Interaction (OMCI) tool during a 5-minute observed mother and child interaction at 24 months of age. ECD was assessed at 24 months of age, using the Malawi Developmental Assessment Tool (MDAT; assessing motor, cognitive, language and social development) and the MacArthur-Bates Communicative Development Inventory (CDI) (assessing vocabulary and grammar). Generalised estimating equations were used to estimate effect size, while accounting for within-cluster correlation. Possible confounding factors were assessed first in bivariate analyses and included in final models if p<0.2 or difference >0.25 SD. Multinomial and ordinal regression models with robust variance estimation and Somers' D for medians were used to compare baseline factors between groups depending on the distribution. Primary results were adjusted for study nurse, age of child, calendar month of birth, sex, randomised arm, home environment factors, highest maternal education, maternal age, wealth and birth weight. A total of 1996 children were recruited to the sub-study and assessed for ECD outcomes at 24 months of age; 540 completed full OMCI assessment and were included in analysis. Baseline characteristics between mothers and infants with and without full OMCI assessments were similar in terms of household characteristics, sanitation, water and hygiene. 26 of 539 mothers (4.8%) met the depression criteria. A significant positive association between OMCI score and ECD score was observed for MDAT total, MDAT fine motor, MDAT gross motor, MDAT language and Mac-Arthur-Bates CDI domains. There was greatest evidence for effect in the MDAT language score, where for 10 units change in total OMCI score, there were 2.3 units (95% CI 1.7 to 3.0) increase in MDAT language score (out of 36 points), equivalent to 0.53 SD. In the MacArthur-Bates CDI score, for 10 units change in total OMCI score there was 8.7 units (95% CI 5.8 to 11.6) or 0.44 SD increase in MacArthur-Bates CDI score (out of 99 points). There was no statistically significant association found between maternal depression and maternal-child interaction or early child development. Within a sample of rural Zimbabwean infants and mothers undergoing live assessment using the Mother Child Interaction (OMCI) tool, a significant association was found between quality of maternal-child interaction and ECD outcomes at 24 months of age.

O.05: Impact of Socioeconomic Status on Stress, Father-child relationships, and Language

O.05.01 Biological indicators of stress activation in response to socioeconomic disadvantage: Findings of infants endocrine and immune profiling. (de Mendonca Filho)

Euclides Jose de Mendonca Filho[1], Irina Pokhvisneva[1], Carine Parent[1], Shanna Milner[2], Natalie Slopen[3], David Williams[4], William Boyce[5], Pat Levitt[6], Charles Nelson[4], Megan Gunnar[2], Nicole Bush[7], Michael Meaney[1], Jack Shonkoff[4], Patricia Silveira[1]

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There is a paucity of research that has examined the association of socioeconomic disadvantage and associated stress signatures on the immune system and HPA axis during the first five years of life. Although recent investigations have begun to differentiate biological and neurobiological responses to a variety of adversities, studies considering both endocrine and immune function in the same data sets are limited. In a sample of 105 caregivers and children with age 3-68 months (M = 20.6, SD =15.7) we tested the associations between early socioeconomic disadvantage - a unidimensional factorial model of caregiver's education, family income, caregiver's perception on how safe their neighborhood is after dark, maternal job status, loss of employment by a member of the family other than the mother,

parents recent separation or divorce - and profiles of stress signatures derived from hierarchical cluster analysis of three salivary inflammatory biomarkers (IL-1β, IL-6, and IL-8) and three hair HPA axis markers (cortisol, cortisone, and dehydroepiandrosterone). We identified three clusters of endocrine and inflammation markers, a profile of young children with low levels of inflammatory and HPA markers (C1), a profile of children with low levels of inflammatory markers and average to high levels of HPA markers (C2), and a group of children with high levels of inflammatory markers and average levels of HPA markers (C3, Figure 1). Higher levels of SES disadvantage were positively associated with the C2 profile (C1 as baseline OR = 2.72, p = .001), and negatively with C3 group (C2 as baseline OR = 0.58, p = .05), see Figure 2. Findings indicate that biological signatures of stress-responsive systems are associated with SES disadvantage at a very early age. Further investigation offers a promising pathway to a deeper understanding of the complex pathophysiology that links a wide range of adversities during the early childhood period to greater risk for impairments in both physical and mental health in the adult years. Figures Caption: Figure 1. Boxplots of the distribution of biomarkers' levels by Profiles. Figure 2. Logistic regression shows that Socioeconomic Disadvantage is associated with inflammatory and HPA axis profiles. A) Logistic regression of C1 (baseline) versus C2. B) Logistic regression of C2 versus C3.

O.05.02 Parent-child interaction, but not SES influences language development in the first year of life (der Nederlanden)

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This study investigates the effects of socioeconomic status (SES) and several other potential predictors of language development during children's first year of life. It is part of a longitudinal study on the social, cognitive and linguistic development of a large cohort of Dutch-acquiring children. We argue that while SES does not affect language development at this young age, parent-child interaction and gestational duration do. Previous research reports that a wide variety of language skills is compromised in children from low SES environments (Pace et al., 2017). While SES-effects on language are well-recognized, to date, there is little research on SES-effects on language in children before age one. Furthermore, evidence of SES-effects on language is mixed (McGillion et al., 2017; Vasilyeva et al., 2008 a.o.). It is possible that some language domains are less susceptible than others to the influence of environmental factors like SES. Taking a formal linguistic approach, we hypothesize that SES may influence lexical and metalinguistic knowledge, but does not affect structural language abilities (i.e. phonology, morphology, syntax). To test this hypothesis, we investigated a) when the first SES-effects on language are observed, b) whether SES affects structural language abilities differently from non-structural abilities and c) the effects of three variables linked to SES - gestational duration, stressful life events and parent-child interaction - on language development in the first year of life. Parents/caregivers of 540 Dutch-acquiring infants aged 8-13 months responded to an extensive questionnaire. Questions on highest finished level of education and subjective financial stability were used as measures of SES. Language development was measured using scores on the first 28 questions of the LENA Developmental Snapshot (Gilkerson et al., 2017). These questions were categorized into structural, and non-structural language ability questions. Parent-child interaction was measured using scores on the Brigance Parent-Child Interaction Scale (Glascoe & Brigance, 2002). Regression and correlation analyses provide the following results: a) None of the SES-variables are significant predictors of language scores. b) SES-variables do not

significantly predict either structural or non-structural language scores. c) - Gestational duration positively correlates with language scores, r(538) = .16, p = <.001 (Figure 1). However, when controlling for gestational age, gestational duration does not significantly predict language scores. - There is no correlation between language scores and three stressful life events (divorce, disease and job-loss); - Parent-child interaction scores significantly predict language scores (X2 (1, N = 540) = 15.343, p <.001) (Figure 2). Our results provide no evidence for influence of SES on language development during the first year of life. It is therefore unsurprising that we find no evidence either for the hypothesized difference between SES effects on structural language vs. non-structural language abilities. Interestingly though, variables linked to SES, such as parent-child interaction and gestational duration (but not stress) do predict language development. While previous studies report that parent-child interaction influences language development (Hoff, 2003; Weisleder & Fernald, 2013; Rowe, 2012), the current study shows that this effect can already be observed during the first year of life.

O.05.03 Explaining the Long Reach of Fathers' Prenatal Involvement on Father-Adolescent Relationships in Low-Income Families (Ghosh)

Rachel Ghosh[1], Natasha Cabrera[1], Jay Fagan[2]

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Decades of research have shown that the early relationships children have with their caregivers are unequivocally the most influential on their development. More recent research finds that early relationships begin before the child is even born and have enduring long-term effects on children's development through adolescence and beyond (Fraley et al., 2013; O'Connor et al., 2019). However, this literature has been conducted mostly with mothers, and the enduring effects of early relationships between children and their fathers, and between mothers and fathers on later father-child relationships, especially among low-income families, are relatively unknown. Framed within developmental and family systems theories, this study is the first to examine the importance of early (i.e., prenatal) father involvement for the father-child relationship quality in adolescence. Specifically, using data from the Fragile Families and Child Wellbeing study (FFCW), we asked: (1) Are low-income fathers' prenatal involvement, presence at birth, pregnancy wantedness, and mother-father relationship at birth associated with 15-year-old children's perceptions of their relationship with their father?, and (2) How do family coresidence structure, father engagement in infancy, and coparenting relationship quality during infancy mediate the afore-mentioned associations? This study used the FFCW dataset that followed a cohort of nearly 5,000 children born in the United States between 1998 and 2000. The sample includes a large number of Black, Hispanic, and low-income families and oversampled births to unmarried couples (McLanahan & Garfinkel, 2000). Fathers and mothers were interviewed shortly after the birth of their child (baseline) and again when children were 1 (Y1), 3 (Y3), 5 (Y5), 9 (Y9), and 15 (Y15) years of age. Children were interviewed at Y9 and Y15. The analytic sample in the present study was limited to parents who were not married when the child was born and cases in which the child completed an interview and answered items regarding the biological father at Y15 (N = 1776). Structural equation modeling (SEM) was carried out with AMOS software to test the hypotheses predicting father-child relationships at Y15. We found support for our hypothesis that the early parenting context (fathers' prenatal support, presence at the birth, wanting the pregnancy) and quality of the early mother-father relationship are significant predictors of fathers' relationships with adolescents at age 15. Fathers' early (prenatal) involvement and relationships with mothers are associated with closer relationships with

their adolescent offspring, suggesting that these fathers, despite their residence status, did not become emotionally disconnected from their children. Although all of the prenatal variables were significantly and directly related to some of the father-adolescent relationships, they did not significantly predict all outcomes. Fathers' presence at birth predicted father-adolescent engagement, but it did not predict father-adolescent closeness. This long-term association between fathers' prenatal involvement, partner relationship quality, and father-adolescent relationship implies that the time before a child's birth is critical for the development of a man's commitment to fatherhood and to his child, especially among men who are at high risk for becoming disconnected from their children.

O.05.04 The effect of socioeconomic status on early vocabulary size in South Korean children (Jung)

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Socioeconomic Status (SES) is associated with children's language development (Dwyer et al., 2018; Hart & Risley, 1995). As in many Western countries (e.g., Piot et al., 2021), previous studies have shown that Korean mothers' education level (MEL) and family income (FI) affected children's language outcomes (e.g., Lee et al., 2008). However, little is known about the underlying pathways of this association, for example, mothers' knowledge in child language development, the properties of mother-child reading and playing activities, and language input as a function of mothers' working status (MWS) (Laing et al.,2019). In this study, we examined the relationships between the SES variables (i.e., MFL, FI, and MWS) with mothers' knowledge, the properties of mother-child reading/playing activities, and the quantity of language input, and investigated whether they predicted children's vocabulary outcomes. We collected demographic information from 206 children and mothers (108 boys; age range = 9-36 months), including MEL, FI, and MWS. Children's vocabulary sizes were collected using MacArthur-Bates Communicative Development Inventories-Korean (CDI-K; Pae et al., 2008). An adapted version of Survey of Parent/Provider Expectation and Knowledge (SPEAK; Suskind et al., 2018) was filled out by 98 participants to examine mothers' knowledge in child language development. The adapted version contained three additional questions about reading and playing behaviors (RPB). LENA daylong recordings were collected (n = 78) to investigate the language input properties. We conducted a series of generalized linear mixed models and multinomial models to analyze the data. The results indicated that there was a significant main effect of FI (b = 2.212, p = 0.042), a marginal effect of MEL (b = 4.32, p = 0.058), but no effect of MWS on CDI-K percentile scores. There was no effect of MEL, FI, and MWS on LENA measured outcomes (adult word counts per hour, and conversational turns per hour), and on SPEAK scores either. A multinomial model analysis showed no effect of MEL, FI, and MWS on RPB as well. The subsequent analyses showed that among LENA outcomes, SPEAK scores, and RPB, only RPB had a marginal effect on CDI-K scores (b= 5.52, p = 0.069). The effect was driven by a particular question, asking how many times the mother reads books to their child per week (RPB19). When RPB19 was entered into the same model with MEL, FI, and MWS to predict CDI-K scores, the three SES variables were not significant but the effect of RPB19 on CDI-K was significant (p = 0.033). Our findings indicated the frequency of book reading activities per week had a significantly positive effect on CDI-K, suppressing the effect of MEL and FI. MEL and FI showed positive effects on CDI-K but not mothers' knowledge in child language development, the quantity of language input, and reading/playing activities. We found no effect of MWS on outcome variables. The lack of association between LENA measures and CDI-K may need further investigation because a recent study on Korean maternal

language input reported a significant correlation with CDI-K (p < .05) when the model employed only the child-directed speech count in the AWC (Ko & McDonald, 2020). To our knowledge, this is the first study examining the underlying mechanisms between SES and language development for Korean children. These findings suggested that book reading is important, possibly mitigating the SES effect on child language outcomes.

O.06: Physiology

O.06.01 A longitudinal study of the gut microbiota during the first three years of life: links with executive functions at age three (Willemsen)

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Background: The brain undergoes rapid development in early life, as does the gut microbiota. Bidirectional communications between the gut microbiota and brain functions have been observed in an increasing number of animal studies and human trials. This communication is known as the microbiota-gut-brain axis. To date, several studies have found associations between specific gut bacteria and cognitive outcomes, which indicates the potential importance of gut microbiota in child cognitive and behavioral development. However, the relations between behavior and gut microbiota are inconsistent, and evidence from longitudinal studies are lacking. Therefore, we investigated the potential links between early and current gut microbiota and child cognitive outcomes (executive functioning) at age three. Methods: Participants were healthy three-year-old children (n=79) and their parents. Stool samples were collected at age two, six, and 12 weeks and at one and three years. Gut microbiota composition was analyzed using 16S ribosomal RNA gene sequencing. Executive functioning behavior was assessed via parental questionnaires (Rating of Everyday Executive Functioning (REEF) and Behaviour Rating Inventory of Executive Functioning - Preschool (BRIEF-P)) at child age three. Random forest models and Bayesian linear regression models were conducted to assess the associations between behavior and the gut microbiota. Results: Significant relations were found between different genera of bacteria and executive functions. These associations were found at all fecal sampling ages. One of the strongest relations was between Streptococcus at two weeks and the BRIEF-P (est. = 0.40), indicating that high levels of Streptococcus were associated with worse executive functions at age three. Furthermore, higher alpha diversity at 2 weeks of age was associated with better executive functions (REEF) (est. = 0.31). Discussion: Our findings suggest potential associations between gut microbiota composition throughout the first three years of life and executive functions at three years of age in a healthy, low-risk, sample of children. The results therefore provide tentative evidence supporting the idea that gut bacteria of infants might play a role in the development of their brains. Future studies in other cohorts are necessary to confirm our findings and shed light on key bacterial groups and potential pathways that are involved in cognitive development.

O.06.02 Siblings and Stress: Associations Between Children in the Home and Infant Cortisol (White)

Hannah White[1], Alexandria Heinlein[2], Nicole Shelley[1], Abby Jenson[1]

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While growing up with another child in the home is intuitively expected to impact infant development, empirical studies are mixed in whether the effects are largely positive or negative. It has been found

that older siblings in the home can negatively impact the development of cognitive and social skills by 9 months of age (Cruise and O'Reilly, 2014). Alternatively, by 14 months of age, the presence of older siblings has been found to promote theory-of-mind development (McAlister & Peterson, 2007). One avenue through which the presence of children in the home may influence early development is by impacting how infants experience home chaos (i.e., unpredictability, confusion, and noise in the home environment). Specifically, it is possible that chaos in the context of siblings functions differently from general chaos such that the association between home chaos and infant stress differs in single child and multi-child homes. In the present study, we examined whether the presence of other children in the home moderates the association between infants' basal cortisol (indexed via saliva and corrected for time of day) and chaos in the home environment (measured using the Confusion, Hubbub, and Order Scale; Matheny, Wachs, Ludwig, & Phillips, 1995). In a longitudinal sample of 75 infants assessed at 3.5 and 5 months of age, a significant interaction between chaos at 3 months and children in the home was found when predicting cortisol at 5 months, controlling for chaos at 5 months, cortisol at 3 months, sociodemographic risk, and sex, ß = -.45, p = .01. For infants with no other children living in the home, there was a significant positive association between home chaos and cortisol, r (37) = .32, p = .04. Unexpectedly, we also found a marginally significant negative association between household chaos and basal cortisol for infants living with other children, r (29) = -.33, p = .07. In other words, elevated infant stress in the context of more chaotic home environments was observed only among infants who were only children. This supports our hypothesis that the nature of home chaos changes depending on whether the home is single or multi-child, perhaps indicating that the source of the chaos matters and homes that are more "chaotic" due to several young children may pose fewer threats to infant development than homes that are chaotic due to factors such as marital conflict or economic strain. Furthermore, the ability of additional children in the home to moderate the effect of home chaos on basal cortisol underscores the importance of taking into account family dynamics beyond the parent child dyad when examining infant development.

O.06.03 Respiratory and cardiac interoceptive sensitivity in 9-month-old infants (Tünte)

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Interoception refers to the sensing of internal bodily signals, such as heartbeat and respiration. Humans differ with regard to their interoceptive sensitivity, the degree to which they can perceive internal bodily signals. Despite being a fundamental ability, empirical results on the development of interoceptive sensitivity in infancy are still lacking. In fact, to date only one published study has explored cardiac interoceptive sensitivity in 5-month-old infants (Maister et al. 2017). Here, we report results from a study investigating cardiac and respiratory interoceptive sensitivity in 9-month-old infants. To measure cardiac interoceptive sensitivity we used the iBeat task (Maister et al. 2017). In the iBeat task, infants are presented with images pulsating synchronously or asynchronously to their own heartbeat. Further, we developed the iBreath paradigm, which, for the first time, allows us to quantify whether infants already show sensitivity to their own breathing. In the iBreath paradigm infants are presented with images expanding and decreasing synchronously or asynchronously with their own breathing tempo. Following our preregistration, we collected data from 90 infants at 9-months of age. For our preliminary analysis reported below we included 30 infants that completed the iBreath paradigm, 32 infants that completed the iBeat paradigm, and 14 infants that completed both paradigms. The preliminary analyses

indicate that in both the iBeat- and the iBreath paradigm infants distinguished between synchronous and asynchronous conditions: In the iBreath paradigm infants showed longer looking times for stimuli presented asynchronously (Figure 1a, N = 29, t = 2.164, p = .039). In the iBeat paradigm infants showed longer looking times towards synchronously presented stimuli (Figure 1b, N = 31, t = 1.762, p = .088), however this difference did not reach significance. Next, we investigated whether looking times in iBeat and iBreath were related. We computed individual difference scores as absolute difference between synchronous and asynchronous conditions for the iBeat- and the iBreath paradigms, which were found to be positively correlated (N = 14, r = .56, p = .04). As we have currently only processed part of our sample, it will be highly informative whether these results hold true in the full sample to be presented at ICIS. In sum, our preliminary results indicate that 9-month-old infants show cardiac and respiratory interoceptive sensitivity. Moreover, we provide preliminary evidence that interoception in cardiac and respiratory domains are related in this age group.

O.07: Social Interactions II

O.07.01 Validating Baby FaceReader for automatic facial expression analysis of face-to-face interactions in 4- and 8-month-old infants (Zaharieva)

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Facial expressions are crucial to pre-verbal social interactions and among the earliest behaviors that can be used for inferring infant emotional states. Recent developments in computer vision have brought about substantial advances in automatic facial expression analyses in adults, yielding rich, potentially reproducible results at a relatively low cost- and time-investment, in turn warranting further applications to infant research. Baby FaceReader 9 (Noldus, 2021) is one of few commercially available solutions for automatic classification of infant facial expressions. The goals of the current study are to: 1) assess the validity and feasibility of using the global emotional valence formula of Baby FaceReader 9 by comparing it to manually coded valence data from naturalistic social interactions, 2) explore the relations between individual facial action units (AUs) that have been previously associated with positive and negative facial expressions and manually coded valence categories, and 3) determine which video characteristics affect the automatic analysis. We compared the performance of Baby FaceReader 9 to manual coding in a pre-existing longitudinal dataset for which facial expressions of 52 infants at 4 months (156 videos) and 43 infants at 8 months (129 videos) during a naturalistic face-to-face interaction were classified. The automatic system modelled the facial expressions of 94% of the 4-month wave data and 66% of the 8-month wave data deemed as "codable", likely due to differences in video recording conditions. The Area Under the Curve (AUC) from the signal-detection theory framework was used to quantify the prediction accuracy of the automatic classifier and the presence of misclassification biases, while controlling for video quality characteristics. The automatic system distinguished beyond chance-level both positive facial expressions from negative and neutral (Mean AUC = 0.75, SD = 0.14), and negative facial expressions from positive and neutral (Mean AUC = 0.71, SD = 0.13); see Figure 1. Negative and neutral facial expressions were not reliably discriminated. The concordance between automatic and manual classifications for positive but not for negative facial expressions was higher at 8 compared to 4 months of age (b = 0.06, t = 4.32, p < .001) and improved substantially with video quality (b = 0.71, t = 3.49, p < .001). In a follow-up analysis, we use multinomial logistic regression to

model the probability of increased activation in specific facial actions during periods that were manually coded as positively versus negatively valenced. We report on the between-infant variation in the models that fit the data most closely and evaluate the presence of a model that holds across the whole sample. We conclude on a discussion of a set of guidelines for improving the quality of infant video data collected 'in the wild' during home visits so to maximize the performance of automatic facial expression analyses.

O.07.02 Concurrent associations between parent-infant engagement and cortical selectivity to social auditory and visual stimuli in 5-month-old infants. (Ilyka)

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Introduction. Previous functional near-infrared spectroscopy (fNIRS) studies showed that by the age of 4 to 8 months infants exhibit selective neural responses to social relative to non-social auditory and visual stimuli across the temporal regions (aMTG-STG for auditory; pSTS-TPJ for visual stimuli) (Grossmann et al., 2010; Lloyd-Fox et al., 2009; 2015). While this emerging cortical specialization was revealed in both high-and low-resource settings (Lloyd-Fox et al., 2017), variability between infants suggests that neural specialization may vary depending on an individual's early experiences. In a prospective longitudinal study (Brain Imaging for Global Health; BRIGHT Project) which charts trajectories of neural and behavioural development from birth to 24-months of age, interactions during a parent-infant play session at 5 months of age were studied in relation to specialisation to social stimuli during an fNIRS task in the UK cohort. Methods. Videos from parent-infant free play sessions were coded on a second-to-second and on a microanalytic basis, and two measures - mutual gaze and dyadic engagement - were assessed. On the same day, infants participated in an fNIRS task in which they viewed the videos depicting an actress performing hand games (e.g. incy-wincy spider) accompanied by silence, vocal or non-vocal sounds. Additionally, static images of objects of transport were used as a baseline. Infants' neural responses to these stimuli were then pre-processed following well-established pipelines (Di Lorenzo et al., 2019) and, if inclusion criteria were met, the neural responses to each condition were averaged for the whole temporal area (11 channels) bilaterally across a broad time window of 8 to 16 seconds post-stimulus presentation. Averaged responses to vocal versus non-vocal stimuli and visual social stimuli relative to baseline were used as markers of social auditory and visual selectivity. A final sample of 26 infants with valid behavioural and neural data was available for further regression analyses to explore associations. Results. Infants who were more engaged with their parents and had more episodes of mutual gaze showed reduced brain specialisation to vocal vs non-vocal sounds across the temporal region bilaterally (oxy-haemoglobin (ΔHbO2): uncorrected ps<.03). These results survived the correction for multiple comparisons (FDR-corrected ps =.04), except for the association with dyadic engagement in the left hemisphere (FDR-corrected p=.08, Figure 1). For social visual selectivity, only high mutual gaze was linked to reduced brain activation across the temporal region in the left hemisphere (ΔHbO2: FDR-corrected p=.04). When corrected for multiple comparisons, no significant associations with de-oxyhaemoglobin (ΔHHb) were noted. Discussion. Taken together, these preliminary findings suggest that high parent-infant engagement in interactions is linked to reduced neural

selectivity to social auditory and visual stimuli in the temporal area in 5-month-old infants. One possible interpretation is that infants who have more frequent social interactions require fewer neural resources to process social stimuli and, thus, show reduced responses to social auditory and visual stimuli. Results presented in this study are limited by a small sample of 26 infants, and, at present, this potential interpretation is being further explored by assessing these datasets at other age points within the BRIGHT Study as well as exploring this in other longitudinal studies.

O.07.03 Infants' use of partiality as a cue for kinship detection (McPhee)

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Being able to understand third-party social interactions is fundamental to successfully navigating our social worlds. Research has shown that within the first year of life, infants are able to use various types of social cues to anticipate and understand third-party social affiliations (e.g., Liberman et al., 2014). Yet, little research has examined how infants come to understand specific types of relationships, such as kinship relationships. In accordance with previous studies examining close interpersonal relationships in early childhood (e.g., Liberman & Shaw, 2017; Spokes & Spelke, 2016), recent studies in our lab suggest that children as young as 4 use the observation of partiality in resource distributions to identify third-party parent-child relationships (McPhee et al., submitted). The purpose of the current study was to explore the developmental origins of these abilities, by investigating whether 12- to 24-month-old infants use partiality as a cue to infer third-party parent-child relationships. Participants (n = 48) were randomly assigned to one of two conditions in which they were shown four familiarisation trials in which an adult distributed resources either partially (3:1 ratio; experimental condition) or impartially (2:2 ratio; control condition) to two babies. On test, participants were shown a display in which an occluding screen covered the babies. Next, participants heard one of the babies call out, "Mama," from a central speaker. Participants' anticipatory looking was recorded and used as an indicator as to which of the two babies the participants expected the adult to approach. After the occlusion was removed from the screen, the display revealed the adult character approaching one of the two baby characters. Participants' looking time to the test display was recorded and used as a measure of participants' attention to the stimuli. In the experimental condition, 75% of participants displayed anticipatory looking, with 83% of them anticipating that the adult would attend to the baby given the advantageous distribution (with responses significantly above chance; p = .008). In contrast, in the control condition, only 50% of participants displayed anticipatory looking, with 50% of them displaying anticipatory gaze shifts to the baby who received the 'yoked advantageous distribution' (with responses not significantly different from chance; p = 1.00). These findings suggest that children use the observation of partiality to anticipate an affiliation between the adult and advantageous baby recipient. When examining looking times to test displays, participants in the experimental condition who viewed the adult approaching the disadvantageous baby recipient looked significantly longer than those who viewed the adult approaching the advantageous baby recipient (p = .03). In contrast, participants in the control condition did not significantly differ in their looking times to the two test events (p = .21). These findings illustrate that infants expect adults to approach the advantageous baby recipient and are 'surprised' when they approach a disadvantageous baby recipient. Together, these findings illustrate that the ability to use social cues to determine third-party caregiving affiliations is present in infancy.

The presence of these cues early in development illustrates the fundamental role partiality plays in infants' implicit kinship detection abilities.

O.08: Word Learning

O.08.01 WOLVES: A neural process account of the interaction of visual exploration and word learning in infancy (Samuelson)

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Visual exploration is a central process in early cognitive development. As infants gaze around their environment and attend to the many people and objects in view, they form representations that are the basis for learning to discriminate between new and old stimuli. Visual exploration is also central to building categories, learning which sounds go with seen events, and learning words. A long history of experimentation and theory has provided a rich picture of the multiple processes supporting visual exploration, but also revealed their complex and interdependent action. Here, we used a neural process model to elucidate this interaction in the context of the developing influence of words on visual exploration in the second year, a period characterized by early, but often rapid, vocabulary development. WOLVES (Word Object Learning via Visual Exploration in Space, Bhat, Spencer & Samuelson, 2021), a model recently shown to capture the processes supporting word learning in the context of multiple individually ambiguous naming episodes, was used to simulate three published experiments examining how words impact children's attention to novelty. Simulation 1 captures data from Mather, Schafer & Houston-Price (2011) Experiment 1 in which 9- to 22-month-old children were shown two novel stimuli, one of which repeated on each of the 30 trials, in either a silent condition, or in the presence of a novel word. They found that the novel word disrupted the formation of a novelty preference and that this occurred more quickly for older children. WOLVES captures these findings (Figure 1) with a mean absolute percentage error (MAPE) of 3.43 for all data points and with minimal changes to the published parameters. Simulation 2 captures data from Experiment 2 of the same paper which focused on older children but added more visual stimuli and words to increase task demands. WOLVES captures the finding of an earlier novelty preference in the condition without labels (9.05 MAPE). Further, because WOLVES generates autonomous gaze data we can look at patterns of within-trial looking, just as Mather et al. (2011) did with infants. WOLVES captures the inverted U-shaped pattern of more novelty bias in the middle of individual trials in the silent but not labelling condition, as well as developmental differences (Figure 2). Simulation 3 captures data from Mather & Plunkett's (2012) examination of the role of novelty in the mutual exclusivity bias, showing that when a name is presented in the context of a name-known, a pre-exposed but unnamed, and a completely novel unnamed object children prefer the completely novel object. Across simulations, WOLVES confirms that habituation processes competing with the top-down effect of accumulating word-object associations are responsible for the looking preferences infants demonstrate. These simulations achieve two critical goals. First, they provide new understanding of the processes supporting integration of words and visual information in early vocabulary development. Second, they provide a critical test of the theoretical claims instantiated in WOLVES as it is extended to new behavioral paradigms without changes to its architecture and with very few changes to parameters.

O.08.02 Parents' estimates of infants' noun exposure predict noun frequency in home recordings and infants? word comprehension (Moore)

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Parents can provide a subject-but-accurate estimate of their child's vocabulary (Fenson et al., 1994; Frank et al., 2021). Here we test a new measure of children's word exposure, by validating a parental estimate of how often infants hear words relative to home recording data. We then link these estimates to word comprehension measures, asking how well word exposure predicts word comprehension over 8-18mos using both parental report and real-time eyetracking measures. We analyzed data from 44 families who provided monthly MCDIs (Fenson et al., 1994), daylong audio-recordings, and hourlong videos when children were 6-18mos. Concrete nouns in these recordings were manually annotated (~80hrs of data/child). Every other month, caregivers estimated how frequently their child heard 16 nouns on a 1-5 ordinal scale (1=never; 5=several times/day). Different words were probed at each session. 8/16 words were common nouns queried in all families ("generic"), while 8 were selected for each infant based on their high frequency in that child's previous 2 months' annotations ("hand-picked"). Infants were then tested on their comprehension of all 16 nouns in a Looking-While-Listening task. We first asked whether exposure ratings were linked to home recording data, by predicting each noun's frequency in the previous two months' recordings as a function of exposure score and noun-type (generic vs. hand-picked). There was a significant exposure-by-noun-type interaction (p<.001): words rated as high-exposure by parents were also high-frequency in recordings; this relationship was stronger for hand-picked words than generic ones. This suggests that our exposure survey is sensitive to differences in how often children hear common nouns based on sparsely-sampled naturalistic recordings. We next tested whether exposure ratings (1-5) predicted comprehension over development, using parents' estimates of their child's comprehension via MCDI, and with eyetracking data. Both analyses showed that exposure scores predicted word comprehension. For the MCDI, a mixed-effects logistic regression revealed an exposure-by-age interaction (z=3.7, p<0.001) in addition to significant effects of both age and exposure on word knowledge. Exposure predicted comprehension best ~12mos, in line with the "comprehension boost" reported elsewhere (Bergelson, 2020). Eyetracking results were similar: in a growth-curve analysis, exposure significantly predicted baseline-corrected target looking both overall (t=2.00, p=0.045) and as a function of age (t=-2.61, p=0.009); again exposure mattered most ~12mos. These results suggest that asking parents how often they believe their child hears a word provides a developmentally-sensitive proxy for language input, which in turn predicts early word knowledge. This initial evidence suggests parents can reliably assess how frequently their children hear common nouns with a very coarse, brief survey. These ratings in turn capture variance in early comprehension, both in parent-reported vocabulary (MCDI) and in real-time word comprehension measures (eyetracking). Given how much easier asking parents about word exposure is than measuring it directly, this approach provides a new tool to understand the language input/learning relationship. In turn, this holds promise for articulating the complex functions linking age, language input, and word-learning.

O.08.03 Investigating the onset of verb comprehension in young infants (Frewin)

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Verbs are used to label actions, events, and the ways in which entities relate to each other. Verbs are also pivotal in determining sentence structure and what kinds of words can be used in a sentence. Research has shown that children find verbs challenging to acquire, with verbs appearing later and less frequently in children's expressive vocabularies compared to nouns (e.g., Bornstein et al., 2004; Fenson et al., 1994; Gentner, 1982). Despite this, some verbs do appear early in children's word acquisition (Fenson et al., 1994; Hall & Waxman, 1993). This discrepancy has previously been coined as the "verb learning paradox" (Maguire et al., 2006). But when does the capacity to comprehend verbs emerge? Recent evidence suggests that infants begin understanding more abstract words around 10-months-old (Bergelson & Swingley, 2013). Across two on-going studies, our research extends this work by exploring the onset of verb comprehension during infancy. We tested 10- and 14-month-old infants in an online "looking while listening" task (Fernald & Zangl, 2008). During this task, we presented infants with yoked pairs of videos, side-by-side, displaying everyday actions across a Zoom videocall. To measure verb comprehension, we offline video coded infants' fixations to a target video after it was labelled. To correct for stimuli preference, we computed the proportion of time infants spent looking at an action when it was the target, minus the proportion of time infants spent looking at the same action when it was a distractor (Bergelson & Swingley, 2012, 2013). Scores greater than 0 indicate looking longer at the target video. So far, we have collected data from 28 infants (14 x 10mo, 14 x 14mo). Preliminary plots show that, across 10- and 14-month-olds, median looking difference scores are positively trending above 0 (Figure 1). Across our verb items, our preliminary data analyses revealed a marginally significant finding, that 14-month-olds looked at named targets more than would be expected by chance (median = .085, p = .09). In contrast, we did not find a significant effect for the 10-month-olds (median = .023, p = .71). Data collection is on-going with the aim to collect useable data from 48 infants in total. In a follow up study, we are using eye-tracking and event-related potential (ERP) tasks to further explore verb comprehension with 10-month-olds. Firstly, we explore infants' verb comprehension during an eye-tracking replication of the aforementioned "looking while listening" task. Secondly, during an action-verb priming ERP task, we present infants with videos of actions followed by a verb that either matches or mismatches the action. Across trials, larger N400 amplitudes in response to mismatched actions and verbs, compared to matches, can be interpreted as an indicator of verb comprehension. Due to COVID-19 delays, data collection for this study is on-going but we expect to have data ready to present at this conference. Using a novel combination of established techniques used to investigate word acquisition, the present studies will evaluate when verb comprehension emerges during early development, contributing to a broader understanding of infant language milestones.

O.08.04 Toddler temperament and fast mapping: accuracy and looking times. (Axelsson)

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When hearing a novel word, children use strategies to determine a speaker's referent. One strategy is fast mapping where children rule out familiar objects in favor of a novel object. However, not all children do this to the same extent and the child's temperament can play a role. Shyness is associated with poorer fast mapping and less attention to target objects during fast mapping and this is associated with poorer retention (Hilton et al., 2017; 2019). We further investigated the role of temperament during fast mapping in 2.5-year-old toddlers, but considered two types of temperament: how

approaching or withdrawing children are in new situations, a construct comparable to shyness; and how reactive children are, which could affect children's capacity to engage during fast mapping trials. Children with a more approaching temperament had greater fast mapping accuracy for both familiar and novel targets. A more approaching temperament was also associated with greater retention accuracy for novel targets. Children with less reactive temperaments had greater looking time proportions to the targets during fast mapping. This was found with overall looking time proportions averaged over entire fast mapping trials, but also when investigating more fine-grained looking times in 50ms time bins. This provides support for the role of two forms of temperament in fast mapping -- how approaching children seems to predict how willing children are to guess a speaker's referent and how reactive are children seems to be associated with the capacity to focus and attend during word learning situations. Temperament therefore, could have implications for children's language development.

O.09: Interactions in Atypical Development

O.09.01 Adding to the conversation: Language delays and parent-child interactions in the younger siblings of children with autism (Roemer)

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Neurotypical children say their first words, answer questions, and have increasingly complex conversations in their first three years, beginning to respond in ways that maintain topics and add new information (Snow et al., 1996). These skills emerge in the context of dyadic exchanges - parents create opportunities for conversation, eliciting responses with questions (e.g., Rowe et al., 2017). Conversations build on the child's language and pragmatic abilities, areas of known challenge for children with autism spectrum disorder (ASD; Tager-Flusberg et al., 1991; 2005). Compared to children with no family history of autism (typical likelihood, TL), the younger siblings of children with ASD are at elevated likelihood (EL) for both ASD (Ozonoff et al., 2011) and non-ASD language delays (Marrus et al., 2018). However, few studies have examined the early conversational skills of EL children and the communicative contexts in which they emerge. Here, we present findings on parent use of questions and three-year-old children's responses that maintain the topic and add new information to the conversation. Participants included TL (n=11) and EL (n=41) children. Standardized language assessments were administered at 18, 24, and 36 months. EL children were evaluated at 36 months and classified into three groups: EL-ASD (n=10), non-ASD language delay (EL-LD, n=17), and no diagnosis (EL-ND, n=14). Parent-child dyads were videorecorded in their homes at 36 months for 10-13 minutes during play with a standard set of toys. Parent and child speech was transcribed. Parent questions were identified and child utterances without intelligible words were marked unintelligible. Child utterances were classified based on whether they were adjacent (occurred within 5 seconds of a parent utterance) and contingent (relevant to the topic of conversation). Contingent utterances were further classified based on whether they added new content to the exchange (e.g., parent: "what's he doing up there?", child: "he's stuck on the roof"). While parents of TL children tended to talk slightly less than parents of EL children (Figure 1a) and use a higher proportion of questions (Figure 1b), there were no significant differences between groups (ps > 0.17). The rate of child utterances that included intelligible words was significantly lower for children with ASD than any other group, including EL siblings with non-ASD language delays (Figure 2a, ps < .05). However, when children did produce intelligible utterances, most occurred within 5 seconds following a parent utterance (Figure 2b) and were contingent to the

topic of conversation (Figure 2c), with no significant differences between groups. When children responded contingently, those with ASD, but not non-ASD language delays, were less likely to add new information to the conversation than their EL-ND peers (Figure 2d, p = .03). Thus, parents of TL and EL children with a range of developmental outcomes provide similar opportunities for emerging conversational skills. While three-year-old children with ASD produce fewer intelligible utterances and are less likely to add new information to conversations, there are striking similarities in contingent (topic-related) responses when TL and EL children with and without ASD and non-ASD language delays respond to parents with words.

O.09.02 Socio-communicative skills and gaze-following behavior before cochlear implantation: effects of early auditory deprivation (Bosch)

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Access to auditory information is dramatically delayed in infants born deaf with a bilateral sensorineural hearing loss. This initial delay in perceiving the sounds of the ambient language/s and in discovering their communicative value in the first twelve months of life (early cochlear implantation usually taking place around 12 months of age) has a negative impact on the oral language learning processes. The development of precursors to language learning in the oral and gestural communicative domain, as well as the engagement in gaze following and joint attention routines are areas likely to be affected by the auditory deprivation. It is thus relevant to gain a better understanding of the specific effects that the hearing loss can have on some basic communicative, interactive skills and socio-adaptive behaviors in pre-implanted infants. Variability in later language outcomes after cochlear implantation has often been reported. A focus on pre-implantation skills in the communicative and interactive domains might inform about the development of these precursor abilities and increase their predictive value for language learning outcomes. From this perspective, we tested a total sample of N=32 10-month-old infants, half of them with normal hearing (NH) that were closely matched in age, sex, parental education and social status to a group of pre-implanted deaf and hard of hearing participants (DHH). We gathered information about their pre-linguistic vocalizations and gestures from parental reports using the MacArthur CDI; about Socio-Emotional development and Adaptive Behavior from the BSID-III parental questionnaires (involving seven sub-domains); and we measured gaze following (GF) skills using a classical experimental task (Senju & Csibra, 2008). Between-group differences were expected, favoring NH participants, although gestural development could show an advantage in the DHH group due to their limitations in oral communication. As for gaze following behavior, while it has been found to be enhanced in deaf infants from deaf parents (Brooks, Singleton & Meltzoff, 2020), we did not expect such result in our group of deaf from hearing parents. Nevertheless, variability in this task could inform about candidates more readily to succeed in lexical learning from triadic contexts after implantation. Results revealed significant between-group differences in measures obtained from parental reports: NH infants had a better performance than their DHH peers in pre-linguistic vocalizations (p<0.001), but the pattern was reversed for the gestures, favoring the DHH group (p <0.044). The NH group scored higher in both the socio-emotional (p< 0.001)and socio-adaptive behavior (p<0.016) questionnaires. Crucially, no significant differences were found in the gaze following task relative to the difference score variable (number of trials following adult's gaze to the congruent object, minus trials gazing to the incongruent object). However, a significant interaction was

found between group and overall attention time to type of object (gaze congruent and gaze incongruent) (p<0.020), with DHH showing longer attention time to the congruent object than did the NH group. Interestingly, a marginally significant correlation (p=0.066) was found between the difference score in the GF task and the Adaptive Behavior questionnaire (social sub-domain). The overall positive results and the range of variability in gaze following by the HDD group suggests that this task can be valuable to identify participants more ready for the language learning demands after implantation.

O.09.03 Face looking in young children with Down syndrome in the context of parent-child interaction (D'Souza)

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INTRODUCTION: Faces are thought to play a special role in early development. In fact, a number of interventions with atypically developing or "at-risk" populations encourage young children to focus on others' faces in order to facilitate interaction and learning. However, much of the available evidence on face looking in young children with disorders comes from tightly controlled laboratory studies or from anecdotal evidence. This study focused on face looking during naturalistic play with objects in young children with Down syndrome (DS) and their parents. PARTICIPANTS: Sixty-three parent-child dyads participated in this study. Young children with DS between 32 and 62 months (N=43) were matched on mental age to typically developing (TD) infants and toddlers (N=20). METHODS: We examined face looking in young children and their parents during 10-minute free play with objects. Children were also administered the Mullen Scales of Early Learning. RESULTS & DISCUSSION: The children spent less time (4% TD, 6% DS) than their parents (14% TD dyads, 18% DS dyads) looking at faces (Fig.1a). Also, DS dyads showed more face looking than TD dyads (Fig.1a). Irrespective of group (TD, DS) or agent (parent, child), face looks tended to be short (on average less than 1 second long) (Fig.1b). Parents showed more face looks than children, and dyads with DS showed more face looks than dyads with TD children (Fig.1c). Furthermore, the parents' face looks were more variable than their children's (Fig.1d). This profile of face looking suggests that the parents, especially of children with DS, were monitoring their children's behaviour. This interpretation is consistent with the finding that the number of looks of the parent to the child's face was positively associated with receptive language skills in children with DS (r=.40, p=.014). Perhaps parents who look more at the face of their child with DS are better at tailoring their behaviour (e.g., labelling) to their child (their attentional focus, emotional state, etc.) and this could lead to better learning of receptive vocabulary. While parental looking behaviour was associated with receptive language skills, expressive language skills were positively associated with child looking behaviour in DS dyads (specifically the length of the looks of the child to their parent's face, r=.38, p=.017). It is likely that those children with DS who look at the faces of their parents for longer can extract more information on how to produce words (as articulation is something they often struggle with). Interestingly, the dyads with children with DS showed twice as many mutual looks than the dyads with TD children (Fig.1e). While in TD dyads there was no difference between number of mutual looks initiated by the parent and by the child, in DS dyads, mutual looks were mostly initiated by the parent (Fig.1f). This suggests that the parents of children with DS were more directive during parent-child

interaction. Understanding face looking in DS in a naturalistic context is a crucial step towards reframing some of the existing interventions and beliefs of the parents and practitioners.

O.09.04 Hierarchical Temporal Structure in Parent-Child Vocal Interactions: Relationships with Child Language Skills and Autism Diagnosis (Lense)

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Timing is essential for successful caregiver-infant social interactions. From infancy, caregivers adjust the rhythm and timing of their vocal communication to support their child's developing communication skills. The temporal structure of dyadic vocal interactions emerges from the rhythm, timing, and frequency of each individuals' vocalizations and their interplay with each other. In this way, the temporal structure of caregiver-infant interactions reflects how the dyad dynamically organizes, adapts, and responds during a shared interaction. Prior research indicates greater hierarchical temporal structure (i.e., temporal clustering of acoustic events across timescales) of caregivers' infant-directed than adult-directed speech (Falk & Kello, 2017) but hierarchical temporal structure has yet to be examined at the level of the dyad. We investigate changes in dyadic hierarchical temporal structure longitudinally in typically developing (TD) infants, as well in comparison to toddlers with ASD, to identify how developing language and social skills impact the temporal dynamics of the interaction. 47 parent-child dyads of TD infants were audio-recorded at 9, 12, and 18-months of age, as well as 23 parent-toddler dyads of children with ASD (27 ± 4 months), during a 10-minute parent-child free-play activity. Peak amplitude events in audio recordings were used to compute Allan Factor (AF) variances, which reflects event clustering at multiple time scales (from a 0.0146-second scale to a 30-second scale). Quadratic slopes were fit across each dyad's Allan Factor (AF) functions to quantify hierarchical temporal structure of the acoustics of the interaction. We first used mixed-effects models to test changes in AF slopes with expressive language development in the TD longitudinal infants from 9- to 18-months of age. Next we compared AF slopes in the ASD sample versus two samples of TD infants - one TD group matched for nonverbal skills (NVM); and one TD group matched for expressive language skills (ELM). When examined longitudinally across TD infants from 9 to 18 months of age, child expressive language level was a significant predictor of the hierarchical temporal structure of the vocal interaction (Beta=-0.02, p=0.02) with steeper slopes (i.e., more hierarchical clustering across timescales) observed in dyads with infants with lower language levels. The ASD group had significantly steeper slopes (mean=0.77) than either the nonverbal matched (0.66) or expressive language matched TD groups (0.69) (ASD vs. NVM: p<0.001, d=0.41; ASD vs. ELM: p=0.002; d=0.28). In the ASD group, hierarchical temporal structure was unrelated to child expressive language skills. Our findings that hierarchical temporal structure declines with increasing child language skills in TD infants suggests that TD children's developing language skills changes the dynamics of the parent-child dyadic system, moving the interaction toward more mature, adult-like dynamics. At the same time, the greater hierarchical temporal structure observed in the ASD dyads, even when matched on expressive language skills, suggests the temporal dynamics reflect not just children's language skills but also the social attunement of the interaction. Results will be discussed with regard to mechanisms underlying dyadic temporal structure (e.g., role of vocal prosody and balanced vocal turn-taking).

O.10: Language Segmentation

O.10.01 Word segmentation from an artificial language in German-learning infants (Marimon Tarter)

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It is well established that infants can segment fluent speech into words from about 7-8 months of age (e.g., Jusczyk & Aslin, 1995). Research has suggested that infants can use distributional statistical cues like transitional probabilities to extract words from fluent speech (Saffran et al., 1996). This ability has been attested in English-learning infants (Thiessen & Erikson, 2013; Aslin et al., 1998) and in infants learning other languages such as Dutch (Johnson & Tyler, 2010) or French (Mersad & Nazzi, 2012). Studies from our lab (Marimon, 2019; Marimon & Höhle, in prep) have shown that both German adult speakers and 6-month-old German-learning infants rely more strongly on prosodic cues when both statistical and prosodic cues indicate different word boundaries. However, to our knowledge, word segmentation following transitional probabilities has yet not been found in German-learning infants at 7 months of age. The goal of the present study was to investigate whether German-learning infants can segment words from an artificial learning sting containing only statistical cues. We familiarized 6-to-7-month-old German infants (n= 24) with the MBROLA synthesized version of the same artificial language as used in Marimon (2019). The artificial language contained 4 disyllabic words and had a duration of 2 min 10 s. The TPs between syllables within the four disyllabic sequences considered as words were 1.0, whereas the TPs across the words were lower, ranging between 0.4 and 0.2. As in Marimon (2019), testing included three conditions: disyllabic items with high TPs in the familiarization string (words), disyllabic items with low TPs (part-words) and disyllabic items with syllables that had never co-occurred in the string (non-words; TP = 0.0). Infants would segment the words from the string correctly if they relied on the TPs. We employed Linear Mixed Effects Models with random factors for Participants and Items. Condition (part-word, non-word, word), Age (in days), Gender, Side and Trial Number were included as fixed factors. Condition was contrast coded so that the non-word condition was compared to the two other conditions, as it served as a baseline. Because Age turned out to be significant in this first model (p = .01), we explored Age as an interaction with Condition. The model output shows a significant the interaction between Condition and Age (p = .02), suggesting an increase in looking times for part- and non-words compared to words (novelty effect) as infants grow older. We suggest that older infants are better able to segment words (compared to part-words) based on statistical information from the string than younger infants. This finding underlines early impacts of language specific structural properties on segmentation mechanisms and their development.

O.10.02 Effects of speech register and cross-linguistic variation on speech segmentation with statistical cues (Langus)

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Statistical learning in language acquisition was originally conceived as a gateway to speech segmentation in the absence of pre-existing knowledge about the language to be acquired. Initial support for this hypothesis came from corpus analyses that showed that Transitional Probabilities (TPs) tend to be higher within words than at word boundaries and that adults and infants can segment continuous

streams of stimuli in various perceptual domains by calculating TPs (Brent & Cartwright, 1996; Saffran et al., 1999; Kirkham et al., 2002; Pelucchi et al., 2009). However, corpus studies have questioned the universality of TPs by showing that the most successful statistical segmentation strategy for a given language depends on the specific language under question. While Italian child-directed speech (Verb-Object language) is best segmented with Forward-TPs (FTPs), Hungarian (OV language) is best segmented with Backward-TPs (BTPs) (Gervain & Guevara, 2012; Saksida et al., 2016). Furthermore, knowledge about average TPs at word boundaries (i.e., language-specific thresholds) significantly increases the performance of segmentation models6. This suggests that speech segmentation using TPs may depend on language-specific knowledge. We argue that linguistic input to infants (IDS) or children (CDS) differs from that of adults (ADS) at the prosodic, phonological and syntactic level (Kitamura et al., 2002; Kondaurova & Bergeson, 2011; Cristia, 2013). IDS and CDS have not only slower speech rate, longer pauses between words and higher pitch (Fernald et al., 1989), but also contain more redundant utterances and repetitions of words (Soderstrom et al., 2008) - i.e., distributional aspects that may influence the statistical regularities between syllables. To investigate how speech register influences statistical regularities in the input, we compared IDS and CDS from 7 languages (German, Estonian, Italian, Dutch, English, Greek, Hungarian) to children of varying ages (range 1.5 to 75 months). We compared the segmentation performance of FTPs and BTPs using a relative algorithm (word boundaries are assigned when TPs between two syllables are lower than TPs of surrounding syllable pairs) and an absolute algorithm (word boundaries are assigned when TPs drop below a fixed language-specific threshold). We find that while the type/token ratio of syllables remains constant (ß=0.019, SE=0.014, t=1.32, p=.186), the type/token ratio of words increases (ß=0.04, SE=0.012, t=3.04, p<.001) as children become older. The increase of different word types as children become older increases the number of ways existing syllable types are combined and decreases the overall value of TPs (ß=-0.4, SE=0.1, t=-7.23, p<.001). Furthermore, the performance (i.e., F-score of segmented words) of the absolute algorithm increases in language-specific ways. In Object-Verb languages (Dutch, Hungarian) segmentation with BTPs improves with age, outperforming FTPs as children get older (ß=-0.23, SE=0.07, t=-3.43, p<.001). In contrast, in Verb-Object languages (English, Estonian, Italian, Greek) FTPs improve with age outperforming BTPs as children get older (ß=-0.23, SE=0.07, t=-3.36, p<.01). The relative algorithms performed poorly in all languages and ages. The results show that the statistical make-up of linguistic input changes as children get older, with better segmentation observed with language-specific and not universal statistical regularities.

O.10.03 Verb segmentation in infancy as a predictor of language outcomes in 3 year olds (Jo)

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Evidence is accumulating that young infants' performance on tasks like word segmentation (Newman et al., 2006; Singh et al., 2019) and speech perception (Cristia et al., 2014) predicts later language outcomes, whether infants are learning one language or two. Besides elucidating mechanisms of acquisition, investigating the relationship between individual differences in lab tasks by infants and language outcomes is also critical for early identification of children at risk for language disorders. The key challenge in evaluating individual differences is the inherent noisiness of the data alongside the small number of trials in infant experiments. We used Bayesian multilevel analyses to model trial-level performance of individual infants (de Klerk et al., 2019), benchmarked against group data from 444 infants between 6-12 months, nested within 16 experiments on verb segmentation. In all experiments infants were tested using the Headturn Preference Procedure; they were familiarized with two verbs

and tested on four verbs, two familiar and two novel, looking times to which were statistically compared (Yun & Sundara, 2021; Sundara et al., 2021). As in de Klerk et al., (2019), we modeled individual and group level data simultaneously. Specifically, the looking time (LT) was modeled as a function of trial-type (novel vs. familiar) and the LT of the previous trial (autoregressive structure), with random intercepts for each infant and a random slope for the effect of trial-type within an experiment for each infant. Crucially, the random slope parameter estimate was used to index performance at the individual level. Then we assessed one or more of the following language outcomes for 78 infants (+30 in progress, n=108): expressive vocabulary using web-CDI at 30-months (de Mayo et al., 2021); receptive vocabulary using PPVT (Dunn, 2019); and two measures based on a speech sample elicited via a picture description task (Eisenberg & Guo, 2013) - MLU in morphemes and the Type-Token ratio (TTR = different words produced / total number of words produced). The three latter measures were obtained at 30 and/or 36-months. We found that (centered and scaled) individual estimates of verb segmentation in the first year significantly predicted scaled expressive vocabulary at 30-months (Figure 1; β = 0.45, 95% CrI [0.09, 0.82], p(|β| > 0) = 0.99) and the scaled TTR obtained from the language sample (Figure 2; β = 0.30, 95% CrI [-0.03, 0.63], p(|β| > 0) = 0.96). We discuss (a) the relative merits of approaches to characterize individual differences comparing our method with raw difference measures and methods based on modeling individual subjects only (b) and the implications of our findings for uncovering the relationship between verb segmentation and lexical diversity in expressive vocabulary, in typically developing children as well as those at risk for language disorders.

O.11: Maternal Effects on Language Development

O.11.01 Moderators of the Relation between Mothers' Pointing and Infants' Word Comprehension (Ertaş)

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Parents' pointing for infants predicts infants' concurrent and prospective language development (Colonnesi, 2010). However, whether individual differences such as family socioeconomic status (SES) and point-following skills affect this predictive relation is largely unknown. The present study examined whether (1) mothers' pointing frequency at 12 months predicts their infants' word comprehension at 14 months, and (2) whether infants' SES and point-following skills at 12 months moderate this relationship. We longitudinally examined the interactions of 42 Turkish-speaking mother-infant (26 girls) dyads from low- and high-SES backgrounds (18 high-SES; based on maternal education) when the infants were 12 and 14 months old. To measure mothers' pointing frequency, we used the decorated room paradigm in which mother-infant dyads were asked to spend 5 minutes in a room with 21 objects hung on the four walls (Liszkowski et al., 2012). To measure infants' point-following performance, we used an adapted paradigm (Mundy et al., 2003) in which an experimenter pointed to four pictures located at the front left, front right, behind left, and behind right of the infants. Given that most infants could follow pointing to the two pictures in their front, we only focused on point-following to the two pictures behind. We categorized the infants as 'followers' if they successfully followed points to at least one picture behind and as 'non-followers' otherwise. We used the Communicative Development Inventory-Turkish (CDI-TR; TIGE) to measure infants' word comprehension at 14 months (Aksu-Koç et al., 2019). We ran two separate moderation analyses to test our research questions. Results revealed that SES and infants' point-following skills moderated the relation between mothers' pointing frequency and infants'

word comprehension. While mothers' pointing frequency at 12 months positively predicted infants' word comprehension at 14 months in the high-SES group (β=3.47, SE = 1.51, p<.05); it negatively predicted infants' word comprehension in the low-SES group (β=-3.41, SE=1.64, p<.05; Figure1). Furthermore, mothers' pointing frequency was predictive of infants' word comprehension only for infants who were 'followers' of pointing (β=4.22, SE=1.46, p<.01; Figure2). Our findings contribute to the literature in two ways. First, we show that maternal pointing positively predicts infants' later language development only for high-SES infants, while this prediction is negative for low-SES infants. This may be related to the nature of pointing for high- and low-SES mothers. Namely, low-SES mothers may point in a directing way (Koskulu et al, 2021) which may have negative implications for word learning (Tomasello & Todd, 1983), while high-SES mothers may point in the following way which promotes word learning. Second, we show that maternal pointing is predictive of infants' later language only for point-follower infants. This may indicate that infants' ability to pick up on potential linguistic information that accompanies maternal pointing (e.g. labels) might benefit their word learning.

O.11.02 Early Adversity and Attachment Security as Predictors of Receptive Language and Executive Function Skills (Weinberger)

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Early experiences of adversity have negative effects on children's development, including their language and executive functioning abilities (Cicchetti, 2016; Van IJzendoorn & Juffer, 2006). The first aim of this study was to test whether children's language and executive functioning abilities exhibited catch-up after children were removed from adverse circumstances and placed in safe, stable environments (namely, foster care or adoptive families). The second aim of this study was to test whether infant attachment security predicts children's language skills and executive functioning among children who experienced early adversity. While infant attachment security has been associated with healthy social and emotional development, there has been theoretical debate whether cognitive outcomes can be predicted by early attachment security (e.g., Sroufe, 1988; Van IJzendoorn et al., 1995). Prior studies have shown infant attachment security to be associated with children's language skills and executive functioning abilities among low-risk children (e.g., Bernier et al., 2015, Van IJzendoorn et al., 1995). However, no large-sample studies have examined this issue among children at elevated risk for problematic development. We predicted that attachment security would be positively associated with children's language skills and executive functioning abilities in a high-risk sample. Our sample included 177 children whose parents had been referred to Child Protective Services (CPS) due to allegations of maltreatment, 202 children in foster care, 118 children who had been adopted internationally, and 46 children from low-risk families. Attachment security was measured between 12 and 36 months using the Strange Situation Paradigm (Ainsworth et al., 1978), and children were classified as having formed a secure or insecure/disorganized attachment with the parent. Children's receptive language was assessed at 36 months and 48 months using the Peabody Picture Vocabulary Test-Revised (PPVT; Dunn & Dunn, 1981). Cognitive flexibility, which is an indicator of executive functioning (Zelazo, Carlson, & Kesek, 2008), also was assessed at 36 months and 48 months using the preschool versions of the Dimensional Change Card Sort (DCCS; Beck et al., 2011) for all children except those from CPS-referred families. Children's receptive language skills differed across the four groups of children. At both 36 and 48 months, children from CPS-referred families had lower PPVT scores than all three other groups. In

addition, children in foster care had lower PPVT scores than both children adopted internationally and low-risk children (Figure 1). Similar group differences were observed for cognitive flexibility at 48 (but not 36) months. Children in foster care had lower scores than both children adopted internationally and low-risk children (Figure 2). Children adopted internationally did not significantly differ from low-risk children in terms of DCCS and PPVT scores. Altogether, these results support the idea that receptive language and cognitive flexibility skills catch-up when children are removed from adverse circumstances, especially for children placed in highly enriched families. Regarding our second aim, results indicated that infant attachment security did not significantly predict receptive language or cognitive flexibility skills at 36 or 48 months. These results do not support the idea that attachment security predicts cognitive developmental outcomes.

O.11.03 Mother's initiative role in conversational exchanges and its effect on children's language outcome (Chai)

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Conversational exchanges are one of the key aspects of mother-child interactions (Snow, 1977), in which mother, as the more mature speaker, is regarded to play a leading role (Kochanska & Aksan, 2004; Vygotsky, 1978). Yet, both the child and mother play an active role in these interactions, especially in their own-initiated conversations (Ko et. al., 2016; Salo et. al., 2021; VanDam et. al., 2022). While previous studies (Bornstein et. al., 2015; Warlaumont et. al., 2015) examined mother-child interaction patterns in terms of contingency and how it might relate to learning, our current study directly compared the relationship between the interaction patterns and children's word learning. First, we examined whether Korean mother-child interaction patterns are consistent with the findings in the English speaking population (Ko et. al., 2016). Then, we examined what aspects of the mother-child interaction are beneficial for language learning captured using the Korean adaptation of the MacArthur-Bates Communicative Development Inventories (CDI-K; Pae et. al., 2008). Using 228 daylong LENA recordings from 141 Korean mother-child dyads (60 girls) with children aged between 7 and 30 months (M = 14.1, SD = 6.5), we examined four metrics: segment duration, number of segments, response interval of conversational turn (child responding to the mother (M-to-C), mother responding to the child (C-to-M)), and the number of conversational turns. In generalized linear mixed model analyses (GLMMs), we examined whether these measures might be influenced by speaker (mother and child) and block type (adult-initiated (AICF) and child-initiated (CIC)). Pairwise comparisons of the interaction effects revealed that mothers and children tend to produce longer (p's < .001) and more vocalizations (p's < .001), mothers tend to respond quicker (p < .001) and both mother and children tend to respond more often (p's < .001) in their own-initiated conversational blocks than when they were the respondent. Furthermore, we examined what aspects of mother-child interaction are beneficial for language development. GLMMs on a subsample of recordings with age-matched children (N = 40) between 13-14 months of age revealed significant interactions between CDI percentile and the block type with regard to the number of vocalizations (p = .04), and the turn type with regard to the response time (p = .006). The marginal effect plots of these interactions revealed that mother-child dyads of children with higher CDI percentile tend to engage more often in AICF blocks and in overall respond to each other more quickly. Supplemental analyses revealed that the normalised number of adult-initiated blocks were significantly related to mother's contingency scores (b = .153, p < .001) operationalised

based on Warlaumont et. al. (2015). These findings suggested that the dyads were active in their interactions, the role of mother-initiated interactions were important in facilitating children's vocabulary learning and that higher engagements in adult-initiated blocks are related to more mother's feedback. To our knowledge, this is the first study that examined LENA-captured mother-child interaction patterns and its role with learning in a non-Western population. This work contributes towards the understanding of how mother's initiative efforts support children's language learning and provides valuable insights for speech practitioners in clinical settings.

O.12: Language & Diversity

O.12.01 Bridging ethnographic and quantitative characterizations of Mayan developmental language environments (Di Giovanni)

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The prevalence and style of infant-directed speech varies substantially across cultures. Most research establishing these differences has arisen from linguistic anthropology, particularly language socialization research, using both ethnographic and linguistic analysis of everyday interactions (e.g. de Leon, 2000; Gaskins, 2006; Brown, 2007). Recent efforts to unite language socialization findings with quantitative research inspired by developmental psychology have focused primarily on quantities of input, especially which input types 'count' toward meaningful quantity estimates (e.g. Shneidman and Goldin-Meadow, 2012; Casillas, 2020). Quantity is informative for understanding the amount of material children use to develop linguistic knowledge, but we must further investigate children's experiences with linguistic practices to better orient our understanding of how language development--including input and outcome patterns--is fundamentally shaped by expectations of children as (a) potential interlocutors and (b) to-be members of society. To that end, we present preliminary findings from a mixed-methods study of utterance types in infant-directed speech from daylong recordings of Tseltal Mayan children under 0;8. Ethnographic findings characterize the Mayan caregiving language environment as 'non-child-centric'; children are socialized to attend to interactions occurring around them and to not expect to be the center of social attention, especially infants, who are not typically considered viable interactional partners (i.e., they don't understand/can't talk back) and who are better served by remaining calm (i.e., not overstimulated) and well fed and rested (Brown, 2014; Gaskins, 1996). We first identified infant-directed utterance types on three bases: (a) relevance to prior ethnographic work on Mayan language socialization; (b) relation to different interactional roles (e.g., information recipient vs. conveyor); and (c) any other common, distinct communicative practices that we discovered during initial qualitative transcript review. The final inventory includes five utterance types: imperatives, cultural routines, questions, child-centric non-declaratives (e.g., "kala k'ox!" (dear little one!)), and "other". We classified all infant-directed utterances in nine 5-minute clips from daylong at-home audio recordings for 9 children under 0;8. Annotation is ongoing; we report observations for the 6 of these children who had 5+ infant-directed utterances. In line with prior work, we find that caregivers use imperatives (e.g., "ila" (look)) and culturally relevant speech routines (e.g. directed repetition or repetitive infant games "tsaka tsaka tsaka" (take take take)) with nearly all children. We were also surprised to find questions directed to these young infants (eg. "binti ya awal k'uxinul?"(what are you eating?)) which does not neatly accord with a view of the child as a non-viable interactant. Informally, we find that these categories, while encompassing both expected and unexpected communicative acts on the basis of past ethnography,

lack the pedagogical, performative style typically observed in the infant-directed speech of middle-class, Western families. These preliminary findings form a basis for further work exploring how variation in caregiver communicative practices relates to variation in quantities of infant-directed speech within this community, which we plan to investigate with more children from this same dataset under 1;2.

O.12.02 An English vocabulary gap between UK monolingual and bilingual toddlers in both comprehension and production (Siow)

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Researchers, medical practitioners and parents alike have long been interested in the question of whether bilinguals' vocabulary growth is comparable to monolinguals'. For bilingual toddlers living in communities that predominantly speak one language (e.g. the UK, which uses English), it is particularly important for them to acquire the community language. Previous findings in the literature on bilinguals' vocabulary size have been mixed. Bilingual toddlers have been found to have smaller vocabularies than monolinguals when comparing in one language, but comparable or even larger vocabularies when both languages are added together (Pearson, Fernández, Lewedeg, & Oller, 1997). In contrast, De Houwer, Bornstein and Putnick (2014) found no significant difference in the vocabulary sizes of monolingual toddlers learning Dutch and bilingual toddlers learning Dutch and French. With school-age children, Yan and Nicoladis (2009) found that while comprehension was comparable, school-age bilinguals performed significantly poorer in a production task compared to monolingual peers. We compared 12 to 36-month-old bilingual toddlers (N = 489) growing up in the UK with English and one additional language (AL) (Dutch, French, German, Italian, Polish, Portuguese or Spanish) to age-matched UK English monolinguals (N = 1732). Vocabulary knowledge in English for both groups was collected using the Oxford Communicative Development Inventories (CDI), which has 418 words commonly known to British toddlers. Parents indicated for each word whether their child understands and says, understands but does not say, or does not understand the word. We therefore have parent-reported data on both word comprehension and production for each child. This allowed us to directly compare toddlers' parallel growth in comprehension and production. We split bilinguals into three groups: English-dominant (60-75% English exposure), Balanced (40-60% English exposure) and AL-dominant (25-40% English exposure). We ran a linear regression model with vocabulary size in English as the dependent variable. The three bilingual groups were compared against the monolingual group (reference level). Bilinguals' vocabulary size in comprehension was significantly smaller than monolinguals after controlling for age. This was seen for the English-dominant group (t = -7.34, p < .001), Balanced group (t = -9.33, p < .001) and AL-dominant group (t = -12.62, p < .001). This difference was also found for vocabulary size in production, with the English-dominant group (t = -7.52, p < .001), Balanced group (t = -9.61, p < .001) and AL-dominant group (t = -10.99, p < .001) all lagging behind monolinguals. Lastly, we compared the relationship between comprehension and production. We used the MatchIt package in R (Ho, Imai, King & Stuart, 2011) to match a subset of the monolingual group to the bilingual group by vocabulary size in comprehension. There was no significant difference found for vocabulary size in production between comprehension-matched groups in 1000 iterations of the matching function. In summary, bilinguals were found to have lower vocabulary sizes than age-matched monolingual peers but comparable productive vocabulary size with (younger)

monolinguals matched by comprehension. These results suggest that bilingual toddlers show delayed but not divergent developmental trajectories in comprehension and production.

O.12.03 Effects of multilingual exposure to harmonic and non-harmonic languages on perceptual preferences in infants growing up in Africa (Omane)

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Previous studies have demonstrated that infants show language-specific phonotactic knowledge from the first year of life. For example, if infants learn a language that shows vowel harmony (VH), a phonotactic constraint that requires similarity between co-occurring vowels, they show a listening preference for vowel harmony patterns from around 6 months of age (Turkish: Altan et al., 2016; Van Kampen et al., 2008; Hungarian: Gonzalez-Gomez et al., 2019), but not if their language is without VH (e.g., German, French). Given the high attestation of vowel harmony across the world's languages, it has been proposed that the acquisition of vowel harmony may be facilitated by innate learning biases (e.g., Finley & Badecker, 2008). To better understand how learning biases and language experience interact in phonotactic learning, it will be relevant to study infants with more diverse backgrounds. So far, studies investigating infants' vowel harmony preferences have focused on infants growing up monolingually in Europe. In Africa, many infants grow up multilingually with three or more languages. Many African languages have vowel harmony. Hence, we ask how multilingual experience with languages with and without VH shapes infants' phonotactic preferences. For the present study, we focused on infants growing up in Ghana (West-Africa) with both non-VH languages (e.g., Ewe, Ga, Ghanaian English) and Akan, a language with Advanced Tongue Root (ATR) vowel harmony, to determine the degree to which exposure to both a VH language and non-VH languages modulates infants' preference for harmonic or non-harmonic syllable sequences. Two predictions are plausible: either infants consistently show a preference for VH, as long as they get at least minimal exposure to Akan as a VH language, or their preference depends on the degree of exposure to Akan. So far, nine (of planned 40) 6-months-old multilingual infants with experience in Akan and additional non-harmony languages (e.g., Ewe, Ga) has been tested in Accra, Ghana's capital. In a single-screen central fixation paradigm (Cooper & Aslin, 1990), infants listen to trials of bisyllabic CVCV nonwords with VH (e.g., bidu) or without VH (e.g., bɔde). Looking times (LT) are analyzed to determine whether infants prefer listening to harmonic or non-harmonic nonwords. Additionally, using a questionnaire and a day-long logbook method, infants' experience with harmonic and non-harmonic languages is assessed. Preliminary data shows slightly longer looking times for harmonic (8042 ms) than for non-harmonic (7444 ms) trials. We do not perform any statistical analyses on the preliminary data, since we do not have enough participants for this yet. However, we anticipate the end of data collection by January. Hence, by the time of the conference, we will be able to present the full statistical results including exposure to Akan as a predictor to see whether exposure modulates the preferences. Gaining insight into how multilingual exposure to languages with and without vowel harmony, which is the linguistic reality for many infants growing up in Africa, shapes phonotactic preferences in infancy will help us better understand how language experience and potential learning biases influence infants' acquisition of phonotactics.

O.12.04 Exploring the general expansion hypothesis for accent adaptation in toddlers: Is there a hidden cost? (Paquette-Smith)

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In recent years, we have learned a lot about when infants first develop the ability to adapt to other-accented speech. Although infants struggle to understand other accents prior to 19 months of age, by their second birthday they begin to show great facility with accent adaptation (van Heugten et al., 2018). But how do infants adapt to other-accented speech? Three possibilities have been proposed (Johnson et al., in press). According to the Specific Mapping Hypothesis, infants and toddlers adapt to novel accents by generating a precise mapping between accents (e.g., they work out that in a novel accent the short vowel in 'kiss' is pronounced as a long vowel, and then generate an expectation for other short vowels to be produced in the same way). According to the General Expansion Hypothesis, however, children adapt to new accents by simply relaxing their criteria for what counts as an acceptable pronunciation of a familiar word (e.g., after hearing 'kiss' pronounced with a long vowel, children would also perceive other unrelated vowel substitutions as acceptable). A third possibility is that children use both strategies (i.e., the Flexible Hybrid Approach). Although both the General Expansion and Flexible Hybrid hypotheses do a good job explaining how infants adapt to novel accents so quickly, they also predict a potential cost for this fast adaptation. Expanding what they consider as an acceptable pronunciation of a familiar word in response to encountering a novel accent could temporarily slow children's recognition of familiar-accented words. Evidence for this can be seen in an artificial language study, in which children had difficulty recognizing words pronounced in a familiar accent after exposure to an unfamiliar artificial accent (Cooper et al., in press). But does this effect generalize to natural speech and real accents? Here, we investigate this by exposing 27-month-old Canadian English learning infants to a 1.5-minute video recorded story spoken by either a Mandarin-accented English speaker (n = 23) or a Canadian-accented English speaker (n = 24). The story contained highly familiar words (e.g., apple, boat, duck). After the exposure phase, children's recognition of a new set of familiar words was tested using an eye-tracking paradigm. In each test trial, one of the two familiar objects presented on the screen was labeled (by a new speaker) in the local Canadian English accent. Following Buckler et al. (2017), children's proportion of looks to the named target in the test phase was analyzed over two 1-second windows following word onset (see Figure 2). Contrary to the predictions of the General Expansion Hypothesis, we observed no cost associated with exposure to Mandarin rather than Canadian-accented speech in the first window, $t(45) = -0.72$, $p = .476$, or second window, $t(45) = -0.79$, $p = .435$. Previous work has shown that infants exposed to an artificial accent subsequently recognize words in their own accent less efficiently (Cooper et al., in press). However, a comparable effect was not observed in our natural accent version of this task. It may be that the artificial accent used in previous work was more distant from Canadian English. Or perhaps having different speakers in the exposure and test phase in our experiment prompted toddlers to switch adaptation strategies instead of applying the same strategy to the test stimuli. Future work should examine these possibilities, as well as examine how children's speech processing might adjust in response to routine accent exposure.

O.13: Mental Health

O.13.01 Infant Functional Network Topology: Associations with Infant Temperament Trajectories in the Context of Maternal Anxiety Over Time (Anaya)

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Emotion regulation is essential to child competence, and behavioral studies indicate that its development begins early in infancy. However, the neural processes that support these early foundations are poorly understood. Furthermore, emotion regulation is a heterogeneous process that involves many components of emotion and context (Gross & Jazaieri, 2014). Thus, using neural network approaches may best capture how the brain, as a whole, self-organizes to support the development of emotion regulation. Moreover, early temperamental predispositions may condition developmental links between emotion regulation and child outcomes (Stifter et al., 2011). Infant functional network topology may then reflect broad brain-level functional responses to the environment and may help better predict temperament-linked individual differences (Filippi et al., 2020). Thus, this association must be examined in the context of environmental influences, such as maternal psychopathology, which may affect caregiving quality and hinder development of neural networks (Hanford et al., 2018). The present study used graph/network analysis of EEG coherence to 1) examine associations between 8-month infant network topology and maternal anxiety, 2) test whether infant network topology predicted negative affect trajectories, and 3) test whether average and fluctuating levels of maternal anxiety moderated this link. Sixty infants provided EEG at 8 months, and mothers completed the Infant Behavior Questionnaire (IBQ) and the Beck Anxiety Inventory (BAI) at 4, 8, and 12 months. We computed EEG coherence between all electrode pairs (32-channel net), estimated a network for each infant, and extracted three metrics that reflect network centrality and functional integration. Betweenness Centrality identifies nodes located on heavily traveled paths; higher values reflect central communication paths. Community identifies hubs of densely connected nodes; lower values indicate higher modularity. Network Distance measures the network's average path-length; lower values reflect higher functional integration. Repeated measures of BAI were split into average (individual's mean over time) and fluctuating (deviations from individual's mean) components. Eight-month infant network topology and maternal anxiety were not related. Instead, higher 4-month maternal anxiety predicted lower 8-month Betweenness Centrality (γ_{30}= -0.371, p = .001) and Distance (γ_{30}= -0.035, p = .001) after controlling for 8-month anxiety (Fig 1). Growth models indicated negative affect trajectories varied as a function of Community (γ_{30}= -0.050, p = .001). Regions of significance (RoS) analysis (Fig 2A) showed that negative affect increased over time in infants with lower Community (<12.9 hubs) but significantly decreased over time in infants with extremely high Community (>20.32 hubs). Finally, average maternal anxiety levels moderated this link (γ_{112}= 0.006, p = .014). RoS analysis (Fig 2B) indicated that in the context of low and average levels of maternal anxiety, negative affect trajectories were stable for infants with Community > 13.57 and 15.35 hubs, respectively. In contrast, with higher maternal anxiety, there was an inverted U-shaped relation, such that only at extreme low and high Community size, negative affect trajectories were stable. We discuss how low network modularity may contribute to atypical negative affect trajectories and increase psychopathology risk in the context of maternal anxiety.

O.13.02 Exposure to War prior to Conception: Maternal Emotional Distress forecasts Child Behavior Problems (Beijers)

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Background and objectives: Animal studies provide compelling evidence that exposure to stress prior to conception can compromise offspring outcomes, but human studies are few. We investigated the links between maternal emotional distress following preconception exposure to war, and child outcomes at age 3 and age 10. Methods: Before becoming pregnant, mothers were exposed to missile bombardment on the north of Israel in the 2006 war. Mothers who conceived within 12 months after the war were recruited and compared to mothers who conceived during the same period but lived outside missile range. During the initial assessment, mothers completed a questionnaire on emotional distress. At 3 years and at 10 years of age, child socio-emotional outcomes were measured. Results: At age 3, the results indicate that war experience engenders higher levels of mothers' separation anxiety, lower emotional availability in mother-child interaction, and lower levels of children's adaptive behavior. At age 10, the results revealed that, in girls, higher maternal emotional distress following preconception war exposure predicted more internalizing and externalizing behavior problems, and more behavior regulation problems. In 10-year-old boys, maternal emotional distress was not significantly related to outcomes. Conclusions: Maternal emotional distress following preconception exposure to war forecasts child socio-emotional outcomes. As such, this study captured a one-time-only combination of circumstances and the findings suggest that maternal preconception stress should be considered as a determinant of child development. Maternal emotional distress following preconception war was not only associated with maternal report of child socio-emotional functioning, but also with observations and child report, suggesting that our findings are robust and likely not due to a reporter-bias. Our findings add to the small but growing body of research on the consequences of maternal stress exposure prior to conception for the next generation.

O.14: Neuroscience II

O.14.01 Language acquisition and the development of preferred phase in cortical tracking of auditory rhythm (Ni Choisdealbha)

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The acoustic speech signal contains information varying at multiple timescales. Neural oscillations that track these underlying rhythms in speech differ between children with and without dyslexia (Power et al., 2016). This occurs particularly in the delta band (1-3Hz) which corresponds to the rate of syllabic stress in stress-timed languages. This suggests a role of delta band neural oscillations in language development. Relative to adult-directed speech, infant-directed speech contains additional energy in this frequency band (Leong et al., 2017). Our aim was to examine how infant neural responses to slow, rhythmic auditory stimulation change over early development, and how this might relate to language acquisition. Power and colleagues (2013) found that children's phonological awareness was related to the phase at which the brain tracks incoming 2Hz auditory stimulation. We therefore played repetitive 2Hz audiovisual stimuli to infants at the ages of six and nine months. These stimuli took the form of a ball bouncing on a drum, creating a drumbeat, and the head and shoulders of a woman repeating the syllable "ta", played in trials of 16 to 24 beats each. At six months, 113 infants took part, of whom 106 took part at 9 months, along with two more infants who had missed the 6-month session. EEG recording took place while infants watched the audiovisual stimuli, and also in a silent condition in which no visual

stimulus was displayed. As seen in Figure 1, there is significantly more inter-trial coherence (ITC) in the audiovisual conditions at 2Hz than in the silent condition (syllable: β = 0.025, t = 6.984, p < 0.0001; drumbeat: β = 0.023, t = 5.745, p < 0.001). This suggests that the infant brain is tracking the audiovisual stimuli at the stimulus rate. However, there is no further increase in ITC with age. When we examine the actual phase of that tracking, age-related changes are seen. First, at both ages and in both audiovisual conditions (but not the silent condition), the Rayleigh statistic showed that distribution of phase angles was significantly different from a uniform circular distribution. Phase was affected by condition ($F(2, 343) = 7.6$, $p = 0.0006$) and the age by condition interaction ($F(2, 343) = 5.03$, $p = 0.007$; Figure 2). Simple effects show that whereas phase angle in the syllable condition was overall significantly different from the silent condition (β = 0.494, t = 2.095, p = 0.037, 275°), in the drum condition it changed with age (β = 1.063, t = 2.981, p = 0.003, from 208° to 255°). These results suggest a general consistency in the phase at which the infant brain tracks simple speech stimuli, and an improvement for non-speech stimuli with age based on the mean angle drawing closer to the target phase (0 or 360°). Individual differences in phase alignment found here will be linked to measures of phonological development obtained from these infants in a non-word repetition task administered at ages 18 and 24 months.

O.14.02 An EEG study of time perception in 4- and 9-month-olds (Sirois)

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This study examines the development of time perception in the first year of life using EEG measures applied to an auditory oddball paradigm. Infants' capability to track time can modulate and facilitate perceptual and cognitive processes (Kopp, 2018), yet few studies have explored this ability. These examined sensorimotor synchronization (Rocha, Southgate, & Mareschal, 2020) and auditory oddball (Colombo & Richman, 2002) for example, using EEG and ECG, respectively. The auditory oddball was also explored with ERPs (Brannon et al., 2008). From a purely cognitive perspective, exploring infants' ability to process causality indirectly relies on time perception (Oakes & Cohen, 1990). Those results suggested a potential shift of processing between the first two halves of the first year of infants. The neural correlates of this shift are not known and, to our knowledge, have not been directly explored with neuroscientific methods. In the current study, infants aged 4 months (n = 26) and 9 months (n = 30) were shown 40 trials of a ball bouncing on a surface. Upon contact, a 500Hz pure tone was played. The duration of the tone was 600ms for 32 trials (standard tone), 300ms for 4 trials (short oddball), and 900ms for 4 trials (long oddball). Trial order was random, with the constraint that no two consecutive trials be oddball. EEGs were recorded with a 128-channel EGI system. 4 distinct electrode montages were used to average signals for auditory and frontal cortices in each hemisphere (6 channels per site). Figure 1 shows the averaged EEG signal per trial type at each of these 4 sites, for both 4-month-olds and 9-month-olds. Preliminary analyses highlight that the 4-month-olds primarily distinguish oddballs from the standard in the right hemisphere, in both auditory and frontal areas. The long oddball has a relatively larger effect. In 9-month-olds, the discriminability of oddballs is muted in the auditory cortex in both hemispheres. However, there is a pronounced effect of the long oddball in the left frontal region. Functional data analysis (FDA; Ramsey & Silverman, 1997) was used to compare the time course of neural processing between 4- and 9-month-olds at each site and for each problem type. Raw data are transformed into smooth cubic functions (in this case, b-splines, using least-square estimates),

and analyses are performed on function parameters, resulting in test statistics that are expressed over time and can inform about the time course of differences. The results of this analysis are shown in Figure 2. The discussion explores the possibility of a shift between the ages of 4 and 9 months from general, right hemisphere processing to focused, left frontal processing of auditory durations. Further attention is paid to the distinction between negative versus positive duration discrepancies to standard/expected durations in time processing, with implications for studies that assess cognitive abilities based on stimuli that unfold over variable time courses.

O.14.03 The P1 event-related potential response and sensory responsivity in infants with fragile X syndrome and high familial risk for autism (Guy)

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Atypical sensory processing and sensory responsivity is widely reported in research on autism spectrum disorder (ASD) and fragile X syndrome (FXS) and may result from atypical neural processing, signal integration, or gating (Sinclair et al., 2017). Examination of sensory processing in infancy could provide insight into the development of atypical sensory responsivity within these disorders. Event-related potentials (ERPs) are valuable for investigating relations between neural correlates of sensory processing and emerging behavioral sensory responsivity. In particular, the infant P1 ERP component is associated with visual sensory orienting, providing a sensitive index to examine early occurring neural responses in relation to observed behavioral sensory responsivity. Objective: To investigate neural correlates of sensory processing in 12-month-old infants at high-risk for ASD in relation to clinical measures of sensory responsivity concurrently and as a predictor of sensory responsivity in early childhood. Methods: Twelve-month-old infants with FXS (n=15), siblings of children with ASD (i.e., ASIBs; n=21), and low-risk control (LRC) infants (n=21) participated in an ERP study including presentations of familiar and novel faces and toys (Guy et al., 2018). Group differences in P1 amplitude were investigated. The Sensory Experiences Questionnaire (SEQ) total score was used to assess sensory responsivity in participants at 12 months and early childhood (M = 43.15 months). SEQ scores were analyzed in relation to P1 responses. Results: The groups differed on P1 amplitude, F(2, 972) = 55.97, p < .001, np2 = .10. Amplitude was greater among participants with FXS, M = 18.39µV, than ASIBs, M = 10.71µV, or LRC participants, M = 11.01µV. At 12 months of age, there was an interaction of SEQ score and participant group on P1 amplitude, F(2, 864) = 5.16, p = .006, np2 = .01. Higher SEQ scores at 12 months were associated with greater concurrent P1 amplitude responses for ASIBs, however, the opposite pattern was observed in LRC infants, and no relation was seen for infants with FXS. In predicting SEQ scores during early childhood from 12-month-olds' ERPs, there was an interaction of SEQ score, group, and stimulus type, F(4, 882) = 2.45, p = .045, np2 = .01. Among participants with FXS, greater amplitude P1 was associated with higher SEQ scores across stimulus type, while LRC participants showed relations between P1 amplitude and SEQ varied based on stimulus type. There were no significant effects of SEQ scores in early childhood for ASIBs. Conclusions: High-risk infant groups demonstrated unique patterns of P1 activation, which were uniquely associated with sensory responsivity concurrently during infancy and as a predictor during early childhood. Although infants with FXS demonstrated greater P1 amplitude responses than ASIBs or LRC infants, greater SEQ scores were observed only as a predictor of elevated sensory responsivity in early childhood. In contrast, elevated sensory responsivity was associated with greater P1 amplitude during infancy for ASIBs, despite not

displaying elevated atypical P1 responses. Results indicate that P1 amplitude is associated with sensory responsivity, but that the nature and developmental timing at which these relations are observed varies based on risk group.

O.14.04 Brain imaging of neonates with familial history of autism reveals predictive links between salience network connectivity and attention to social partners (Vernetti)

Angelina Vernetti[1], Ruchira Ray[2], Dustin Scheinost[1], Laura Ment[1], Suzanne Macari[1], Hannah Neiderman[3], Chaela Nutor[4], Carolyn Gershman[5], Hannah Feiner[6], Rachel Foster[1], Todd Constable[1], Joseph Chang[1], Katarzyna Chawarska[1]

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Brain Imaging of Neonates with Familial History of Autism Reveals Predictive Links Between Salience Network Connectivity and Attention to Social Partners Vernetti, Ray, Scheinost, Ment, Macari, Neiderman, Nutor, Gershman, Feiner, Foster, Constable, Chang, & Chawarska Background: Although signs of altered social attention to dynamic faces in infants later diagnosed with autism have been reported in infants as young as 6 months of age (Chawarska et al.,2013; Shic et al.,2014; Macari et al.,2021), the early brain mechanisms that contribute to the emergence of this vulnerability have not been identified. Several large-scale cortical networks support selective attention from infancy to adulthood. The salience network (SN) is known to regulate attention to behaviorally relevant stimuli and has, as well as the default mode network (DMN) been heavily implicated in autism (Menon & Uddin 2010; ssaf et al.,2010; Burrows, Laird, & Uddin,2016). Whether social attention during the first year of life is related to neonatal brain connectivity within and between these SN and DMN networks remain to be investigated. Objectives: To examine the predictive links between SN within-network and SN-DMN between-network intrinsic functional connectivity (iFC) at birth and attention to faces measured using eye tracking at 4, 6, 8, and 12 months in infants with (high-likelihood, HL) and without (low-likelihood, LL) familial history of autism. Methods: 45 neonates (13 HL) were scanned during natural sleep on a Siemens Prisma 3T scanner at the mean age of 3.89 weeks (SD=1.52). SN within-network iFC was assessed between the left and right anterior insula (aInsula) and the anterior cingulate cortex (ACC) of the SN. SN-DMN between-network iFC was assessed between the left aInsula and angular gyrus node of the DMN. 24 of the neonates (9 HL, 54% male) completed a social selective attention eye-tracking task (SSA4.0) at 4, 6, 8, and 12 months involving watching a video of a person where gaze (direct/down) and speech (child-directed speech/silence) were manipulated (Fig.1). Linear mixed models (LMM) were used to evaluate the contribution of neonatal iFC and age at the time of the eye-tracking task to percent looking to the face region during SSA4.0 and included main and interaction effects of iFC and age, main and interaction effects of speech and gaze conditions (all fixed effects), random intercepts for subject, and random slopes for age. Results: The LMM models assessing contribution of SN and SN-DMN iFC to attention to the face region during the first year of life indicate that, at 4 months of age, while higher SN-DMN between-network iFC was associated with lower attention to faces (p<0.001, Fig2, left panel), higher SN within-network iFC was associated with higher attention to faces (p=0.018, Fig2, right panel). Conclusions: Both lower between-network connectivity and higher within-network connectivity at birth, thought to respectively indicate better network segregation and synchronization in typical development, predicted higher attention to faces at 4 months, a highly formative age when infants begin to develop sophisticated face processing skills and engage in reciprocal interactions. This is the

first demonstration of complex patterns of brain functional connectivity at birth associated with social attention that may be impacted in neonates who later develop autism.

O.15: Language

O.15.01 Using dimensionality reduction to quantify diversity of infant vocalization types and similarity to adult productions (Pagliarini)

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Most characterizations of infant vocalizations are based on acoustic analysis of specific acoustic features (such as fundamental frequency and formant frequencies, e.g., Kent & Murray, 1982), human listener categorizations into protophone categories (Oller, 2000), or phonetic transcription (Vihman, 1996). Data-driven analysis of raw acoustic information could provide a complementary approach. We attempted this using a dataset of vocalizations from 28 long-form home recordings from 12 infants recorded longitudinally at 3, 6, 9, and 18 months (not all infants had recordings at all ages) obtained using the LENA system. We extracted audio clips for sections of the recording labeled by LENA's built-in algorithm as speech or pre-speech vocalizations by the infant wearing the recording, an adult female, or an adult male (Xu et al., 2008). We used openSMILE (Eyben, 2010) to extract Mel-frequency cepstral (MFCC) coefficients and their first and second derivatives for a sequence of timebins of the audio waveform; we then summed each MFCC-derived feature across the clip's timebins. This yielded a 39-dimensional vector of acoustic features contained within each sound clip. From these vectors we obtained a 2D representation of the vocalization space using Uniform Manifold Approximation and Projection for Dimension Reduction, an unsupervised machine learning method (UMAP, McInnes, 2018). In the resulting 2D space, sound clips with similar acoustic features are positioned near each other. Figure 1 shows this vocalization space for all infant, adult female, and adult male sounds in the dataset. Vocalizations generally clustered together depending on the class they belong to, but with a fair amount of overlap between classes. The 2D representation can be quantified in various ways; here we showcase two. First, for each audio recording, we measured the distance from the centroid (i.e. the mean position) of the infant vocalizations to the centroid of the adult female vocalizations. Plotting these results as a function of age gives the plot in Figure 2 (left panel). Statistical analyses with infant ID as a random effect found a statistically significant positive quadratic effect validating the u-shape relationship between age and infant-adult female centroid distance. This suggests that infant and adult female vocalizations become increasingly similar from 3 to 9 months of age, and then diverge again as infants get to be 18 months old. Second, for each recording, we measured the average distance of the infant vocalization points from the infant's centroid, providing a measure of acoustic diversity. The results are shown in the right panel of Figure 2; statistical analyses found both a linear and a quadratic relationships between age and centroid distance to be negative and statistically significant ($p = .03$ and .02, respectively). It appears that, when infant vocalization acoustics are represented in this way, the diversity of sounds infants produce during a day rises to a peak at 6 months and then decreases from that time point on. We hypothesize that the 6-month peak might relate to the so-called "expansion stage" of infant protophone development (Oller, 2000), and aim to test this in future work.

O.15.02 The motor development of vocal production in late infancy (Borjon)

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Vocal production is a complex behavior requiring the coordination of functionally distinct muscle groups (Thelen, 1991, Jurgens, 2002). The production of a simple one-syllable word requires the coordination of over 80 muscles and 10 different body parts, most of which are also vital for stereotyped behaviors such as breathing, swallowing, and chewing (Jurgens, 2002; Hage et al., 2013). Like adults and other mammals, infants coordinate vocalizations by vibrating the vocal folds of the larynx and pushing air through the vocal-tract airways (Ghazanfar & Rendall, 2008). Learning to successfully coordinate this dynamic is essential for the development of speech (Nip, Green, & Marx, 2011; Zhang et al, 2019) such that infants with dysphagia, a difficulty swallowing, exhibit concomitant delays in language development (Malas et al, 2017). Nonetheless, vocalizations require more than the orofacial tract. The transition to walking from crawling, whereby infants move upright and unsupported, frees-up the lungs and diaphragm (Yingling, 1981) and is a period of time oft linked to advances in language development (Walle & Campos, 2014; West et al., 2019). Thus, the overarching hypothesis of the present study is that the motor development supporting changes in vocalization is tied to the whole body. The data presented demonstrate substantial developmental changes in the temporal properties of head and hand movements around naturally occurring vocalizations in dyadic play. A total of 3,163 vocalizations emitted by 44 unique infants were studied across a total of 128 sessions. To capture changes in movement, children wore a motion capture sensor affixed to their head and both hands, from which the rotational velocity was calculated. For most age levels, infants start to move before a vocalization even begins (Figure 1). For younger infants, this buildup in motor activity precedes the vocalization by at least half a second. Older infants, however, exhibit a more tightly coordinated change in movement with the onset of a vocalization indicating more mature motor coordination (Figure 1). For each visit during this study, caregivers completed the MacArthur Bates Communicative Development Inventories (Fenson et al., 2007). Infants who exhibited greater acquisition of vocabulary production from 9- to 24-months-of-age exhibited more stable movement patterns than those individuals who acquired less vocabulary production (Figure 2). The present findings provide evidence that the motor coordination necessary to produce a vocalization may be indicative of general motor maturation (Fagan & Iverson, 2004, Locke et al., 1995). Implications for typical and atypical development are discussed as are possible neurophysiological pathways governing this coordination. Future research, currently underway, will examine whether the phonological structure of infant vocalizations relate to the observed coordination of gross motor activity with vocalization onset.

O.15.03 Listening preference for speech exhibiting natural phonetic cue relations (Hullebus)

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Infants learn to distinguish speech sounds in their native language remarkably quickly despite being exposed to substantial variability in the acoustic-phonetic cues produced by different or even the same speakers. One way the perceptual system may adapt to such variability is by using compensatory interactions between cues called trading relations (Repp, 1982). For instance, to perceive a /p/ as opposed to a /b/, durational cues such as voice onset time (VOT; Lisker, 1986) and spectral cues such as first formant (F1) onset frequency: e.g., when VOT is ambiguous, higher F1 causes listeners to be more likely to perceive a /p/ rather than a /b/ (Summerfield & Haggard, 1977). The current study investigates whether infants acquiring native categories are sensitive to the cue trading relation

between VOT and F1, and particularly whether they have a preference for speech in which the phonetic cues adhere to the natural trading relation attested in adults' and non-human animals' (Kluender, 1991) perception as opposed to the reverse relation. Such a preference could aid infants in forming phonetic representations that are adaptable to speaker variability and adverse listening conditions. In a head-turn preference procedure (HPP; Hirsh-Pasek et al., 1987), 24 6-month-old monolingual German infants heard stimulus strings consisting of non-words of the form /da:və/, recorded in a mildly infant-directed manner by a female native speaker of German. Stimuli were manipulated to vary continuously in both VOT and F1 and were divided into 2 conditions: a natural condition, in which long VOT (30-40 ms) coincided with high F1 onset frequency (840-1000 Hz) and short VOT (5-15 ms) coincided with low F1 onset frequency (600-760 Hz), versus a reversed condition, including long VOT combined with low F1 and short VOT with high F1 (see figure 1). Each of the 16 trials lasted 21 s and contained 14 stimuli sampled from the natural or reversed continuum. In a booth with light bulbs and loudspeakers on left and right sides, stimuli from each condition were played alternatingly on either while a camera allowed an experimenter to track looking times to the corresponding lights per trial. On average, infants' looking times were 10.1 s (SD = 6) in the natural condition and 9.3 (SD = 5) in the reversed condition. Modeling looking times using a linear mixed model with fixed effects for naturalness and trial order, an interaction between effects and random subject intercepts revealed significantly longer looking times for the natural condition (p<.01) and a significant trial order interaction (p<0.001) and effect (p<.001). The results indicate that infants have a perceptual bias towards speech which adheres to natural phonetic cue trading relations as opposed to other relations after minimal exposure. The trial order effect suggests that preference decreases over the course of the experiment, which may be attributed to the general decrease in attention over time. Overall, the current work as far as we know presents first evidence for a perceptual bias towards natural cue relations in native-language speech continua.

O.16: Cognitive Development I

O.16.01 An itsy bitsy audience: Infant behaviour and physiological responses to a live or recorded opera for babies (Kragness)

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In March 2020, many of the experiences that make up the social fabric of our daily lives - school, work, parties, and entertainment - began to be delivered virtually. This shift attracted substantial societal debate about potential differences in attention and engagement elicited by live vs. recorded modalities. In the present study, we investigated the effects of live presentation and social context on infants' responses to an infant-directed concert composed and performed by professional musicians. One group of infants (N = 55) was videorecorded while watching a live performance in a specialized performance hall optimized for scientific research (livelab.mcmaster.ca). A second group (N = 55) watched a recorded playback of the same performance in the same auditorium, but the performance was projected onto a large screen at life size. The perceptual (visual and auditory) and social experiences (large audience context) were therefore closely matched between these two conditions, but differed in their mode of delivery (live vs. recorded). Finally, a third group (N = 45) watched a recorded playback of the performance in their own home. Research assistants annotated the video recordings to indicate when each infant was watching the performance and when infants moved rhythmically, such as when

"dancing", swaying, or clapping. Heart rate was also measured for a subset of the audience-member infants. Initial analyses indicate that the live+audience condition elicited the most attention from the infants, and the recorded+audience condition elicited the least (Figure 1). The recorded+alone condition fell between the two, suggesting that infants were more distracted in the context of an audience, but that the distractions were overridden by the engaging aspects of the live performance (all pairwise p's < .05). Likewise, the live performance elicited longer windows of uninterrupted interest than either recorded performance (Figure 2). Future planned analyses will examine whether conditions affected behavioural and physiological coherence between audience members, and how behaviour and physiology were influenced by the features of the music. Overall, results suggest that live entertainment best engages infants' attention, and that the live modality is sufficiently engaging to overcome the distractions associated with a large audience.

O.16.02 The self-perspective in infant perspective tracking (Yeung)

Emanuela Yeung[1], Dimitrios Askitis[1], Velisar Manea[1], Victoria Southgate[1]

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Although many years of research in developmental psychology had converged on the conclusion that mentalizing was an achievement reached somewhere between 3 and 4 years of age, new data suggests that young infants are already making inferences about other people's thoughts. This has led to considerable debate, largely centered on whether behaviour that looks like mentalizing in infants reflects the same underlying processes that enable older children to pass traditional verbal mentalizing tasks. One popular but untested explanation of infants' success on NVMTs (non-verbal mentalizing tasks) is that these tasks do not demand inhibitory control, and thus enable infants to reveal their belief-tracking ability by removing the need to inhibit their own conflicting perspective. Although there is general support for the idea that inhibitory control may be related to false belief understanding in older children, there is not yet evidence that the same processes are required to pass NVMTs. In addition, it may be the case that infants do not experience a perspective conflict until they develop the ability to represent the self-perspective. To test this, we presented 18-month-olds (n = 50), half of whom passed the mirror self-recognition (MSR) task, with a NVMT and used pupil diameter as an index of conflict processing and anticipatory looking as a measure of action anticipation based on false belief attribution. We manipulated conflict by including a low-demand and a high-demand condition. Differences in pupil dilation over time were analyzed using functional data analysis (Sirois & Jackson, 2007). A functional 2x2 mixed ANOVA revealed significant differences in pupil dilation between mirror groups during the action anticipation window, and functional t-tests (t(25) as a function over time) showed that this was driven by differences in pupil dilation between groups in the high-demand condition. In addition, we detected greater dilation in mirror recognisers at an earlier time window, before the agent was occluded. In line with recent replication efforts (Kampis et al., 2021), infants did not reliably make belief-based action predictions. Although infants were not reliably making anticipatory looks, we considered post hoc whether examining differences in latency to make anticipatory looks would allow us to better interpret the differences in dilation during the anticipation phase. Exploratory analyses examining latency to making anticipatory looks revealed that mirror recognisers were significantly slower than non-recognisers to saccade only in the high-demand condition (t(35.79) = -2.03, p = .05, d = -.57).We argue that this longer latency in mirror recognisers could reflect a delay related to two conflicting representations. Taken together, our results suggest that mirror recognisers did perceive

greater conflict during the action anticipation phase, specifically in the high demand condition in which conflict between self and other should be particularly salient.

O.16.03 Promoting infant cognition and learning by enhancing parental responsiveness: A systematic review and meta-analysis (Andrews)

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Background: This systematic review and series of meta-analyses examined the use of randomized controlled trials (RCTs) to evaluate responsive parenting interventions for infant cognition and learning (ICL). The objectives were to obtain a precise estimate of the causal influence of responsive parenting on ICL and to investigate substantive and methodological moderators that strengthen or weaken intervention effectiveness. Methods: Studies included: interventions targeting responsive parenting using an RCT design; initiated < 6 years old; included an ICL outcome (i.e., reasoning, language, executive functioning, pre-academics). Special populations (e.g., neurodevelopmental and/or hearing disorders) were excluded. The search strategy included MEDLINE, PsycINFO, ERIC, and ProQuest Dissertations & Theses (October 2021) and backward/forward searching of eligible studies. The risk of bias of included studies was assessed using the CLARITY tool. Moderators included outcome, infant, contextual, intervention, and methodological characteristics. Pooled analysis used random effects modelling, with moderation via Q-statistics and meta-regression. Results: The average age of infants at baseline was 18.8 months old (SD = 18.4 months) and 34.7 months old (SD = 18.0 months) at outcome assessment. There was a significant effect of responsive parenting interventions on ICL ((k = 54, g = .32 (95% CI .22 .42) p<.0001)). Effectiveness varied based on infant outcome domain: reasoning (g = .60), language (g = .30), executive functioning (g = .07), and pre-academics (g = .16). Moderation analyses showed domain-specific patterns, though generally showed more intervention effectiveness in lower risk samples (i.e., lower infant and/or contextual risk), and in older studies, published studies, and studies with a higher risk of bias. Limitations in primary studies were noted in transparent reporting, with relative strengths in reducing selection and detection bias. Discussion: Findings provide evidence for causal relations between responsive parenting and ICL. Findings are discussed in relation to understanding developmental and intervention science as they relate to social disparities in ICL. Future directions include the need for primary studies with underrepresented groups (i.e., fathers, adolescent parents, parental mental health), outcome domains of executive functioning and pre-academics, and improved reporting.

O.17: Infant Directed Speech

O.17.01 Es una pelota, do you like the ball? Infant-directed speech with Spanish-English bilingual parents (Ramirez Barajas)

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The goal of this research is to understand how bilingual parents adjust their speech when addressing their infants. Infant-directed speech (IDS) includes higher mean pitch, wider pitch range, and longer word durations than adult-directed speech (ADS) (Broesch & Bryant, 2015). However, there is limited understanding of how bilingual caregivers produce IDS because most IDS research has focused

on monolinguals. Studies that do compare bilinguals and monolinguals do not often compare across registers (Danielson et al., 2014).The current study addresses this gap, investigating the prosodic characteristics of IDS and ADS by Spanish-English bilingual and English-monolingual parents addressing both their infants (8-20 months of age) and an adult researcher. 20 bilingual and 20 monolingual dyads participated in 12 minute naturalistic play with 10 target objects (e.g., toy dog, lion). To collect ADS, parents spoke with a bilingual researcher about the same objects. Using Praat, we measured fundamental frequency (f0), a measure of pitch, for all target object names parents produced. Analysis 1. Bilingual vs. monolingual differences. We tested whether bilingual and monolingual parents make similar acoustic adjustments in pitch during IDS. We used a linear mixed effects model with fixed effects of Register (IDS/ADS) and Language Group (monolingual/bilingual), and by-Speaker random intercepts. Results showed that both parent groups produced higher IDS than ADS (p<.001). Bilinguals produced higher mean pitch than monolinguals (p< .001), yet, there was no interaction between language groups, suggesting that caregivers adjust pitch similarly in IDS. Analysis 2. Bilingual speakers' IDS/ADS across languages. For bilinguals, we used a linear mixed effects model to test whether the pitch difference in IDS versus ADS differs across their languages, with fixed effects of Language, Register (their interaction) and by-Speaker random intercepts. We observed one effect (Figure 1), an interaction between Register and Language (p<0.01). The IDS vs.ADS difference was greater in English than Spanish, consistent with prior evidence that American English has exaggerated IDS relative to other languages (Kitamura et al., 2001), but we further showed that this occurs within the same participants. Analysis 3. Bilingual vs. monolingual differences in repetitions. We examined how bilingual and monolingual parents adjust pitch across repetitions of target words. Prior evidence indicates that repetition shows a reduction effect in English-speaking monolingual adults (e.g., Lam & Watson, 2010). A linear mixed model, with fixed effects of Language group, Register, and Repetition (first vs. second mention), showed that in ADS, pitch decreases from first to second mention (p<0.05; Figure 2). In IDS, there was no change in pitch across the first and second repetition of target words. For bilinguals, the same consistent pitch pattern in IDS occurred when they repeated labels for the same object in a single language ("It's a dog! Look at the dog!") or across languages ("It's a dog! Mira al perro!"). Taken together, our results suggest that bilingual parents are adjusting their pitch similarly to English-speaking monolinguals and bilinguals are exhibiting similar prosodic characteristics in both of their languages.

O.17.02 Infant-directed speech might be tailored for learning phonotactics (Garcia)

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It has been proposed that infant-directed speech (IDS) has characteristics which facilitate infants' learning of prosody (Fernald & Simon, 1984) and phonemes (Kuhl et al., 1997). The present study examined whether IDS also provides cues for infants to learn the phonotactics (permissible phoneme combinations) of their ambient language. Phonotactic acquisition may be facilitated by biases such as the Sonority Sequencing Principle (SSP; Berent et al. 2011) which requires that syllables ideally rise in sonority (~ loudness) from the edges towards the nucleus (typically a vowel, Clements, 1990). Glides are the most sonorous (highest sonority index) consonants, followed by liquids, nasals, and obstruents, respectively. Steeper sonority rises (big difference between index of consonant2 and consonant1; e.g., /blik/) are more well-formed than flatter ones (small difference; e.g., /bnik/), while sonority plateaus (0

difference; e.g., */bdik/) and falls (negative difference; e.g., */lbik/) are typically ill-formed. Studies have shown that even newborn listeners prefer SSP-conforming structures compared to SSP-violating ones (Gomez et al., 2014). However, it has not yet been shown if IDS provides enough cues for an SSP generalization.

We performed corpus-based lexical statistics to investigate the degree to which the SSP affects German, a language described as following the SSP (Wiese, 1988), and whether German IDS provides cues for learning the SSP. We assessed the probability at which consonants form word-initial consonant clusters in IDS to 0;6 to 1;8 infants (database from Stärk et al., 2021, extracted from CHILDES, MacWhinney, 2000), and in adult language (CELEX lexical database, Baayen et al., 1995). For cluster type attestation, we calculated the Actual/Possible (A/P) ratio (Frisch, 2015) by dividing the number of actual consonant clusters by the number of possible clusters that the language could have if consonants combined freely. For lexical type frequency, we fitted Poisson logistic regression models to determine if sonority contour and index difference predict the type frequency of a cluster (how many words begin with a given cluster). If combinations follow the SSP, more well-formed clusters should have higher A/P values and higher lexical type frequency. Additionally, we looked at how this changes in clusters with initial "s" and "sh" which have been proposed to be exceptions to SSP (Goad, 2011).

The A/P calculations (Table 1) show that similar to the adult lexicon, sonority-rising clusters in IDS generally have higher A/P values compared to sonority plateaus and falls. However, the obstruent-glide combination which has the steepest rise does not have the highest A/P value. The logistic regression models show that in IDS, clusters with a rising contour (Est.=0.92, SE=0.43, p=0.03) and bigger sonority index difference (Est.=0.53, SE=0.22, p=0.02) have higher type frequencies; but not in clusters with initial "s" and "sh" (Figure 1). The adult lexicon seems to have the same distribution, but there are no significant effects once item variability is accounted for.

Overall, the results show that German generally follows SSP in that sonority falls are avoided. Moreover, IDS seems to present more consistent evidence for the SSP compared to the adult lexicon. This suggests that IDS is specifically tailored for infants to learn the SSP, which can guide their phonotactic acquisition.

O.17.03 Parents' pitch-increase and vowel compactness in IDS, but not vowel extension, correlate with Norwegian toddlers' vocabulary size (Rosslund)

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The acoustic features of infant-directed speech (IDS) - higher and more variable pitch, slower utterances, and larger extension of vowel space, as compared to adult-directed speech (ADS) - have been linked to toddlers' vocabulary size, as these features were claimed to make IDS clearer and, hence, easy to learn from (e.g., Kalashnikova & Burnham, 2018). Yet, IDS might differ across languages and cultures (Saint-Georges et al., 2013), be less clear than ADS, and its relation to language outcomes might depend on socio-linguistic context, children's age, and the procedures to generate and measure it. The aims of the current pre-registered study were three-fold: First, to assess IDS compared to ADS in Norwegian parents - by examining traditionally-reported IDS measures: pitch, pitch range, vowel duration and vowel space area, but also novel measures of vowel category: compactness and category distinctiveness, directly assessing the "clarity" of speech (larger vowel spaces might contain more

variable categories, e.g., McMurray et al., 2013). Second, to evaluate whether IDS/ADS differences, if any, predict the expressive vocabulary size (using the CDI; Fenson et al., 2007) in their 18-month-old toddlers. Finally, to assess whether any of the traditional and novel measures, in IDS, not the difference between the registers, predict toddlers' expressive vocabulary. Twenty-one parent-toddler dyads were recorded in the lab in Tromsø, Norway (9 girls and 11 boys, M age = 17.9 months; 16 mothers and 5 fathers, Mdn education = master's degree), while parents read a custom-based child-friendly book twice; once to their child, and once to the experimenter (order counterbalanced). The book was created such it allowed to collect multiple tokens for each of the 9 long vowels, providing a more comprehensive vowel analysis as compared to the 3 point vowels reported in previous research, and ensuring identical linguistic contexts across IDS and ADS. In sum, we identified 923 and 818 phrases and 1577 and 1527 vowels in IDS and ADS, respectively. Results of our mixed models showed that Norwegian IDS is characterized by (a) higher phrasal pitch, (b) larger pitch range, vowel duration and vowel space area, but (c) less compact vowel categories, yet (d) comparable distinctiveness of vowel categories as compared to ADS (Figure 1). Further, results of our beta-regression showed that parents' higher pitch predicted toddlers' vocabulary, $\beta = 0.72$, $p = .003$ (see Figure 2). However, when examining the acoustic measures of IDS only, parents' vowel category compactness predicted toddlers' vocabulary, $\beta = 0.50$, $p = .049$. In sum, this study provides evidence that IDS to 18-month-old Norwegian toddlers follow the same prosodic characteristics as typically reported in the literature for other languages, including vowel space extension, previously reported absent in Norwegian parents to 6-month-olds (Englund, 2017). Yet, parents' vowel categories were also more variable in IDS than ADS. Furthermore, the study indicated that increase in IDS pitch (over ADS) as well as vowel compactness in IDS, positively correlated with toddlers' vocabulary, suggesting that parents' increase in pitch when talking to their child and consistency in vowel production, can facilitate early word learning.

O.18: Environment and Motor Behavior

O.18.01 Infant containers: movement opportunities they provide and constraints they impose throughout the first year of life (Alghamdi)

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Introduction: There are a variety of infant containers (i.e., equipment that surrounds and contains infants), such as bouncers, strollers, and supportive pillows, commonly used by caregivers. These products can contain infants in one location safely, allow caregivers to transport infants, and afford infants opportunities for play. Because infant containers are common, most parents likely utilize them. Therefore, it is important to examine commercially available containers in terms of the opportunities they provide and constraints they impose on infants. Methods: We performed a systematic evaluation of commercially available containers for infants 0-12 months of age identified through an online search through Amazon and other online stores such as Target, Walmart, and buybuy BABY. The categories of containers reviewed included: 1) stationary containers (e.g., activity centers and bouncers); 2) moving containers (e.g., walkers and strollers); and 3) positional containers (e.g., supportive pillows). Trained, reliable researchers evaluated each container in terms of the position of the infant allowed by the container (i.e., supine/ reclined, prone, upright), movements afforded by the container (i.e., head, trunk, arm, leg movements), and the presence and location of toys within the container (i.e., present or not; within or out of infant's reach). Data were normalized to percentage of the total number of containers

within each age group. Results: A total of 343 containers were evaluated. Broken down by the earliest recommended age, 64.2% of the containers were for 0-3 months, 31.5% were for 4-6 months, 2% were for 7-9 months, and 2.3% were for 10-12 months. The majority of containers for infants 0-3 months old restricted body movement, especially at the trunk (Figure 1). Additionally, only 10% of the containers encouraged prone positioning across all age groups, including for infants 0-6 months old. Moreover, when analyzing the presence and location of the toys within containers, the results showed that, there were fewer containers with toys present for earlier ages, especially 0-3 months, and in 1/5 of the cases when toys were present in containers for 0-3 months, the toys did not afford manual interaction (Figure 2). Conclusion: These results provide insight about the movement, positioning, and play opportunities and constraints that infant containers provide. The findings highlight that: 1) time outside of containers is especially important for infants in the first months, since containers at that age tend to constrain movement, 2) more containers that encourage prone positioning are needed, and 3) there are opportunities, especially at younger ages, to expand learning opportunities for infants by incorporating objects more often in containers and ensuring they are positioned to afford manual interaction.

O.18.02 Development, not differences: Conjugate reinforcement training of cradle-reared infants in Tajikistan (Karasik)

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The conjugate reinforcement paradigm has been widely used to study infant learning and memory. The mobile task allows infants to manipulate their environment by actively exploring the effect of their actions. In this task, infants lie supine with one leg tethered to an overhead mobile, causing spontaneous movements of the tethered leg to jerk the mobile. Movement of the mobile is thought to be visually appealing and thereby reinforce kicking. Learning is assessed by comparing kicking when the leg is tethered to untethered periods before and after training. Previous research with conjugate reinforcement has demonstrated associative learning in 3-month-olds from typical Western childrearing traditions, which emphasize abundant opportunities to move without restriction. Preterm infants tested at adjusted ages also show increased kicking rates, but fewer infants meet learning criteria compared to infants born full-term. Differences between preterm and typically developing infants imply that associative learning is sensitive to early experiential effects on cognitive development. We applied conjugate reinforcement to evaluate learning in 3-month-old infants in Tajikistan. Tajik infants are reared in a "gahvora" cradle from birth, which restricts infants' posture, limbs, and visual input, and thus limits opportunities for unfettered movement. Infants (N=36) were observed at home in 5 3-minute phases in the mobile task: baseline, 3 learning trials, and extinction. We coded the frequency of infants' tethered leg extensions from video in all 5 phases. To assess motor abilities and general activity level, infants' spontaneous movements were video-recorded for 20 minutes. Mothers reported daily gahvora use in time-diaries and responded about infants' temperament (IBQ). We expect that the rate of associative learning depends on rate of spontaneous leg kicks. Because gahvora experience reduces spontaneous leg movements, and learning in the mobile paradigm is thought to depend on accrued experience associating leg movements with their consequences, we hypothesized that Tajik infants will show slower rates of learning relative to Western full-term and preterm infants. We further expect that individual differences in activity level or temperament will predict how infants' respond to conjugate training. Preliminary data from 8 Tajik infants demonstrated learning during the session. Rates of kicking

increased over training trials and remained elevated during extinction, M = 7.25 kicks/minute, compared to baseline, M = 3.50 kicks/minute, p<.05. But, kicking rates were significantly lower relative to Western full-term and pre-term infants (Fig.1). We will test whether individual differences (i.e., gahvora experience, temperament, sex, motor abilities, hours since cradled) predict performance in the task. Conjugate reinforcement may be useful in exploring cultural differences by integrating spontaneous motor activity, visual attention, arousal, and self-regulation. More important, patterns of learning in Tajik infants can shed light on how experience contributes to the process of motor development. By exploring child development from a wider cultural perspective, we hope to broaden our developmental theories and knowledge that can inform practices and intervention strategies for children around the world.

O.18.03 Developmental and real-time influences on infant locomotor activity: Effects of locomotor status and toy dispersion (Hospodar)

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The onset of independent walking fundamentally changes infants' interactions with the world. When infants transition from crawling to walking, they can cover more ground in less time (Adolph et al., 2012). Walking also provides access to a larger visual field--crawlers primarily see the ground in front of their hands, whereas walkers' higher vantage point allows them to see the whole room (Kretch, Franchak, & Adolph, 2014). But is a faster speed and higher vantage point always beneficial for locomotion, or are advantages dependent on the environment? Here, we tested the effects of locomotor status in two environmental conditions and video-coded how much infants moved in each condition. Using a within-subjects design, we tested age-matched crawling and walking infants (M = 12.5 months; range = 11.5 - 14.1 months) during free play with their caregivers in two 10-minute conditions in which we varied the proximity of interesting destinations--toys clustered in one location versus dispersed around the room. We report preliminary data from 11 crawling and 5 walking infants (by the time of presentation, expected ns = 20 per group). We predicted main effects for locomotor status and toy condition--that is, we predicted that walkers would move more than crawlers overall, and that both crawlers and walkers would move more in the toys-dispersed condition compared to the toys-clustered condition. We also predicted an interaction between locomotor status and toy condition, such that walkers would move most in the toys-dispersed condition. Our preliminary results largely support our predictions, although our full sample is needed for adequate power. Averaged across conditions, walkers spent more time in motion (M = 29.2%) than crawlers (M = 11.0%), supporting a main effect of locomotor status, t(14) = -4.64, p<.001 (Figure 1A). With crawlers and walkers collapsed to one group, infants tended to spend more time in motion in the toys-dispersed condition (M = 19.2%) compared to the toys-clustered condition (M = 14.1%), albeit the difference was not significant, t(14) = -1.68, p = .11 (Figure 1B). Most important, as predicted, we found preliminary evidence for an interaction between locomotor status and condition: Walkers moved more in the toys-dispersed condition compared to the toys-clustered condition (M difference = 10.8%), whereas the mean difference for crawlers was only 2.5%; however, change scores were not significantly different between crawlers and walkers, t(14)= -1.30, p = .22 (Figure 1C). Thus, the complete data set is needed to confirm our preliminary findings. Assuming our predictions are supported by the full sample size, why would walkers display an advantage over crawlers only in the toys-dispersed condition? The faster speed and higher vantage point for

walkers might only be beneficial when the locations of interesting objects are spread throughout the room, as they were in the toys-dispersed condition. In the toys-clustered condition, walking provides no advantage. Our findings suggest an interplay between developmental and real-time factors, such that the interaction between locomotor status and environmental conditions shapes infants' locomotor activity.

O.18.04 Posture Support and Naturalistic Object Interactions in Six-Month-Old Infants (Malachowski)

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Infants' manual interactions with objects are critical for development (Franchak, 2020; Muentener et al., 2018). While playing with objects, infants learn about object properties (Slone et al., 2018), enhance their motor actions (Libertus et al., 2016), and learn the names of objects (West & Iverson, 2017). Early interactions with objects may also trigger a developmental cascade linked to cognitive skills, such that object play in early infancy uniquely predicts IQ in toddlerhood (Muentener et al., 2018) and even academic achievement in adolescence (Bornstein et al., 2013). However, despite the known benefits of object interactions, we still know very little about infants' day-to-day experiences with objects, or the "natural input to learning" (Herzberg et al., 2021). A recent study indicated that crawling and walking infants accumulate a vast amount of experience interacting with objects across a typical day (Herzberg et al., 2021). However, before infants can crawl or walk, and even before they can sit independently, their opportunities for object interaction are determined by the actions of their caregivers. Postural support is one factor that may shape an infants' opportunities for object interaction. For example, pre-sitting infants spontaneously engaged in more object interaction when physically supported by a caregiver compared to when lying supine or prone (Soska & Adolph, 2014). In another study, pre-sitting infants engaged in more object contact when given full sitting support (i.e., in a Bumbo? floor seat) compared to when given minimal sitting support (Woods & Wilcox, 2013), perhaps because postural support frees up cognitive resources that would otherwise be focused on balance. However, because these studies were conducted in controlled laboratory settings, it remains unclear how postural support may shape infants' interactions with objects in more naturalistic settings. We observed video data of 38 6-month-old infants in their homes (SEEDLingS dataset; Bergelson, 2017). Using Datavyu (datavyu.org), we marked the onset and offset of each unique location where the infant spent time (lasting at least 30 seconds). Each location fell into one of three categories: places with no postural support (e.g., lying supine on the floor), places with support from a seating device (e.g., bouncy seat, exersaucer), and places with support from a caregiver (e.g., held, caregiver supporting infant's midsection as they play on the floor). We then marked the onsets and offsets of infants' "bouts" of object contact (i.e., manually interacting with a toy or object). In aggregate, 76.13% of object contact time occurred while infants were supported either by a caregiver or a seating device (orange colors in Figure 1). Additionally, caregiver support represented a significantly greater proportion of total object time (41.68%) compared to no postural support (23.88%), $F(2,111)=3.175$, $p=.0456$ (Figure 2). Overall, these results are consistent with previous lab-based findings that postural support promotes object interaction (Soska & Adolph, 2014; Woods & Wilcox, 2013). While some 6-month-old infants do engage in exploration without postural support (as represented by the blue in Figure 1), providing postural support in the home context may be a key component of infants' early interactions with objects.

O.19: Autism

O.19.01 Do Toddlers' Age and Sex Impact Parental Reports of Early Signs of Autism Spectrum Disorder? A Moderated Nonlinear Factor Analysis (Chen)

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Objective: The use of parent-report screeners for early detection of autism spectrum disorder (ASD) is time- and cost-efficient in clinical settings but their utility may be influenced by factors such as family and child demographics. The First Years Inventory version 3.1 (FYIv3.1) is a parent-report questionnaire for identifying early risk markers of ASD among general populations of infants aged 6-16 months, comprising 7 constructs tapping social communication, sensory-regulatory functions, and motor development. This study aimed to examine the degree to which child's age and sex impact their parent's endorsement of items about early signs of ASD and evaluate whether item-level biases (i.e., differential item functioning, DIF) impact construct-level estimation of ASD risk in a heterogeneous community sample. Methods: Participants were 6,636 caregivers of infants who were recruited through the North Carolina state birth registry and returned the FYIv3.1 questionnaire. The final sample for analysis included 6,454 infants with complete data (<25% missingness) and corrected chronological ages 6 to 16 months. We leveraged moderated nonlinear factor analysis (MNLFA), a novel method that expands upon traditional factor analysis and item response theory for assessing and adjusting for DIF, on each of the 69 FYI items with child's corrected age, sex, and their interaction term as covariates. To assess the cumulative DIF impact at the construct level, differences were compared between latent factor scores derived from the baseline model (impacts on latent mean and variance) and those from the final MNLFA model (impacts on latent mean and variance as well as DIF). Results: Younger infants tended to have higher latent factor means in constructs related to social communication and motor development (|β|=.04 to .37, p all<.001) but a lower factor mean of sensory hyperresponsiveness (β=.06, p<.001). Boys on average had higher latent means across almost all constructs (|β|=.07 to .23, p all<.05). A total of 17 items were flagged with DIF in small to medium effect sizes and most of the biases were related to age (Table). In most of these items (e.g., "walking" and "object mouthing"), the response categories that indicate higher risk were more likely to be endorsed by parents of younger infants (β=-.17 to -.04, p all<.001, rs=.11 to .27) when holding traits constant. The sex-related bias was most prominent for the item "typical play with toys" (β=.28, p<.001, d=.26; i.e., less frequent typical play for girls). At the construct level, cumulative DIF effects only resulted in salient changes in factor scores for certain domains among a small number (<2%) of participants (Figure). Conclusions: Overall, more items related to social communication and motor development showed larger DIF, particularly age DIF, consistent with our expectation that some of these behaviors emerge or mature at different age points during infancy. These findings have critical implications for the utility of the FYI as well as other early screening tools when being applied to a broader age range at infancy. Accounting for measurement variance using psychometric strategies, such as MNLFA, can help to minimize biases and thus properly estimate the risk associated with ASD.

O.19.02 Developmental trajectories of motor and language skills in infants with and without Autism Spectrum Disorder and their relationship to future outcomes and services received. (Bhat)

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Objectives: Autism Spectrum Disorder (ASD) can be reliably diagnosed between 2 and 3 years of age making it possible for families to gain access to early intervention and improve future outcomes (Zwaigenbaum et al., 2015). The earliest reliable markers of ASD are communication delays in the second year, but there are no reliable markers of ASD within the first year. Fine and gross-motor delays are often reported in infants at-risk for ASD within the first year however they are not found to be ASD-specific (Ozonoff et al., 2008; Iverson et al., 2019). The present study examined the relationship between early motor delay, future communication delay, and ASD outcomes/severity in a large sample of children with ASD and those without ASD (unaffected siblings of children with ASD) from the SPARK cohort (N for ASD ~ 18,000, N for Non-ASD ~ 9,000). Methods: Parents of children with and without ASD (unaffected siblings) were asked to recall their child's motor and communication milestones for when their child first (i) sat without support, (ii) crawled, (iii) walked alone, (iv) used words, (v) fed self with spoon, (vi) combined words, and (vii) combined phrases using pictures and videos. They also completed the Vineland Adaptive Behavioral Scales (VABS), a measure of adaptive functioning as well as ASD-related outcomes of social communication performance using the Social Communication Questionnaire (SCQ), repetitive behavior severity using the Repetitive Behavior Scales-Revised (RBS-R), and motor performance using the Developmental Coordination Disorder-Questionnaire (DCD-Q). Results: Kaplan-Meier estimates of probability of time to skill acquisition were calculated. In the first year, compared to children without ASD, children with ASD had mild to moderate gross-motor delays of 1-3 months. In the second year, children with ASD had moderate to severe gross-motor and fine-motor delays of ~4-18 months. In the third year, children with ASD had substantial fine-motor and language delays of ~12-33 months. Significant group differences were confirmed using the Wilcoxon Group Homogeneity test (ps < 0.0001). The motor and language milestone acquisition data were also used to predict future ASD outcomes using logistic regression analyses. Language milestones predicted future ASD outcomes (area under the curve/AUC=0.82) but that was only possible by around 2 years. However, gross / fine-motor milestones in the first year predicted a future ASD outcome with 74% probability (AUC=0.74). Conclusions: Infants who later developed ASD, had mild to moderate gross-motor delays in year 1, moderate to severe gross and fine-motor delays in year 2, and moderate to severe language delays between 2 and 3 years of age. Additionally, gross and fine motor delays are able to predict a future ASD outcome with 74% probability. These data call for gross and fine motor delays to be included within early ASD screening tools. Infants at-risk for ASD should be screened for early motor delays and should receive early motor interventions to provide them the motor means to communicate and socially interact with their caregivers.

O.19.03 Relating motor and communication development in young children with autism spectrum disorder (ASD) and those without ASD from the SPARK study cohort (Bhat)

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Objectives: Communication delays are one of the earliest reliable markers of Autism Spectrum Disorder (ASD) in young infants who later develop ASD. Fine and gross motor delays are also often reported in young infants who later develop ASD; however, they are not considered ASD-specific. Moreover, the relations between motor and communication development in typically developing young infants are well-recognized. However, the relations between early gross and fine motor development as well as

later language development/outcomes have not been studied in large samples of children with ASD to understand if there are any sub-phenotypic patterns to the relations between early motor and later language delays in children with ASD. In the present study, co-occurrence of motor and communication delays were studied in young children with ASD from the SPARK study cohort (N for ASD = 18,000; N for non-ASD = 9000). Additionally, relations between early motor and communication milestones and future outcomes (with ASD / no ASD) as well as differing levels of ASD severity (subgroups based on SCQ, RBS-R, and DCD-Q performance) will be reported. Methods: Parents of children with and without ASD (unaffected siblings) were asked to recall their child's motor and communication milestones for when their child first (i) sat without support, (ii) crawled, (iii) walked alone, (iv) used words, (v) fed self with spoon, (vi) combined words, and (vii) combined phrases using pictures and videos. The Vineland Adaptive Behavioral Scales (VABS), a measure of adaptive functioning, ASD-related outcomes of social communication performance using the Social Communication Questionnaire (SCQ), repetitive behavior severity using the Repetitive Behavior Scales-Revised (RBS-R), and a motor performance measure using the Developmental Coordination Disorder-Questionnaire (DCD-Q) were also obtained. Results: Based on milestone acquisition data and normative values for skill acquisition from standardized tools (Piper & Darrah, 1994, Stanford Wordbank), all children with ASD were categorized into four subgroups: (a) Yes motor-Yes communication delay, (b) No motor-No communication delay, (c) Yes motor-No communication delay, and (d) No motor-Yes communication delay. Majority of children with ASD showed alignment in delays across motor and communication domains with 51-70% of children with ASD showing a co-occurrence of no delay in both domains or a co-occuring delay across motor and communication domains. Of those, "independent walking" (58% of N=14,659) and "feeding self" (70% of N=13,300) had a larger co-occurrence of motor and communication delay/no delay. Next, the prevalence for early motor and communication delays as a function of increasing levels of social communication impairment (SCI) using the Social Communication Questionnaire (SCQ) was examined. For early motor skills such as walking and feeding self, as well as the communication skill of "using words", an increase in social communication impairment was associated with greater prevalence of moderate to severe motor or communication delays. Similar relationships will be explored between early motor/communication milestones and repetitive behaviors, cognitive, functional and language delays. Conclusions: Early gross and fine-motor delays provide a window for identifying future communication delays as well as future ASD outcomes. It is important to assess early motor skills to improve the sensitivity of early screening tools. Last but not the least, early motor interventions may provide at-risk infants with a means for social interaction and communication with caregivers and should be included within early ASD interventions.

O.19.04 Information-theoretic metrics of statistical causality for identifying developmental cascades in infancy: vocal development in ASD (Ramsay)

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Developmental cascades occur when changes in dynamical processes that shape the ontogenetic landscape propagate, interact, and spread over time into other processes to create lasting downstream alterations in pathways of development. Identifying developmental cascades through measurement or manipulation is challenging, requiring methodologies that are capable of distinguishing temporal

causality from correlation or covariation in large-scale, multi-level, longitudinal data sets that are difficult to acquire and analyze. This is an important area of investigation, since research on early detection and intervention for many neurodevelopmental disorders that unfold from infancy through adulthood often centers on resolving these issues. The goal of this study was to apply new information-theoretic metrics of statistical causality to densely sampled, longitudinal measures of vocal behavior in order to identify developmental cascades leading to altered outcomes in infants at risk of Autism Spectrum Disorder (ASD). We aimed to test the hypothesis that early deficits in social interaction, a core deficit defining the condition, drive later disruptions of vocal behavior in infant and caregiver. As part of an NIH Autism Center of Excellence (NIH P50 MH100029), we tracked vocal development among 45 high-risk infants with a family history of ASD and 35 low-risk controls. Each child wore a recording device (LENA) for one day every month from 0-24 months to provide audio recordings of their natural language environment. Using speech recognition technology, we identified the number of vocalizations per hour for infant and caregiver, and calculated the rate of contingent interactions based on timing statistics. We also took random samples of infant and caregiver vocalizations during periods of interaction, and used multitaper harmonic analysis to calculate fundamental frequency statistics characterizing the prosody of infant-caregiver exchanges. Using Functional Data Analysis, we determined developmental trajectories for all of these measures for each infant-caregiver dyad. Adopting Wiener's definition of statistical causality, we calculated the transfer entropy between each ensemble of trajectories to determine the dependence of the future unfolding of each measure on the past history of every other measure, above and beyond what can be predicted from its own past history. We determined the resulting graph of information transfer, and used permutation tests to identify significant asymmetries in the magnitude and direction of information flow between measures as evidence for developmental cascades. Across groups, we found that early deviations in infant-caregiver contingency drove later differences in caregiver, then infant, volubility. We also found that elevated fundamental frequency in caregiver infant-directed speech was driven by infant-caregiver contingency and by elevated infant fundamental frequency, but the reverse was not the case. We found significant differences in all of these measures associated with autism. These results suggest a developmental cascade in infant-caregiver vocal signaling and response involving separate endogenous and social pathways of development that are driven differently in infant and caregiver by contingent interaction, both of which pathways are serially disrupted in ASD.

O.20: Parental Responsiveness

O.20.01 Parental screen time and toddlers' language development (Nguyen)

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Our society is concerned about the effects of mobile devices on children's language and cognitive development. Many studies have reported an association between excessive screen time (time spent using an electronic device) in young children and language delays (e.g. Zimmerman, Christakis, & Meltzoff, 2007). However, most research in the field of social media analyses the effects of their use in children and teenagers instead of focusing on the parents' screen time. Parental screen time could affect children's language development in various ways, by reducing the number of exposure opportunities and/or disrupting learning interactions (Reed, Hirsh-Pasek, & Golinkoff, 2017). In two studies we investigated whether parental screen time affected toddlers' language development. In the first study,

parents of 117 children aged 11 to 26 months completed the Oxford Communicative Development Inventories (CDI) prior to completing a questionnaire estimating their own daily screen time. Results showed that the more time parents spend on screen while their child is around, and the less words children produce. A second study was run to replicate this result with more objective measures of language skills and parental screen time. Fifty-five children aged 19 to 26 months took part and their parents were asked to report their daily smartphone usage by answering a daily questionnaire during one week, including reporting the total number of hours per day as displayed by their phone inbuilt app. Due to the COVD-19 restrictions, 32 children performed the language assessment test, the WinG test (Cattani, Krott, Floccia, & Dennis, 2019) online via the Zoom application. Then, 23 children did the WinG test face-to-face at the University Babylab. The WinG test consists of a series of 3 cards depicting common objects, and participants were asked to point to which one corresponds to a word produced by the experimenter (e.g. 'dog'). It provides a measure of comprehension and production for words and predicates. The CDI and a demographic questionnaire were also completed by the parents. Results collected so far do not provide indication of parental screen time effects on children's language development. It was found that parents reported spending on average 8 min per day on their phone while their child is around, which might not be significant enough to impact children's vocabulary. However, this contrasts with data from the first study where parents reported an average of 1.14 hours of daily screen time while with their child. Incidentally we found higher language scores for children who did the WinG online as opposed to those who did it in the Babylab, which suggests a strong effect of distraction when the environment is unfamiliar. Regarding the effect of parental screen time on vocabulary knowledge, we are planning to replicate Study 2 by asking parents to report hour per hour screen time activity, in an attempt to obtain a more accurate picture of their engagement.

O.20.02 Complementary feeding and maternal responsiveness in 8-month-old infants (Addessi)

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In many Western countries, infants are traditionally introduced to solid foods through spoon-fed pureed foods (parent-led weaning [PLW]), but an alternative approach known as "baby-led weaning" (BLW) has become increasingly popular. With BLW, children participate in family meals and, when they show interest, caregivers provide food that they can eat independently. BLW is not recommended by the WHO Guidelines on Complementary Feeding; however, these guidelines advocate "responsive feeding", i.e., feeding in response to the child's hunger and satiation. Responsiveness to feeding cues is central to the hypothesis that a mismatch between a child's internal state and the caregiver's behavior may alter self-regulation in food consumption and increase the risk of being overweight. Responsive feeding has important implications beyond eating behaviour, as feeding cues are among those infant cues that promote the development of a secure attachment with the caregiver. We investigated the relationship between the complementary feeding method and maternal responsiveness to infant feeding cues in 159 Italian typically-developing 8-month-old infants. Mothers reported the complementary feeding method used (PLW, BLW, or mixed), and provided demographic information. We recorded one meal for each child during a videocall and then coded information including the type of food consumed (puree food,

finger food or mix) and the proportion of time the infant self-fed. To rate the maternal responsiveness to infant hunger and satiety cues, we scored the videos using the Responsiveness to Child Feeding Cues Scale (Hodges et al., 2013). Maternal responsiveness to infant receptiveness and fullness cues were significantly correlated (r = .270, p = .001), but mothers were more responsive to infants' receptiveness than fullness cues (t157 = 9.138, p < .001). Multiple linear regressions tested whether gender, siblings, maternal education, proportion of self-feeding, exclusive breastmilk, and weaning age were related to responsiveness. For responsiveness to receptiveness the regression was not significant (R2 =.063, F6,142 = 1.594, p = .153). For responsiveness to fullness the regression was significant (R2 =.121, F6,143 = 3.281, p = .005); maternal education was negatively related to the dependent variable (β = -.220, p = .007), whereas proportion of self-feeding was positively related to it (β = .232, p = .005). Responsiveness to feeding cues did not significantly differ depending on complementary feeding method (receptiveness: F2,153= .712, p = .492; fullness: F2,154 = .291, p = .748) or food type (receptiveness: F2,155= .921, p = .400; fullness: F2,156= .209, p = .812). Our results parallel Hodges et al.'s (2013) findings, indicating higher maternal responsiveness to infant receptiveness than fullness cues, possibly due to an evolutionarily ancient drive to protect infants against hunger. We also provide, for the first time in a sample of young infants of the same age, observational evidence that infant self-feeding relates to higher level of maternal responsiveness to fullness cues. These findings suggest that a complementary feeding approach that emphasizes independent feeding may promote more infant-centered maternal responses at the end of the meal, with potential implications for better infant self-regulation and possibly socio-emotional development beyond the weaning period.

O.20.03 Building resilience: Sensitive caregiving in infancy shapes future preschooler stress response to Covid-19 (Schlesinger)

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Decades of developmental science establish infancy as a sensitive time window, during which foundations of future resilience are laid. Research in high-risk cohorts demonstrate detrimental impact of infant neglect on later child maladjustment. Surprisingly, less research investigates the ways in which optimal infant caregiving, provided in normative/healthy populations, might crucially foster child resilience to future environmental stressors. The COVID-19 pandemic serves as a large-scale psychosocial stressor posing detrimental impact on children's mental health (e.g., Nearchou et al., 2020; Racine et al., 2020). Importantly though, severity of children's emotional/ behavioral symptoms vary considerably. For some children, exposure to Covid-related psycho-social stressors (termed as "dose of exposure", DOE) appears to be detrimental, while others display resilience. Critically, COVID-19 inflicts not only the child but also his/her caregivers. Elevated stress in the caregiver himself, may compromise caregivers' capacity to provide optimal real-time buffering of child stress (Chung et al., 2020). We propose that in the context of elevated caregiver stress, children will be particularly vulnerable to detrimental effects of DOE, (i.e. caregiver stress will moderate links between DOE and child symptomology). We further propose that while children's stress-response may largely depend on parental buffering of stress in real-time - when parents are experiencing elevated stress themselves, children might draw on resilience which was acquired prior to stressor-onset, in infancy. Specifically, we propose that normative variations in sensitive caregiving experienced in infancy may shape children's response to future large-scale stressors. We conducted follow up assessments on a cohort of preschool

children (N=181), previously assessed 4 years ago, during infancy. Early maternal sensitivity was assessed at 4-months via observed mother-infant interactions. Follow up assessments were conducted during a COVID-19 nationwide lockdown when children were 36-60 months old. Mother-child interactions were recorded remotely, and mothers reported on children's DOE and concurrent emotional/behavioral symptoms. Structural Equational Modeling tested the two proposed models (Figures 1 and 2). Model A revealed that DOE significantly predicted children's internalizing symptoms (β =.19, p < .01) and maternal stress during lockdown (β=.16, p<.05), which in turn significantly predicted children's internalizing symptoms (β=.51, p<.001). Furthermore, maternal stress during lockdown significantly moderated links between DOE and child internalizing symptoms (β =.13, p <.05), such that DOE positively associated with children's internalizing symptoms when maternal stress was high (β = .32, p<.001) but not when maternal stress low (β =.07, p =.45). Finally, Model B revealed significant moderating effects of early maternal sensitivity, above and beyond those of concurrent maternal stress (β =-.16, p =.04). Children who experienced low levels of maternal sensitivity during infancy, revealed significant links between DOE and concurrent internalizing symptoms (β =.37, p <.001), whereas children who experienced high levels of maternal sensitivity during infancy, revealed no such Covid-related effects (β =.06, p =.60). The present study is the first to demonstrate that sensitive caregiving experienced in infancy may shape children's response to future large-scale stressors.

O.21: Methods

O.21.01 Adapting infant looking time paradigms for the web (Li)

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Paradigms like head-turn preference procedure (HPP: Nelson, Jusczyk, Mandel, Myers, Turk, & Gerken, 1995) have been crucial to the study of language acquisition in infants, but remain difficult to conduct due to the highly controlled lab settings they require. While researchers have successfully adapted preferential looking paradigms to collect data from infants over the web (e.g. Scott, Chu, & Schultz, 2017), paradigms like HPP remain restricted to the lab. In the present study, we provide the first demonstration that HPP can also be adapted successfully for web data collection. To illustrate, we conducted an online replication of Shi, Cutler, Werker and Cruickshank's (2006) Experiment 1, which employed the central-fixation adaptation of HPP to determine whether functors like 'the' facilitate the extraction of novel nouns in 11 month olds. We leveraged the Lookit platform (https://lookit.mit.edu/) to recruit and run this experiment online. As in Shi et al. (2006), infants heard six familiarization trials alternating between two novel nouns: one preceded by 'the' and the other by 'kuh' (e.g. 'the breek' and 'kuh tink'). At test, infants heard four alternating trials of 'breek' and 'tink' in isolation. All trials were a fixed length (16s) and started automatically after a 5s attention getter video of a laughing baby. We coded the webcam videos (captured by Lookit) for how long the infant looked at the screen during each trial -- a measure of infant attention to the auditory stimulus. If infants use functors to extract novel nouns, they should look longer to the novel noun familiarized with 'the'. We made several modifications to adapt the study for the web (see Table 1). Because compliance was unlikely in an unsupervised online study, parents were neither asked to close their eyes nor to wear headphones. Rather, we instructed parents to simply hold their baby on their lap, in view of the webcam. Because home was likely more distracting than the lab, babies were assigned to one of two conditions: low visual interest, where babies saw a checkerboard on each trial, and high visual interest where babies saw a different toy

popping out of a box each trial. Participants were 62 11-month olds: 14 in the low interest condition, 29 in the high interest condition, and 19 excluded based on the criteria in Table 1. Similar to Shi et al. (2006), to determine whether infants looked longer to 'the' nouns, we calculated each infant's total looking time to 'breek' and 'tink' at test. In a mixed effects regression, functor ($X2(1)=5.58$, $p=0.02$) and condition ($X2(1)=5.11$, $p=0.02$), but not their interaction were significant predictors of looking time. Thus, while infants in the high interest condition looked longer overall, we replicated Shi et al. (2006) in both conditions: infants looked longer to the noun familiarized with 'the', indicating that functors indeed facilitate the extraction of novel nouns (see Figure 1). This suggests HPP can be used to collect infant data over the web as well, indicating new opportunities for infant studies during the pandemic and in the future.

O.21.02 Estimating the rate of behavior: Optimal combination of sample size and observation duration (Han)

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Estimating the rate of behavior is essential to infancy research. To do so, researchers must observe some infant(s) for some duration of time. Due to limited resources and the practicalities of data collection, researchers must decide whether to include more infants in the sample (perhaps to increase sample size or diversity) or to increase the observation duration for each infant (juggling infant compliance and researchers' time). Which strategy best captures the true rate of behavior--more infants or longer observations? That is, with a fixed total observation time (say, 6 hours), what is the optimal combination of the number of infants and observation duration per infant (e.g., observe 30 infants for 10 minutes each or 15 infants for 20 minutes each)? We simulated how systematic variations in sample size and observation duration affect estimates of the rate of behavior. Here, locomotion served as the exemplar behavior. We video recorded two 2-hour visits of natural activity in 36 13-, 18-, and 23-month-old infants and coded each bout of locomotion (each time infants moved by crawling, walking, etc.). We considered the average rate of locomotor bouts per hour (M = 182) across all 144 hours of data as the "best estimate." We simulated the rate of locomotion as if we had observed 1-36 infants (x-axis in Figure 1) for 1-120 minutes per infant (y-axis in Figure 1) for a total of 4320 (36×120) sampling combinations (shown by the grid in Figure 1 created by the intersections of each X,Y value) to compare estimates from each sampling strategy to the "best estimate" derived from the original dataset. For each combination, we randomly selected the corresponding number of infants from the original sample and a snippet of the corresponding duration from each of the selected infants' videos. We computed the average rate of locomotion with the selected video snippets as one simulation (extrapolated to an hourly rate), and repeated the simulation 2000 times (with different random samples) for each combination. We computed the Root Mean Square Error (RMSE) to quantify the average distance of the 2000 simulated estimates from the "best estimate." Lower RMSE reflects more accurate estimates (e.g., the lowest RMSE is for 36 infants with 120-minute observation, the highest is for 1 infant with 1-minute observation). As shown on the z-axis, RMSE decreased as the number of infants and observation duration increased, indicating that estimates are more accurate with larger sample sizes and longer observation durations. Then, we applied a hypothetical total resource constraint of 6, 12, and 18 total hours of data collection. The red, blue, and green curves show all combinations that meet those constraints. Combinations with more infants had lower RMSEs (see colored boxes along the left edge of

each curve). Results suggest that increasing the number of infants is more beneficial than increasing observation durations. We extended the simulation to a less frequent behavior--falling--and the results remained the same. Because interindividual variability is typically larger than intraindividual variability, we obtain better estimates when we sample more infants.

O.21.03 Assessing sensorimotor synchronisation and executive function in toddlers using LookIt and automated movement extraction. (Addyman)

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Adapting gross motor movement to match the tempo of auditory rhythmic stimulation (sensorimotor synchronisation; SMS) is a complex skill with a long developmental trajectory. Achievement of SMS may be related to developing inhibitory control, an executive function that involves overcoming a dominant response to perform an alternative response. In the current study we ask 24-30-month-old toddlers to drum along with the audiovisual presentation of four steady rhythms, using videos of isochronous drumming at 400, 500, 600 and 700 ms IOI, and to provide their spontaneous motor tempo (SMT) by drumming in silence. Toddlers' drumming is observed from video recordings made in participants' own homes, obtained via the Lookit platform for online infant studies (Scott & Schulz, 2017). Caregivers are additionally asked to complete the Early Executive Function Questionnaire online (Hendry & Holmboe, 2021). We predict that toddlers with strong inhibitory control skills will be better able to move away from their SMT and synchronise with the stimuli, due to better ability to suppress their natural rate of movement and adapt to the sounds they are hearing. Our novel approach to coding infant rhythmic behaviour uses the OpenPose software for markerless motion tracking (Cao, Hidalgo Martinez, Simon, Wei & Sheikh, 2019). OpenPose labels each frame with wireframe estimates of hand and body location (see Figure 1). The vertical displacement of hand can then be extracted and the power and frequency of infants rhythmic entrainment can be measured using Fast Fourier Transforms (see Figure 2). Analyses are preregistered on AsPredicted.org, and data have been collected from 45 toddlers of the preregistered sample size of 60. Our results demonstrate the feasibility of a fully digital approach to measuring rhythmic entrainment from within the participant's home, from early in development, and shed light on a potential mechanism of developmental change related to higher-order cognitive processes.

O.21.04 Estimating cumulated experience from short samples: from opportunistic to distributionally-informed sampling of infants' everyday lives (Anderson)

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Introduction. Theorists often extrapolate from sampled experiences in order to estimate quantities that matter for theories of experience-dependent change. For example, extrapolated numbers of encountered words (Hart & Risley, 1995), music (Mendoza & Fausey, 2021), faces (Jayaraman et al., 2015) and motor actions (Adolph et al., 2012) guide theory about early human development. These theory-relevant quantities are linear extrapolations from short samples. The underlying assumption that infants re-live their sampled experience all life long is highly suspect because experiences depend on activity contexts and infants' own abilities that vary over hours, days, months,

and years (d'Apice et al., 2019; Fausey et al., 2016; Iverson, 2021; Tamis-LeMonda et al., 2018; Soderstrom & Wittebolle, 2013). In order to move beyond an opportunistic and suspect status quo, we need quantitative modeling of everyday dynamics at multiple nested timescales for any domain central to theories of experience-dependent change (Montag et al., 2018). Here, we use one corpus of infants' densely sampled audio experiences to address one foundational question: If we sample one hour of infant-available speech and linearly extrapolate to three days of speech, does it matter which hour we sample? Method. Infants (N=34; ages 6 to 12 months) wore a digital language processor (LENA; Ford et al., 2008) at home for three days within one week (Fausey & Mendoza, 2018). Here, we focus on infant-available speech given its central role in developmental theory and practice (Hart & Risley, 1995; Purpura, 2019). We analyzed automatic estimates of "Adult Word Counts" (see Cristia et al., 2020 for high concordance with manual transcription) in 102 daylong audio recordings (Mdn=11.94 waking hours per day). Results. Infants did not re-live the same hour all day long (Fig. 1). Infants encountered between 0 and 7,595 words per hour (Mdn=668.20, IQR=1,342.89 per day). On average, the single most verbose hour per day accounted for 27% of that day's infant-available speech. We implemented four hourly sampling schemes (used in extant literature) from which to extrapolate. From each day, we sampled one: random continuous hour, most verbose continuous hour, median continuous hour, and constructed hour summing 120 random 30-second segments. We multiplied the Adult Word Count of each sampled hour by the total number of hours across the infant's 3 days to yield the extrapolated estimate. The sampled hour mattered for extrapolated estimates (Fig. 2; F(3,303)=261.09, p<.001). Linearly extrapolating from an infant's constructed hour most closely matched their observed cumulated speech quantity (Mdn=-3% difference between extrapolated and observed estimates). Linearly extrapolating from an infant's most verbose hour dramatically overestimated (Mdn=199% difference), and from their median hour underestimated (Mdn=-24% difference), their cumulative speech experience. Linearly extrapolating from a randomly sampled hour yielded unstable cumulative estimates (from -100 to 420% difference). Next steps. An emerging priority in the science of experience-dependent change is to enable moving sensibly from our samples of everyday experience to models of cumulated experience. Distributionally-informed sampling, as shown here for infant-available language, harnesses structure across multiple timescales en route to this goal (Adolph et al., 2008; Cychosz et al., 2021).

O.22: Attention

O.22.01 Focused Attention as a Nascent Marker of Attention Competence and Learning: The Implications of Preterm Birth and Congenital Brainstem Compromise (Burstein)

Or Burstein[1], Lea Kurtzman[1], Ronny Geva[1]

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The ability to selectively focus our attention when we interact with one another or explore objects is an important developmental landmark that could be discerned from 10 months. This ability termed Focused Attention (FA) signifies the transition from mere orienting behavior to goal-driven learning. Preterm birth has been frequently associated with durable attention deficits. In a recent meta-analysis, we demonstrated that preterm birth is a risk factor for impairments in FA ability, noted already in infancy (Burstein et al., 2021); yet, the mechanism accounting for the increased susceptibility is still largely unknown. FA relies on brainstem hubs that amplify the markings of sensorial inputs through modifications of arousal. Compromised brainstem functions (CBF) are a frequent sequela of preterm

birth (Stipdonk et al., 2016) that may explain difficulties in presenting a sufficient repertoire of focused and arousal-charged exploratory behaviors. Hence, we aimed to explore two hypotheses: 1) The integrity of the brainstem in neonates born preterm is related to the establishment of FA ability when it emerges at the second year of life; 2) FA deficit at infancy is a precursor of both short and long-term language and learning difficulties. We recruited a sample of very-to-moderate preterm born babies upon birth. During their NICU stay, auditory brainstem evoked response (ABR) tests were conducted to evaluate CBF status (determined by delayed latencies of wave peaks III and V following the exposure to standardized auditory stimulations). Most of the sample demonstrated expected ABR response patterns according to corrected age norms (n = 83), while 45 babies were classified with neonatal CBF. To establish a control group, generally healthy, full-term born infants (n = 48) were recruited during the same period. We assessed infants' FA ability in a free-play task and verbal comprehension using the Reynell Developmental Language Scales (Reynell & Gruber, 1990). The findings indicated that preterm birth was associated with a diminished frequency of FA during free exploration of toys and that CBF exacerbated the pervasiveness of FA deficits (Fig 1A). A discriminant analysis (Thomas, 1992) further evinced that when considering FA together with less arousal-charged forms of attention (i.e., mere orienting to stimuli and distractors), FA was the prominent factor for group differentiation (Canonical r = .46, $\chi 2(6) = 43.7$, p < .001; Fig 1B), accounting for almost the entire grouping effect (DRC = .96). Further, a mediation analysis (Hayes, 2018) indicated that CBF altered the course of language development by obstructing the infant's ability to explore the world via FA (Fig 1C). Preliminary findings from a 17-year follow-up of the preterm cohort indicate that both CBF and FA ability during infancy predict long-term attention and learning outcomes (Fig 2). The findings suggest that FA is a prominent early marker of attention competence that promotes language acquisition and learning. Preterm birth and brainstem dysregulation were related to impairments in FA development, thus, shedding important light on the neurodevelopmental underpinnings of FA. Potential merits for early assessment of FA ability and development of FA-guided therapeutic strategies for susceptible infants are discussed.

O.22.02 Look at me: How selective attention and contingent caregiver-infant interaction contribute to infant language development (Masek)

Lillian Masek[1], Elizabeth Edgar[2], Brianna McMillan[3], James Todd[2], Lorraine Bahrick[2], Kathy Hirsh-Pasek[4]

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Interactions with caregivers are a key context for infant learning. Of particular importance is contingency, or communicative interactions between infants and caregivers that are temporally and thematically connected (Reed et al, 2016; Tamis-LeMonda et al., 2014). Yet, to effectively learn from these interactions, infants must selectively focus attention to the relevant person and action in a dynamic and cluttered environment (Bahrick et al., 2016; Masek et al., 2021). Infants must filter out input from other speakers and events to focus on their conversational partner. Here, we examine how infant's selective attention to synchronous audiovisual input in the context of dynamic distractors relates to contingency during caregiver-child interaction and how that attention relates to subsequent language skills. This study used data from three timepoints of a longitudinal study on attention development (n = 106). Participants varied in socioeconomic and language backgrounds. Selective attention to social (faces talking) events was assessed at 6-months and 12-months using the Multisensory Attention Assessment Protocol (MAAP; Bahrick et al., 2018). Infants are shown two videos, one of which is synchronous to the audio track (Figure 1). The proportion of time infants look to the

synchronous video measures selective attention. Caregiver-infant interactions were observed at 6- and 12-months playing with age-appropriate toys. The interaction was coded on a scale of 1 to 7 for fluency and connectedness, a global measure of contingency that captures the flow and balance of the verbal and nonverbal communication between infant and adult (Adamson et al., 2016). Infant language at 18-months was measured using the MacArthur-Bates Communicative Development Inventory (MCDI; Fenson et al., 2006). Cross panel models examined the associations between selective attention to social events and fluency and connectedness. No associations were found between the 6-month selective attention and 6-month fluency and connectedness, between 6-month selective attention and 12-month fluency and connectedness, or between 6-month fluency and connectedness and 12-month selective attention. However, selective attention to social events and fluency and connectedness were significantly associated at 12-months (est. = 0.374, z = 2.141, p = .032). Mediation analyses indicated a significant direct effect of selective attention to social events at 12-months on infant language at 18-months (est. = 0.357, z = 2.558, p = .011), but no indirect effect through fluency and connectedness at 12-months (Figure 2a). There was no direct effect of fluency and connectedness at 12-months on infant language at 18-months, but there was a trending indirect effect of through selective attention to social events at 12-months (est. = 0.135, z = 1.867, p = .062; Figure 2b). These results suggest that selective attention to synchronous faces and voices in the context of dynamic distractors might act as a mechanism through which engagement in contingent interactions relates to infant language development. Engagement in contingent interactions with caregivers may encourage infant attention to the social partner during the interaction which in turn may build infants' selective attention to faces and voices and further support infant language development. Further implications will be discussed.

O.22.03 Attention orienting and attention holding biases to caregiver faces develop at different rates from 6- to 9-months of age (Hunter)

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Infants attend to caregivers and other social partners to gather information for learning. This information gathering may be supported by both attention orienting, in which relevant target information is selected from competing stimuli, and attention-holding, in which attention is maintained on a stimulus for detailed information processing (Cohen, 1972). Past research has found that young infants show preferential looking (i.e., attention holding) to caregivers (Barrera & Maurer, 1981) during visual paired comparison tasks, in which only caregiver and stranger faces appear concurrently. However, it is unknown whether infants show similar attention holding and orienting biases to caregiver faces in more complex contexts in which faces compete with multiple distractors for attention resources. To address this question, we recorded eye movements from thirty 6- and 9-month-old infants (anticipated N=50) as they viewed caregiver and stranger faces appearing in multi-item search arrays (Fig. 1). The visual search task included single target trials, in which only the caregiver or stranger face appeared among multiple distractors, as well as dual target trials in which both faces appeared simultaneously to more closely mimic prior attention holding studies that typically present caregiver and stranger faces concurrently. All search arrays remained visible for 4 s and infants completed six trials in each condition (Single target-Caregiver, Single target-Stranger, Dual target). We measured attention orienting based on infants' eye movement response time to look at the faces during each trial and attention holding based on their total duration of looking to the faces. Preliminary results indicated that

infants at both ages oriented to both caregiver and stranger faces at above-chance rates (p's < .001), consistent with research indicating that infants reliably orient to faces in multi-object arrays by 6 months of age (Gliga et al., 2009; Kwon et al., 2016). At 6-months, infants detected stranger faces faster than caregiver faces (MCaregiver>= 1030.04 ms, SD = 360.15; MStranger= 811.02 ms, SD = 295.60; p = .03; Fig. 2A), whereas 9-month-old infants did not show attention orienting biases to caregiver versus stranger faces (p = .86). In contrast, longer looking to caregiver vs. stranger faces was evident at 9 months (MCaregiver = 1610.25 ms, SD = 435.90; MStranger= 1341.55 ms, SD = 495.90; p = .01; Fig. 2B), but not at 6 months (p = .53). Overall, these results suggest that attention holding and attention orienting biases may develop at different rates during the first year of life. More broadly, these preliminary results contrast with prior studies that have demonstrated preferential looking to caregivers beginning in early infancy, suggesting that attention holding biases may develop more slowly in the context of multiple competing items than in traditional visual paired comparison tasks. Additional analyses will examine whether these holding and orienting biases are further influenced by varying selective attention demands across the single and dual target trials.

O.22.04 TV, Books, and Infant Attentional Control (White)

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The American Association of Pediatrics has recommended no screen time for infants under 18 months of age, except if video chatting with a family member that is distant due to COVID-19 considerations (Pappas, 2020). However, a 2009 review on this topic estimated infants under two years old spend 30-40% of their time awake watching TV (Christakis, 2009) and there are now many infant-specific media channels available at any time of the day. The same 2009 review reports two theoretical mechanisms for why infant TV viewing might be deleterious: the fact that what's on the screen overstimulates the undeveloped brain, and that it prevents more appropriate activities like playing with toys (Christakis, 2009). A study comparing TV watching at 2 years old and self-regulation found that even slightly more media was correlated with more regulation problems (Radesky et al., 2014). However, technology is not the only media that infants can be exposed to. Books and reading have almost always been thought to be healthy for children to be exposed to, and infant-specific books have a large market as bedtime stories and parental bonding. An experiment linking parents reading with infants at 8 months to language skills at 12 and 16 months (Karrass & Braungart-Rieker, 2005). Another found that interacting with both reading and a caregiver improved word comprehension and sustained attention (Vally et al., 2014). The present investigation aimed to determine how media exposure (television and books) impacts infants attentional control. Specifically, eye-tracking was used to examine infants' average fixation duration as an index of how efficiently they are able to divide their attention in a visual scene. In a sample of 3.5-month-old infants (N = 44) who participated in a social cognition eye-tracking study where they viewed static images of human bodies, it was found that parent reported hours being read to on average per week predicted better attentional control (lower fixation durations) controlling for parent reported hours spent watching TV on average per week, race, and subjective social status, ß = -.33, p = .03. Hours watching TV did not predict attentional control in this age range. Future work will be needed to determine whether associations between attentional control and TV watching may be present later in infancy. The findings of this study suggest that being read to may have the capacity to promote executive functions, such as attentional control at a very young age. This provides further

evidence that parents should spend time reading to their infants early and often and suggests that reading time may be a useful target for intervention and prevention studies aiming to promote robust cognitive development.

O.23: Cognitive Development II

O.23.02 A Closer Look at the Older Sibling Effect on Early Cognitive and School Readiness Development in Diverse Contexts (Luo)

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The presence of older siblings has been found to negatively relate to early cognitive and school readiness skills. The resource dilution theory (Blake, 1981) and the confluence theory (Zajonc, 1983) propose that firstborns experience higher-quality home learning environment than later-born children. However, empirical studies testing the mediating role of home learning environment are still limited. Furthermore, recent studies in non-Western, developing countries or immigrant samples have found no negative effects or a positive effect of older siblings. It is thus critical to explore how socioecological contexts might moderate the older sibling effect. We used the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B) to investigate the effect of older siblings on children's early cognitive and school readiness skills. We asked whether the older sibling effect was mediated by home learning environment, and whether the mediation pathways were moderated by two contextual factors, children's exposure to cumulative risks and language minority experiences. We hypothesized that, in high-risk or language minority families, older siblings might help bridge the gap between home and school environments and compensate the lack of parental involvement. In these families, the effect of older siblings might be less negative or even positive on home learning environment and child outcomes. Participants were drawn from the ECLS-B sample (N=9,850; 41.5% White, 15.9% African American, 20.6% Hispanic, 11.3% Asian). Children's cognitive skills at 24 months and math and literacy skills at age 4 were assessed using standardized assessments. At each wave, mothers were interviewed about children's home learning environment, including children's engagement in learning activities and access to books. Additionally, children's exposure to cumulative risks was measured based on risk factors of poverty, single-mother household, low maternal education, and maternal depression. Finally, a language minority index was created based on whether children had a non-English home language and whether mothers had low English proficiency or were foreign-born. We conducted a set of moderated mediation models (see Figure 1). Table 1 presented conditional total, indirect, and direct effects. Results showed that the negative effect of older siblings was only evident in low-risk or English-speaking families, but not in high-risk or language minority families. In low-risk or English-speaking families, having older siblings showed a negative indirect effect via home learning activities but a positive or non-significant indirect effect via children's books, suggesting that different components of home environment were not equally susceptible to resource dilution. In contrast, in high-risk or language minority families, the indirect effect via home learning activities was less negative but the indirect effect via children's books was more negative, highlighting the context-specificity of the effect of older siblings. Finally, the direct effect of older siblings above and beyond the mediators was negative in low-risk or English-speaking families, but non-significant or positive in high-risk or language minority families. These findings underscore the complex associations among a family's sibling structure, resource distribution, and ecological context, calling for a contextualized modification of the existing birth order theories.

O.23.03 Infant representation of alternative possibilities: evidence from pupillometry (Cesana-Arlotti)

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Contrasting mutually-exclusive possibilities is a fundamental cognitive resource of the human mind that supports powerful forms of learning, prediction, and decision making. To face an uncertain present and an unknown future, we capitalize on an intuitive understanding of the relevant "alternatives", a batch of conceivable states, or events, that cannot jointly happen, but one of which, we think, must or will occur. Yet, the developmental origins of this precious resource are uncertain. Some findings suggest that even young preschoolers might have trouble in planning actions that take into account mutually-exclusive possibilities (Redshaw & Suddendorf, 2016), while other studies revealed an early understanding of alternative future outcomes based on infants' looking behavior. (Teglas et al., 2007, 2011; Cesana-Arlotti, 2012). The failure to plan optimal actions by considering alternative outcomes has been proposed to show that young children may lack the capacity to represent even two alternative possibilities at once (Leahy & Carey, 2020). Alternatively, young preschoolers' may be able of such representation, but complex decision making that can also integrate mutually-exclusive contingencies may emerge gradually through a protracted development of executive functioning (Deckert et al., 2016). To better understand the origins of the representation of alternatives we used pupil dilation as its potential indicator. In our experiments, ten- and fourteen-month-olds (n=24, each age) were engaged in an object-identification task watching video-animations where three objects with identical top-parts moved behind two screens. Importantly, a target object emerged from one of the screens but remained in partial occlusion, revealing only its top-part, which was compatible with a varying number of possible identities (Fig.1). Just as adults' pupil diameter grows monotonically with the amount of information held in memory, we predicted that if infants represent the possibilities compatible with the object's appearance, their pupil may dilate more in the 2-Possibilities condition than in the 1-Possibility one, due to the higher cognitive load of a more complex representation. Our prediction was borne out for the fourteen-month-olds. Infants were exposed to visually identical events, also matched in terms of the hidden objects to be remembered. However, their pupils increased more at the appearance of the partially-occluded object when there were two possible identities ($t(23)=2.939$, $p=0.007$; Fig.2). A temporal analysis confirmed that their pupillary response was locked to the appearance of the partially-occluded object, with an effect window between 0.8 and 2.5 seconds after the object appearance ($p=0.042$). In contrast, ten-month-olds' pupil in the 2-Possibilities condition was not higher than in the 1-Possibility one. Follow-up analyses indicated that this effect does not simply reflect higher visual attention to the screen where the two objects have been seen the last time: attention toward the sides was not predictive of individual differences in pupil diameter change. This finding is in line with the proposal that infants can spontaneously react to ambiguous events with a representation of alternative possibilities connected in a disjunctive relation (Cesana-Arlotti et al., 2018). We will discuss the implications for the foundation of our capacities to represent mutually-exclusive alternatives and make plans based on them.

O.23.04 On the origins of universal quantification: 10-month-old infants represent the exhaustivity of multi-agent intentional actions (Cesana-Arlotti)

Nicolò Cesana-Arlotti[1], Tyler Knowlton[2], Jeffrey Lidz[3], Justin Halberda[1]

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Universal quantification-the logical operations lexicalized with "all" and "each"-supports the exhaustive (i.e., exceptionless) application of a concept to a group of entities. With logical quantification, the human mind represents exhaustivity over an infinite number of entities (e.g., "EVERY natural number is divisible by 1"). However, we can also recognize exhaustivity in our immediate visual experiences ("look, ALL the apples in front of us are green!"). Our ability to detect exhaustivity based on observable data paves the way for studying forms of universal quantification beyond language (e.g., at the interface with vision) and their cognitive development. On one view, mastery of words like "all" and "each" is required to detect exhaustivity in visual scenes. In contrast, we offer evidence that pre-verbal infants have access to preverbal forms of universal quantification. In an initial series of experiments, adult participants watched simple animations, with no linguistic descriptions, involving agents performing goal-directed actions (scenes of three/five/eleven chevrons, EACH chasing a ball alone, or of three/five/eleven chevrons, ALL chasing one ball). In the "each" situations, adults were less likely to detect exhaustivity when the number of agents exceeded working memory limits (>4 agents). In "all" situations, adults were equally likely to notice exhaustivity no matter how many agents were present. This finding suggests that the distinction between individual-implicating and group-implicating concepts of universal quantification--a distinction that is fundamental to logic and language--might have a precursor in the basic visual-attentional distinction between group- and individual-exhaustivity. This gives reason for suspecting that preverbal representations of exhaustivity predate the vocabulary of universal quantification. In four visual-habituation experiments, we asked whether 10-month-olds can represent the exhaustivity of actions similarly to adults. In Experiment1-2 (n=24 each), infants who were habituated to "all" videos with three chasers successfully dishabituated to "each" videos with three chasers (p=0.008), and vice versa (p=0.01; Fig1). This result shows that infants encoded different representations of "all" and "each" movies. However, it remains unclear how such difference was encoded: along some low-level perceptual dimension (e.g., variability in the orientation of the chevrons' tips), or else in terms of the contrast between group- and individual-exhaustivity? In two ongoing experiments, we habituate infants to 5-agents "all" videos (n=27/30) or 5-agents "each" videos (n=15/30). We test for dishabituation to "broken-chasing" movies in which the chevrons are not pointing toward the target they chase but toward empty locations. Importantly, the change in the variability of the orientations of their tips is equated across the experiments (see Fig.2), and equally detectable. In contrast, preverbal representations of exhaustivity predict that infants, like adults, will fail to form a robust representation of 5-agents "each" chasing (as 5 is above their working memory limit), but will succeed in the 5-agents "all" chasing condition. Preliminary analyses initially confirm our predictions: in Experiment3, infants dishabituate to broken chasing (p=0.02) while in Experiment4 they do not, pointing to a potential precursor of logical quantification in infants' representations of exhaustivity. This suggests that quantificational language builds on pre-existing cognitive machinery, not the other way around.

O.24: Learning, problem-solving, generalization

O.24.01 Humorous demonstration may enhance social learning in infants in a tool use learning task (di Stasi)

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Humor can be defined as feeling or expressing something incongruous, surprising and funny. It is accompanied by a positive emotional response such as joy and specific behavior such as laughing or smiling (Booth-Butterfield & Booth-Butterfield, 1991; Martin, 2007; Gervais & Wilson, 2005) and is present in all types of social interactions (Apte, 1985; Lefcourt, 2001). It has been shown that humor has a positive influence on learning in adults and school-aged children (Banas, Dunbar et al. 2011), yet few studies investigated the effect of humor on learning in infants. Our team was the first to show an influence of humor on social learning in infants as young as 18 months in a tool use context (Esseily, Rat-Fischer et al., 2015). In this earlier study, 64 infants had to use a rake to retrieve an out-of-reach toy after a demonstration of its use by an experimenter. The demonstration was done either in a humorous or in a neutral way. Our team found that 94% of the infants who laughed when exposed to a humorous demonstration of a tool use then reproduced the target action, as compared to only 30% of infants who did not laugh or were exposed to the neutral demonstration. The aim of the current study was to assess the generalizability of the previous findings on a larger sample (110 infants at the time of submission), within a larger age group ranging from 14 to 22 months. In addition to the behavioral analysis, we used a multidimensional method testing several variables that are associated with the emergence of humor and emotions in infancy: a pretend-play measure, to test the hypothesis that humor appears as soon as infants display pretend-play behaviors, at around 18 months; physiological measures by means of a wristband to extract in a non-invasive way both cardiovascular and electrodermal data; an emotion measure by means of an automatic facial expression analysis; and a temperament measure in order to investigate inter-individual differences in infants' reactions to a humorous demonstration, by using the ECBQ questionnaire filled by parents (Putnam, Gartstein et al., 2006). Our preliminary results suggest that the perception of humor (measured by the laughing reaction at the humorous demonstration) appears around 18 months of age but does not seem to be correlated with pretend-play. In addition, infants seemed to learn better when they were exposed to a humorous demonstration regardless of whether they laughed or not, as shown on figure 1 and 2. Further analysis are currently in progress to investigate the potential factors involved in the positive association between humorous demonstration and learning such as surprise (Stahl & Feigenson, 2017). We expect that the facial expression analysis combined with the physiological data analysis will give us some cues about the emotional state of infants during the demonstration (such as surprise or emotional arousal) and its potential link with social learning.

O.24.02 Word form generalisation across voices: the role of infant sleep (Belia)

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Sleep plays an important role in several aspects of infant linguistic knowledge, like the abstraction of recurrent patterns from different but similar referents and their generalisation to similar novel referents, thus supporting category learning (e.g., Friedrich et al., 2015), and the extraction of the core structure of continuous auditory stimuli (e.g., Gómez et al., 2006). Crucially, in some studies, these abilities emerged only when both a nap and nocturnal sleep followed infants' first exposure to the stimuli, while neither alone sufficiently supported them (Werchan et al., 2021; Hupbach et al., 2009). Our study aims to clarify the relative role of sleep and naps in the generalisation of newly learned word forms in infancy. More specifically, we investigate whether sleep supports infants' ability to recognise the same nonwords as produced by different speakers, which involves the extraction of constant

auditory features from a pool of variable acoustic instances. Our methods are based on Houston and Jusczyk (2003), who investigated infants' ability to recognise familiar words across different voices following a delay, without examining the role of sleep. After familiarising infants to several tokens of two nonwords, we test infants' recognition of those nonwords across different voices, both after a nap, or a similarly long wake interval, and on the following day. We test 7.5- to 8.5-month-olds, as at that age word form generalisation ability was found to be still developing (Houston & Jusczyk 2000). On Day 1 we familiarise infants with two nonwords, uttered by the same talker. After the retention period, infants hear the same two nonwords and two new nonwords produced by a novel talker and we test whether they can differentiate them, by measuring their looking time to each of the stimuli. The same happens on Day 2, where infants hear the two familiarised nonwords and two new nonwords, all four produced by a third novel talker. The procedure is run over Zoom on Habit. The study will be pre-registered. We expect to have results to present by July 2022. We anticipate two alternative scenarios: a) If a single nap sufficiently supports generalisation of word forms, napping after exposure to several tokens of the same nonwords uttered by the same speaker should increase infants' chances of recognising the same nonwords produced by a novel speaker already after a single daytime nap; b) If naps combined with overnight sleep are critical for long-term consolidation of word forms, recognition of the nonwords in another voice should be observed only 24 hours after first exposure and only in infants who took a nap after their first exposure to the nonwords. With this study we aim to shed more light on the memory processes involved in the formation and generalisation of long-term phonological representations, which enable recognition of invariant sound patterns across different instances of the same words and thus are key to understanding language.

O.24.03 Are play and learning dichotomous? Parents' attitudes towards play and learning in the U.S. and China (Masters)

Allyson Masters[1], Hailey Gibbs[1], Yijin Fang[2], Jinyun Lyu[2], Xiaoxiang Zheng[3], Stella Christie[2], Fei Xu[4], Roberta Golinkoff[5], Kathy Hirsh-Pasek[1]

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Playful learning sparks more learning than free play and better learning over time than direct instruction (Fisher et al., 2013 Hirsh-Pasek et al., 2020; Zosh et al, 2018). Despite a rich body of evidence about the power of playful learning, misconceptions about play and learning as opposing constructs still abound. This is particularly true among caregivers, who are especially influential in shaping the learning experiences of young children outside school, where they spend the vast majority of their waking hours (approximately 80%; Evans, 2017). However, attitudes about the degree of dichotomy between play and learning may vary across cultures - particularly between cultures that differ in their emphasis on traditional pedagogical approaches. Wu et al. (2018), for example, found that German parents see more value in play than do their Chinese counterparts. Australian parents reported that play was only acceptable after separately completing schoolwork (O'Gorman & Ailwood, 2012). Even in the US, where playful education is making headway, views vary based on the setting and importance of play (Shiaku & Belsky, 2013) and parents of infants hold misconceptions regarding the use of toys for promoting development (Shah et al., 2019). Understanding how caregivers' attitudes reflect these overarching cultural beliefs is critical for shaping children's opportunities for play and playful learning. We therefore examined two samples of caregivers from the US and China, chosen for two primary reasons: (1) they represent two cultures which prior research suggests may have highly disparate

attitudes toward children's learning; and (2) no previous studies have directly compared the disconnect in these parents' attitudes about their children's play and learning as pertaining to prototypical playful learning activities. In the present study, 249 Chinese (182 female, 67 male; Mage 32.8, SD=4.5) and 113 US caregivers (71 female, 41 male, 1 not reported; Mage 33.6, SD=8.2) of infants and children ages 0-3 were surveyed about their attitudes toward what is important for their play and learning. The survey contained two conditions, and parents only saw information about either play or learning, but not both. Questions paralleled each other in each condition, so parents saw questions such as "To what extent do you agree that the following is a ____ activity: Parents help the child to recognize letters and words while reading books together;" in one condition, the term "play" was used and in the other, "learning." Preliminary findings among 5 playful learning items indicate general alignment within country in caregivers' attitudes toward play and learning (see Figure 1). However, we found evidence of persistent cultural differences in the degree to which parents across countries rated activities as both related to both learning and play. The present survey gives novel insight into the cultural differences that continue to underlie parents' attitudes about their children's playful learning. The completed presentation will examine further item comparisons and how attitudinal disparities contribute to caregivers' perceived roles in their infants' and children's learning at home and in their community.

O.24.04 Autonomy in problem-solving: Prioritizing exploration relates to increased persistence (Radovanovic)

Mia Radovanovic[1], Antonia Soldovieri[1], Hannah Solby[1], Yi Lin (Elaine) Wang[1], Justine Vorvis[1], Jasmine Shirvani[1], Jessica Sommerville[1]

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Infant persistence has been emphasized as critical due to links to positive outcomes in later childhood (Banerjee & Tamis-LeMonda, 2007). Simultaneously, autonomy and active experience have long been emphasized as important for cognitive development. In particular, play that emphasizes autonomy has been thought to increase intrinsic motivation as children focus on and discover problem features which they find most interesting (Weisberg et al., 2016). Notably, in many problem-solving contexts infants can choose to persist either by replicating the solutions of others, or by prioritizing their own ideas through exploration (Solby et al., 2021). Together, this work suggests that infants who display greater autonomy by exploring their own solutions may be more intrinsically motivated to continue through difficulty on challenging tasks, relative to infants who are more constrained to imitating the solutions offered by adults. To test whether infants prioritize imitative or exploratory behaviors, and the effects of this prioritization on task engagement, behavioral coding was performed using previously collected data (Lucca et al., 2020). Ninety-six 18-month-olds (17.67 - 19.30 months; MAGE = 18.5; 38 female) took turns across three trials with an experimenter solving a difficult task to retrieve a toy. In each trial, an experimenter first demonstrated attempting to retrieve the toy, then participants engaged in a test trial in which success was impossible. Behavioral coding was performed to classify 5-second intervals of test trials into imitative, exploratory, and off-task behaviors, as well as the number of unique exploratory strategies that each infant attempted. On average, infants spent significantly more time exploring rather than imitating the experimenter (Mdiff = 0.84 intervals; t(95) = 6.28, p < 0.01). As a group, infants' attempts also tended to decline across trials (t(157) = -5.00, p < .001, β = -2.23, SE = 0.45). However, greater exploration in the beginning of test trials related to greater overall persistence, even controlling for overall activity levels (t(209)=2.15,p= .03, β= 3.80, SE= 1.77), while imitation in the

beginning of test trials did not relate to greater persistence (p = .09). Likewise, employing a greater number of exploratory strategies at the beginning of test trials was related to greater persistence (t(210)=2.79,p= .005, β= 0.92, SE= 0.33; Table 1). Therefore, while infants reacted to repeated failure by reducing efforts, exploration may have served as a buffer by maintaining intrinsic motivation and providing alternative avenues for trying. This was reflected in the relationship between increased time exploring and a decreased need for experimenter support on a novel, solvable variant of the task (r(68) = -0.33, p = .005; Figure 1). These results demonstrate that infants generally prioritized their own exploration when an adult's solution failed, and that those who prioritized exploration tend to persist to a greater degree. As efforts were taken to control for a number of confounding factors, these results suggest that inducing a sense of autonomy and encouraging greater exploration may be fruitful routes for increasing infant persistence. Data collection for a short-term, parental intervention is ongoing, and implications for interventions will be discussed.

Poster Session 01

P1-A-1 - Cultural Differences in Infant Motor Development: A Comparison of Early Locomotor Experience (Wang)

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Infant motor development, much like developmental science in general, is based on studies with Western samples, with infants reared in typical Western childrearing traditions. Cross-cultural work reveals vast differences in infants' everyday experiences and differences in infants' motor skills. In this study, we examined the amount of the time infants spontaneously move and explore their environment. We observed 51 12- to 15-month-olds in three societies: Tanna Island in Vanuatu, the Central African Republic of the Congo, and rural Tajikistan. From 221 video records, we identified infants' self-generated motor movements and the proportion of time they were constrained by their caregivers. We expected that infants who had more time to explore unconstrained would have a higher proportion of self-generated movement (out of total time unconstrained). We also expected that infants who had more time to explore (total unconstrained out of total video observation) would be more proficient walkers. Based on cultural norms about independence and autonomy in childhood, we expected infants in CAR to move and explore the most, infants in Tajikistan the least, and Vanuatu infants falling in the middle. Preliminary analyses support our hypotheses. Our observations of infant early motor behaviors across cultures also provide further insight into the striking range of infant's early developmental settings, parental practices, and motor development.

P1-A-2 - What goes into the mouth? Infant mouthing behavior during everyday activity (Kobas)

Mert Kobas[1], Vidisha Goyal[1], Shreya Choudhury[1], Orit Herzberg[1], Karen Adolph[1]

[1]New York University

"Mouthing"-- licking, sucking, and putting inedible objects such as hands and fingers into the mouth--begins in the fetal period. In fact, mouth, lips, and tongue are infants' earliest and most adept exploratory system for learning about object properties. Infants put a variety of body parts and inedible objects and substances into their mouths. Some inedible objects are intended for mouthing (e.g., pacifier, teether, spoon, sippy cup), but most are not (e.g., toys, household objects, clothing, dirt). Thus,

mouthing offers rich opportunities for exploration and learning, but it can also pose potential threats from dust ingestion (via dirty hands, objects, and surfaces) and choking (on small object parts). A rich literature on mouthing during structured object exploration tasks in laboratory studies shows that mouthing decreases by 12 months of age and is replaced by visual and manual exploration. However, researchers know little about the frequency and variety of mouthing during natural everyday activity and whether spontaneous mouthing changes with infant age and motor skill. We videorecorded 56 infants during one hour of natural activity in the home (between meals and naps). To test change across age, we compared 13- and 23-month-old walkers; to test change based on motor skill, we compared 13-month-old crawlers and walkers. Preliminary data from 31 infants show that mouthing is surprisingly frequent at both ages (Ms = 32.9 and 28.5 bouts/hour at 13 and 23 months, respectively) and in both crawlers and walkers (Ms = 34.5 and 31.1 bouts/hour for crawlers and walkers, respectively); ps > .67. Perhaps motor skill was not predictive because half of mouthing bouts (M = 53.9%) occurred while infants were sitting. Mouthed objects included hands (M = 31.1%), toys (M = 27.5%), food (M = 26.2%), and household objects (M = 19.3%) --often simultaneously (thus %s > 100%)-- suggesting that mouthing serves exploratory functions. Only M = 18.7% of mouthed objects (including hands) had contacted the floor in the 10s prior to the mouthing event, and most mouthing bouts were brief (Median = 2.7s) suggesting that potential dust ingestion is also brief. Moreover, only 7.7% of mouthed objects were small enough to be choking hazards. In summary, although exploratory mouthing in structured play tasks decreases by 12 months of age, mouthing occurs at high frequency unabated during natural activity between 13 and 23 months. Moreover, although some mouthing events (hands, pacifiers) likely serve self-soothing functions, most mouthing events (toys and household objects) likely function as part of object exploration. Despite the potential for mouthing to pose threats to infant health, hazardous dust ingestion is mitigated by brief bouts of mouthing and relatively infrequent recent exposures to the floor. Similarly, choking hazards were also infrequent.

P1-A-3 - Amount and Consistency of Infant Locomotor Activity: Effects of Age and Home Environment (Herzberg)

Orit Herzberg[1], Margaret Shilling[1], Catherine Tamis-LeMonda[1], Karen Adolph[1]

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A century of research on the development of walking has examined how well infants walk and how adaptively infants navigate obstacles. But researchers still know little about infants' spontaneous locomotor activity and opportunities to move in the everyday home environment--how much infants move and where they go. Previous work is limited largely to individual lab visits for short time periods (10-30 min), so it cannot reveal whether: (1) infants' locomotor activity in a novel playroom is representative of what they do in their familiar home environments or over longer time periods; (2) activity patterns at home change with infant age, walking experience, or sex; (3) individual differences in locomotor activity are stable from day to day; (4) infants have varied opportunities for learning about upright balance (e.g., steps on varied surfaces and in different rooms) in the home; or (5) home-related factors (e.g., size of the home, available space) contribute to individual differences. We video-recorded 36 walking infants (13-, 18-, and 23-month-olds, 18 boys; 12 per age group) during everyday activity at home (two 2-hour visits within one week) with their mothers. In addition, we took video tours and measurements of the home to describe environmental opportunities for locomotion. Frame-by-frame video coding showed that infants spent M=18.3% of the visit time constrained and time constrained was

dictated largely by caregivers. Of the total constrained time, infants spent M=44.9% sitting on mothers' lap, M=24.1% carried in mothers' arms, M=21.3% in devices like highchairs, M=7.2% on raised surfaces like changing tables, and M=2.5% in other devices that limited freedom to move. Time constrained decreased with age F(2,35)=15.12, p<.001. When infants were unconstrained, they determined when they moved and where they went. Infants moved in short bursts of time-distributed activity. They produced M=224 bouts of locomotion per hour, with brief bursts of locomotion (M= 3.9s) separated by longer stationary periods (M=12.9s). The short bursts of locomotion added up. Infants spent M=24.2% of each hour in locomotion. However, infants showed large individual differences in locomotor activity for each unconstrained hour (i.e., time in motion ranged from 5%-38%). During stationary periods, infants were not inactive--M=43.3% of stationary time was in standing positions. Locomotor activity did not change with infant age, walking experience, or sex. Each hour, infants stepped on M=7.3 surface types (e.g., wood, carpet, tile, foam, objects, mattresses, etc.) with M=206 transitions among surfaces, and they visited M=3.3 different rooms with M=24 transitions among rooms. Time in locomotion was correlated with number of surfaces stepped on per hour, r(34)=.57, p<.01. Home size ranged from 46.6-173.3 m2 (M=75.9). Total home size and available space to move were related to individual differences in locomotor activity, rs(34)=.43-.44, ps<.008. Every measure of locomotor activity (time in motion, bouts/hour, bout duration, number of falls, time constrained, number of surfaces and rooms, transitions between surfaces and rooms) was stable from one visit to the next (rs(34)=.37-.84, ps<.03). In summary, infant locomotor activity is bursty, varied, and time-distributed, with large, stable individual differences. Findings suggest that varied everyday experiences contribute to infants' ability to master upright balance and flexibly navigate novel motor challenges.

P1-A-4 - Parental beliefs regarding motor development of parents of premature and term born infants (Suir)

Imke Suir[1], Marike boonzaaijer[1], Ora Oudgenoeg-Paz[2], Paul Westers[3], Jacqueline Nuysink[1], Marian Jongmans[2]

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Background: Parents of premature born (PT) infants experience a different start, with lots of insecurities about the (motor) development of their infant, compared to parents of a term born (TB) infant. This stressful start may influence parents' thoughts and ideas, parental beliefs, about their infant. According to the developmental niche, parental beliefs influence parental practices, and therefore may influence infant motor development. Little is known about parental beliefs regarding motor developmental of PT and TB infants. In order to tailor the intervention of pediatric physiotherapists to the family system, knowledge of these ideas and beliefs of parents is an important prerequisite. Aim: To compare parental beliefs regarding motor development of Dutch TB and very/extremely PT infants. Method: A prospective cohort study in which parents filled out the Parental Beliefs questionnaire (PB-MD) when their infant was 3.5 months old (corrected age (CA) for PT). The PB-MD encompasses is a valid and reliable instrument. It is composed of seven statements and four case descriptions, followed by statements representing possible interactions and approaches to which parents stated their agreement on a 6-point-scale. The first statement forms a separate item, and the other statements fit in five scales: Stimulation, Natural development, Advice, Order and Own pace. The Parents of typically developing Dutch TB infants (gestational age (GA) > = 37 weeks) and parents of infants born before or at 32.0 weeks GA and/or with a birthweight of <1500 grams without perinatal complications were included. Results:

Questionnaires of 37 parents of PT infants and 110 parents of TB infants were analyzed and compared. Infant characteristics were, as expected, significantly different for their GA and BW. Parental characteristics only differed in age and education of father. Also in this sample, factor analysis showed a negligible differences from the original found scales. The scale Stimulation is the only dimension with a difference between parents of TB and PT infants. Parents of PT infants have a stronger belief that stimulation of motor development is important. In the other scales -Natural development, Advice, Order of milestone attainment ,and Own pace in motor development- no significant differences were found. All parents had the belief that motor development is one of the most important things during the first year of life. Conclusion: Parental beliefs regarding motor development is overall not very different in parents of TB infants compared to very or extremely PT infants. Only concerning the scale Stimulation parents of PT infants are in the opinion that stimulation of motor development is more important than parents of TB infants. Despite the absence of big differences, it is important to get a good understanding of the parental beliefs, to respond suitable and connect to their beliefs in early interventions.

P1-A-5 - Modeling gross motor developmental curves of extremely and very preterm infants using the AIMS home-video method (Suir)

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Background: In the first year of life the most rapid and visible changes are seen in infant motor development, which is one of te first markers of the infant's wellbeing. Research on the course of development and clustering of data -where it is possible to create groups based on similarities and differences- supports decision making in follow-up and early interventions, and decreases parental concerns. On extremely and very preterm born infants without perinatal complications, little is known about their motor developmental curves and how these compare to those of term born infants. Aims: To explore shape and speed of gross motor developmental curves from birth until 18 months corrected age (CA) of extremely and very preterm (PT) infants. Besides, if distinctive gross motor developmental profiles can be identified, they will be related to profiles of term born Dutch infants (TB). Method: A prospective cohort study where parents used a home-video method to record their infant according to the Alberta Infant Motor Scale (AIMS) from 3.5 to 17.5 months CA. Gross motor development was measured with the AIMS. Parents of Dutch infants born before 32.0 weeks gestational age and/or with a birthweight of <1500 grams without perinatal complications were included. Results: The gross motor curves of 42 PT infants showed unidirectional growth with a sigmoid shape and large intra- and interindividual variety. The biggest overall acceleration was apparent between 5.5 and 9.5 months CA. This was also the period in which the largest variability in motor development between infants was observed. Three motor developmental profiles could be identified -late bloomers, gradual developers and early developers-, which are comparable to profiles of the Dutch TB infants until the age of 12.5 months (CA). There were no significant differences between the developmental profiles related to specific characteristics in these groups. The PT late bloomers showed a developmental delay according to the Canadian norm references at 5.5. months CA onwards, whereas the PT early developers scored according to the norm at all ages. Conclusions: Extremely and very preterm infants show large inter- and intra-individual variability in gross motor development. From 12.5 months CA, PT late bloomers and

gradual developers appear to develop at a slower pace than the TB infants. Due to the small sample size, results should be interpreted carefully. Even though, this study may contribute to clinical decision making, as with some caution, early developers may be released from regular follow-up for motor development earlier and monitored less frequently or differently (e.g., with home videos).

P1-A-6 - Dynamics of Agency Formation (Sloan)

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The mobile conjugate reinforcement (MCR) paradigm has been used extensively to explore infants' sensitivities to sensorimotor contingency. In MCR studies, an infant is placed in a crib which has a mobile hanging from above. Classically, when one of the infant's feet is tethered to the mobile, the infant greatly increases its foot movement rate. Bahrick and Watson (1985) noted that this behavior may either reflect reinforcement learning or intentional infant action but that differentiating between these two possible mechanisms remains "a challenge for future research." One of the main impediments to disentangling intentional action from contingency learning is the fact that kicking rate is the target measurement for MCR experiments. However, kicking may be spontaneous one moment but intentional the next. Comparing quantities of activity in various phases is insufficient for differentiating between underlying mechanisms. Recently, Kelso (2016) theorized that if some critical level of coordination between infant and mobile is surpassed, the infant would realize it was in control of mobile motion and suddenly increase its foot activity. This study tracked foot activity in 3D space at 100 Hz through motion capture. We explored both the magnitude of the peak acceleration (change in movement rate) across 1-minute windows and the timing of those peaks in eight infants who greatly increased activity across the tethered phase (by at least 150%). Some infants might steadily increase activity during the tethered phase, reflecting a basic sensitivity to the contingency, whereas other infants might also discover their control over the mobile, abruptly increasing activity upon discovery. We predicted that infants who increase their rate slowly (small peak acceleration) would take longer to reach their peak, continuing to explore the contingency, but not yet realizing their own agency. Three clusters of infants emerged: infants who peaked in acceleration early, midway or late in the tethered phase. Timing of peak was inversely related to magnitude of peak acceleration and extent of total increase across the tethered phase. Average total increases for early, midway and late peakers were 281%, 175% and 151%, respectively. It is important to note that infants (104 and 120 ; see Figure 1) nearly doubled the activity of the foot connected to the mobile during the tethered phase relative to their baseline rates. However, unlike infant 104 who suddenly doubled activity over just one minute, infant 120 slowly increased her activity rate. Infants may be similar in terms of magnitude of change in activity but differ in terms of dynamics. The current findings support Kelso's (2016) hypothesis and suggest that infants may be sensitive to sensorimotor contingencies, but not yet make the leap to discovery of themselves as agents. Critically, the three clusters of dynamically differing infants hint that there may be more than two possible states pertaining to agency: formed or unformed. If viewed from right to left, Figure 1 may be a first group portrait of the process of agency formation. Such quasi-agentive states and intermediate exploration stages may precede discovery of self-agency.

P1-A-7 - Wearable sensor quantification of full-day leg movement patterns in infants with Hypoxic-Ischemic Encephalopathy: A case series (Smith)

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Objective. Hypoxic-Ischemic Encephalopathy (HIE) is hypoxia and ischemia in the fetus or neonate leading to varying levels of brain damage and developmental disability. Early, accurate identification of neurodevelopmental trajectories in HIE is lacking, preventing targeted early intervention. Our objective is to use wearable sensor quantification of full-day leg movement patterns in HIE to accurately identify impaired neurodevelopmental trajectories early in infancy. Methods. This case series represents a prospective, consecutive sample of 9 families. Infants were enrolled in the Newborn and Infant Critical Care Unit at Children's Hospital Los Angeles. Inclusion criteria: perinatal acidosis and moderate/severe encephalopathy by Sarnat exam at < 6 hours of age. Exclusion criteria: moribund condition or clinical instability precluding research MRI exam. Full day wearable sensor data were collected at in-home visits at 3, 9, and 18 months of age. At each home visit, researchers placed a wearable sensor on each of the infants' ankles using custom leg warmers with pockets. Wearable sensors (Opals by APDM, Inc., Portland OR) collected synchronized tri-axial accelerometer and gyroscope data at 20 samples/second across approximately 8-10 hours as the family proceeded with typical activities. Data were analyzed using validated Matlab algorithms (Smith et al., 2015, Trujillo-Priego et al., 2017). Each leg movement was identified, and categorized by type (unilateral or bilateral). To assess amount of leg movement, we calculated the ratio of leg movements per hour of awake time in order to compare across participants with different visit or naptime durations. To assess symmetry of movement we calculated the ratio of right to left leg movements. Results: Infants completed 3 visits each, for a total of 18 visits. Average number of leg movements per hour of awake time was M 1144, SD 329. Ratio of right to left leg movements ranged from 0.75- 1.59 (M 1.05, SD 0.19). Comparison to previously published data from 12 infants with typical development (Smith et al., 2015) reveals that 5/9 infants with HIE had average leg movement rates < 1200 movements per hour awake (the observed minimum in infants with typical development). Further, 6/9 infants with HIE showed a bias away from symmetrical leg movement (ratio ≤ 0.88 or ≥ 1.12). Infants with typical development tend to produce more symmetrical limb movements (ratio M 0.94, SD 0.04)(Smith & Lang, 2019). Conclusions: Wearable sensor quantification of full-day infant leg movement patterns in HIE shows potential to identify impaired neurodevelopmental trajectories early in infancy. Preliminary results show potential differences in leg movement rate and symmetry of leg movements in the majority of infants with HIE compared to infants with typical development. A larger sample and assessment of neurodevelopmental outcomes is a necessary next step before validity can be established.

P1-A-9 - Positive Impacts of Activity-Focused Versus Milestone-Focused Parent Education on Parent-Child Interaction and Motor Development (Babik)

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Introduction: Parent education to enhance early handling, positioning, and play experiences can improve future motor and cognitive outcomes for infants (Lobo & Galloway, 2008, 2012). This study aimed to determine whether parent education impacts parent-child interaction (PCI) as well as motor development. Methods: Twenty infants (Mean=3.4, SD=1.3 months old) were assessed twice at home, one month apart. After Visit 1, infants were randomly assigned to: 1) Milestone Education (Milestone,

n=10), or 2) Activity Education (Activity, n=10). Parents received written information about expected milestones (Milestone) or about how to handle, position, and play with infants (Activity). PCI was assessed via behavioral coding of 40-60-minutes of naturalistic activity to identify: 1) infant's location (floor, held, container); 2) level of physical support from the parent (head, upper trunk, lower trunk, arm, none); and 3) presence of toys (within or out-of-reach, not present). Data were normalized to percentage of the total assessment time. Motor development was assessed using the Alberta Infant Motor Scale (AIMS). Wilcoxon tests were performed for intra-group, Mann-Whitney for inter-group comparisons. Results: All infants spent less time held (z= -2.07; p= 0.038) less time supported at the head (z=-2.310; p= 0.021), more time supported at the upper trunk (z= -2.429; p= 0.015), and more time in the presence of a toy (z= -2.666; p=0.008) at Visit 2 relative to Visit 1. Infants in the Activity education group had toys presented within reach more often (U= 19.00; z =-2.064; p=0.041) and showed greater improvements in motor development (U= 15.500; z=-2.399; p=0.016, Figure 1) as a result of the education. Conclusions: Process-focused may be favorable over product-focused developmental education to change PCI and children's motor outcomes. Parent education programs are broadly utilized. It is important to evaluate how to most effectively design the content of those programs to change PCI and optimize child outcomes. Education about daily activity performance may empower parents to shape developmental landscapes for their children.

P1-A-10 - Do socioeconomic, biological, and parenting factors contribute to individual differences in infant motor development? (Smith)

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Infant motor development is impactful due to its effects across domains and potential predictiveness of emerging developmental disorders (Iverson, 2021; Libertus & Needham, 2011). However, little research has focused on identifying sources of individual differences in early motor development. Socioeconomic, biological, and parenting factors are primary candidates that should be examined as potential predictors of early motor development (Adolph & Hoch, 2018). Previous research has found effects of socioeconomic factors on specific motor skills (Clearfield, Bailey, Jenne, Stanger, & Tacke, 2014), and there are contradictory findings on the role of biological factors in infant motor development (Rose et al., 2013; De Almeida Mai et al., 2021). However, there are few studies looking at socioeconomic, biological, and parenting predictors of motor development across motor domains in the first two years of life. The current study fills this gap in the literature and explores impacts of socioeconomic factors (SES), biological factors (gestational age), and parenting factors (parenting joyful and stressful experiences) on different aspects of infant motor development (i.e., gross motor, fine motor, and perception-action integration skills). A total of 99 infants (50.53% female) ranging from 1.13 to 25.53 months of age and their caregivers participated in the current study. Caregivers completed the Early Motor Questionnaire (EMQ), a parent-report questionnaire regarding their early gross motor (48 items), fine motor (48 items), and perception-action development (31 items). Parents also provided information about their child's gestational age, their self-rated parenting experiences, household income, and parent education. Household income and parent education were combined to create a composite measure of family SES. Results revealed differential effects across the different domains of motor development assessed here. Specifically, SES was found to predict fine motor (p = .005) and

perception-action development (p = .009), but not gross motor development (p = .382; see Figure 1). Gestational age was also associated with only gross motor (p = .025) and fine motor skills (p = .003; see Figure 2). Parenting experiences were not found to predict motor development. Moreover, effects of gestational age and parenting experiences were not found to vary between levels of SES. These results indicate that the relation between a child's home environment and their gestational age shape development differently depending on the motor domain being examined. Our results caution against taking a "one-size-fits-all" approach when examining the factors and experiences that may shape early motor development.

P1-A-11 - Impact of toy characteristics and posture on bimanual object interactions during free-play in infants (Thompson)

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Role differentiated bimanual manipulation (RDBM) is a complex skill where each hand plays a specific role (e.g., Babik & Michel, 2016; Gonzalez & Nelson, 2015; Kimmerle et al., 1995; 2010; Nelson et al., 2013). One-object RDBM occurs when one hand stabilizes an object while one hand manipulates it (e.g., while opening a jar, one hand stabilizes the jar while the other twists open the lid). The development of RDBM provides insight into how infants learn to coordinate movements. In prior research, seated infants were given a series of toys of a similar size and weight in a structured task designed to elicit RDBM. Although informative, this methodology misses how RDBM emerges in naturalistic settings, where other factors (e.g., toy preferences, postures) may impact behavior. In contrast, we observed RDBM in a free-play setting to investigate how infants incorporate RDBM into their everyday lives where infants can move about freely in their environment. Specifically, we examined the posture adopted (e.g., sitting, standing) as well as the toy properties (e.g., size, weight) when infants engaged in RDBM. Thirty-nine 13-month-olds and 39 24-month-olds played for up to 20-minutes in a playroom with 18 toys of varying sizes and weights: small (size of child's hand), medium (larger than hand but smaller than head), large (size of child's head), light (0.5-1.25lbs; 2-5% BW), moderate (2-3lbs; 8-10% BW), and heavy (3-4lbs; 12-15% BW). Size and weight were decoupled; small, medium, and large toys could be any of the three weights. Using Datavyu, trained coders identified instances of one-object RDBM in 16 13-month-olds (8 girls, Mage=13m, 20d, range=13,2-13,29) and 20 24-month-olds (9 girls, Mage=23m, 15d, range=23,0-24,29). For each instance of RDBM, coders recorded the toy size and the child's posture (sitting or standing). An Age (2) x Posture (2) x Size (3) x Weight (3) repeated-measures ANOVA with Bonferroni corrections was conducted using proportion of time infants engaged in one-object RDBM as the dependent measure. There were no age differences. There was a significant Posture x Weight interaction ($F(2,68)= 3.99$, $p=0.02$; Figure 1). While standing, RDBM occurred more frequently with light toys ($p=0.004$), but while sitting, RDBM occurred more frequently with the heavy toys ($p=0.004$). There was a significant Size x Weight interaction ($F(2.96, 101.40)=5.16$, $p=0.002$, with Greenhouse-Geiser correction). Regardless of posture, for toy weight, compared to light large toys, RDBM occurred more frequently with light small toys ($p=0.02$) and with light medium toys ($p=0.04$). For the size comparisons, medium light toys were used more than medium moderate ($p=0.004$) and medium heavy toys ($p=0.016$) Overall, specific toy properties (size/weight) impacted the frequency that infants engaged in RDBM when in sitting or standing postures. Weight was a key factor. Infants choose light over heavy toys while

standing, possibly because they were easier to integrate with this more challenging posture. Our results highlight the importance of exploring infant behaviors in a free-play setting to observe how variations in posture as well as toy properties impact manual behaviors.

P1-A-12 - How walking skill relates to toddlers' physical growth, cognitive ability, and activity level (Gill)

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Walking is a central indicator of children's development. On average, children begin walking at 12 months old, but continue to refine their walking skill until 5- to 7- years old. Therefore, a full understanding of walking involves more than identifying when children begin to walk. The purpose of this study was to examine how walking skill relates to physical growth, cognitive ability, and activity level in early childhood. The sample consisted of 271 2-year-olds and 274 3-year-olds. We conducted computerized video coding as toddlers participated in an episode of the Laboratory Temperament Assessment Battery, which provides standard play situations for assessing temperament. In the "Arc of Toys" episode, toddlers were placed in the center of seven toys positioned in a semicircle and played with the toys for 5 minutes. We operationalized measures of walking skill: step number (how many steps toddlers took) and time spent walking (total time walking). The definitions were used to code the walking skill measures with a frame-by-frame computerized video coding system, Datavyu (datavyu.org). Measures of physical growth included body mass index (BMI) and parent reports of birth length. Two subsections of the Bayley Scales of Infant Development, the Bayley Rating Scale (BRS) and the Mental Development Index, were administered to provide information on motor and cognitive ability respectively. Two measures of activity level (AL) were obtained: an observed measure (i.e., the activity temperament dimension of the Infant Behavior Record (IBR)) and an objective measure (i.e., activity monitors worn in the home). At age 2, toddlers with higher IBR and AL scores took more steps (IBR $r(270)=.289$, $p<.001$; AL $r(269)=.163$, $p=.007$) and spent more time walking (IBR $r(270)=.262$, $p<.001$; AL $r(269)=.195$, $p=.001$). Higher BMI was positively correlated with step number ($r(269)=.148$, $p=.015$). At age 3, the IBR was positively correlated with step number ($r(273)=.314$, $p<.001$) and time spent walking ($r(273)=.234$, $p<.001$). AL and birth length were positively ($r(272)=.205$, $p<.001$) and negatively ($r(215)=-.152$, $p=.026$) correlated with step number, respectively. The BRS was also positively correlated with step number ($r(262)=.180$, $p=.003$) and time spent walking ($r(262)=.187$, $p=.002$). Regressions were run with IBR, BMI, AL, and BRS as predictors on step number and time spent walking. IBR at both ages, AL at age 2, and BRS at age 3 predicted step number at age 2, $R2 = .18$, $F(9, 257)=5.89$, $p<.001$. At age 3, BMI at both ages, IBR at age 3, and BRS at age 3 predicted step number, $R2 = .17$, $F(9, 268)=5.98$, $p<.001$. IBR at age 2, AL at age 2, and BRS at age 3 predicted time spent walking at age 2, $R2 = .15$, $F(9, 257)=4.66$, $p<.001$. IBR, BRS, BMI, and AL at age 3 predicted time spent walking at age 3, $R2 = .13$, $F(9, 268)=4.39$, $p<.001$. Examining concurrent associations between walking skill, physical growth, cognitive ability, and activity level is a first step toward uncovering contributions to toddlers' walking skill. Future studies will focus on the direction of effects between developmental characteristics and walking skill in early childhood.

P1-A-13 - Does lateralization of hand-use for reaching advance the performance of object manipulation and tool use? (Babik)

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Introduction: Previous research suggested that hemispheric specialization increases the efficiency of information processing (Corballis, 2017; Gonzalez et al., 2018; Güntürkün & Ocklenburg, 2017); thus, stronger hemispheric asymmetry should be associated with better motor, sensorimotor, and cognitive performance. Since robust hand-use preference represents stronger underlying hemispheric lateralization (Annett, 2002; Corballis, 2009; McManus, 2002), the former was predicted to be associated with better developmental outcomes. Indeed, the benefits of strong and consistent handedness were found to advance infants' object management (Bruner, 1973; Kotwica et al., 2008), block stacking (Marcinowski & Campbell, 2017; Marcinowski et al., 2016), and language skills (Gonzalez et al., 2020; Nelson et al., 2014, 2017). The goal of this study was to explore the effect of the reaching hand-use lateralization on the development of role-differentiated bimanual manipulation (RDBM) and tool-use (TU). Methods: Ninety infants (57 males) were tested for reaching hand-use and the number of produced simple and difficult RDBMs monthly from 9 to 14 months. In addition, 28 infants (15 males) were tested for reaching hand-use and the number of attempted and successful TU actions from 10 to 14 months. Infants' monthly hand-use for reaching was defined as: 1) lateralization z-scores [z = (R-L)/(R+L)1/2, where R and L represent the total number of performed right-handed and left-handed object contacts]; 2) absolute values of z-scores; and 3) the proportion of unimanual object contacts out of the total number of contacts. HLM software was used to relate trajectories of reaching lateralization to those of RDBM and TU performance. Results: There were no significant relations between the number of simple RDBMs produced and any of the reaching lateralization parameters. For difficult RDBMs, the lateralization z-scores were not related to RDBM performance, whereas absolute values of z-scores ($p = .006$) and proportion of unimanual reaches ($p = .015$) were negatively associate with RDBM performance. Also, all relations between reaching lateralization parameters and TU performance were found to be non-significant. Conclusions: Only more deliberate difficult RDBMs, in contrast to often accidental simple RDBMs, showed a significant effect of reaching lateralization on the RDBM performance. Higher levels of difficult RDBM performance were associated with lower magnitude of lateralization - irrespective of its direction (right or left hand-use preference) - and higher propensity to reach with both hands. Current results do not support the hypothesis of stronger hand-use lateralization for reaching being associated with better sensorimotor and cognitive performance in RDBM and TU, but, rather, show the importance of hands' coupling for better performance of sophisticated role-differentiated bimanual object manipulation.

P1-A-14 - Socioeconomic Status and its Cascading Effects on Infant Development (Dixon)

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Background: Growing literature indicates that poverty can negatively impact school readiness and academic achievement throughout a child's life (Perry et al. 2018). Prior studies investigate the link between poor academic achievement and poverty in school aged children, yet less is known about when these changes may emerge in infancy. A better understanding of the relationship between SES and early developmental outcomes may help of target emerging deficits in infancy and reduce SES-related inequalities. Objective: The current study uses a prospective longitudinal design to examine the

relationship between SES and cognitive, language, and motor development among infants and toddlers. Methods: Participants (n = 53; high SES = 41; low SES = 12) were enrolled in a prospective longitudinal study on early autism symptoms. At 1, 2, 3, 4, 6, and 9 months, clinicians administered the Bayley Scales of Infant Development, 3rd edition (Bayley, 2006; Bayley-III). We measured SES by self-reported maternal education level. "High SES" included mothers with a college degree or higher while "low SES" included mothers without a college degree. Maternal education has been shown to be strongly correlated with both income and SES (Noble et al. 2007) and other studies investigating similar relationships used maternal education alone to establish SES groups (Clearfield & Jedd, 2012; Stevens et al. 2009). We investigated trajectories of Bayley-III scores between groups with linear mixed-effects models. At each time point, the difference of least square means between high SES and low SES groups was calculated. Results: A significant interaction between age and SES was found for gross motor ($F(1, 50) = 5.90$, $p = .02$) and fine motor skills ($F(1, 50) = 4.52$, $p = .04$). Infants with low SES showed slower rates of growth compared to high SES infants and by 9 months, low SES infants were scoring significantly lower on fine motor measures ($t(50) = 2.26$, $p = .03$) and slightly lower on gross motor measures ($t(50) = 1.84$, $p = .07$). While low SES factors have been known to contribute to lower cognitive and language scores, our results did not show any main effects of SES or interactions between age and SES for cognitive skills, receptive language, or expressive language scores. Conclusion: These results suggest that infants from families with lower maternal education show lower growth in fine and gross motor abilities, with significant differences emerging by 9 months. Cognitive skills and language abilities were not significantly associated with SES as previously considered, suggesting that these associations may appear later in childhood. Findings of this study point to how inequity and resource-based differences among lower and higher SES groups may contribute to cascading effects on infant and child development. Additional research is needed to identify specific environmental constraints in lower resourced homes that may lead to altered trajectories in motor development.

P1-A-15 - Latina mothers' talk coincides with mother-infant proximity in crawling and walking infants (Pinheiro Mehta)

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Infants actively shape their learning experiences. New motor skills cascade to other domains, spurring change in cognitive, language, and social domains. In particular, the transition from crawling to walking is a setting event that allows infants to carry objects and share them with caregivers (Karasik et al., 2011). Caregiver language input, in turn, may increase during moments of mother-infant physical proximity. Compared to crawlers, walkers may more readily and actively establish physical proximity with their caregivers as they "go faster and farther" (Adolph & Tamis-LeMonda, 2014), and walkers' language input may critically depend on the proximity to their mothers. Here we ask, 1) do walking infants experience more bouts of mother-infant proximity and similar total time in proximity compared to crawlers? 2) does mother language increase during proximity, and if so, do associations differ for walkers and crawlers? Latina mothers and their 12-to-24-month-old infants (N=50) were recorded at home during everyday activities for 90 minutes (SD=15), with the aim of extending research on mother-infant interactions to a generally understudied sample. Mothers' language was transcribed in Spanish at the utterance level. Proximity was coded continuously during the interaction when infants were arms-distance apart from their mother. We calculated the number of proximity bouts and total time in

proximity for each dyad, because walkers and crawlers may experience similar total time in proximity but initiate more/fewer proximity bouts. Infants were considered walkers if they took 5 independent steps during the recording (76%). An ongoing coding pass annotated the behaviors that preceded proximity (3 seconds before), as infant and/or mother locomotion, infant and/or mother gestures, and infant and/or mother vocalizations. As expected, walkers experienced more frequent bouts of proximity per hour (M=44.05, Mdn=43.45, SD=18.87) compared to crawlers (M=28.55, Mdn=22.24, SD=19.44), p = .004. (Figure 1A), with preliminary analyses indicating that infants moved in space prior to most proximity bouts (M=76%, SD=14%). However, the proportion of time spent in proximity did not differ between crawling and walking infants (Figure 1B). Perhaps walkers experienced more but shorter bouts compared to crawlers. Crawlers and walkers on average spent 48% and 49% of the visit in proximity respectively, p = .925. Notably, mothers produced more language inside proximity than outside proximity, an association that maintained for both crawlers and walkers (Figure 2). Specifically, mothers of crawling infants produced on average 11.87 utterances (SD=6.65) per minute of proximity whereas they produced 5.65 utterances (SD=4.08) per minute of no proximity. Likewise, mothers of walking infants produced on average 13.71 utterances (SD=7.84) per minute of proximity and 7.56 utterances (SD=5.32) per minute of no proximity. In ongoing analyses, we are examining mother-infant behaviors occurring before proximity to test whether crawling infants are as likely as walking infants to initiate bouts of proximity. A limitation is that most infants were walkers and future work should replicate findings in younger infants using equal group sizes and age-matched controls. To conclude, walkers generate more bouts of proximity, but the role of proximity in language experiences do not differ by infant locomotor status.

P1-A-16 - The role of affordances in the home environment in children's motor, cognitive, and language development (Babik)

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Introduction. Previous research showed the importance of home environment and early stimulation for children's motor, cognitive, and language development (Bartlett et al., 2008; Bradley et al., 1989; Miquelote et al., 2012; Walker, 2010). Home affordances in the form of physical space (playroom, garden, playground), equipment (slide, walker, swing), surfaces (slopes, steps, carpet), available toys, as well as opportunities to freely move around and meet other children and adults may have different effects on child development. The purpose of this study was to explore the effect of home affordances on motor, cognitive, and language development of children with motor delays. Methods. In this randomized controlled clinical trial, 112 children (Mean=10.80, SD=2.59 months old at baseline) with mild or significant motor delays were randomly assigned to the Sitting Together And Reaching To Play (START-Play; Harbourne et al., 2018) intervention or usual early intervention care. Twice-weekly intervention was provided during the first 3 months of the study to those in the START-Play group. Children's socioeconomic status (SES) and Affordances in the Home Environment for Motor Development - Infant Scale (AHEMD-IS) were determined at baseline. AHEMD-IS scores were further grouped into five dimensions: total score (AHEMD-T), physical space (AHEMD-PS), variety of stimulation

(AHEMD-VS), gross-motor toys (AHEMD-GM), and fine-motor toys (AHEMD-FM; Caçola et al., 2014). Also, children's motor (GMFM sitting and total scores, Bayley-III fine motor and gross motor subscales), cognitive (Bayley cognitive subscale), and language performance (Bayley receptive and expressive language subscales) were evaluated at baseline and 1.5, 3, 6, 12 months post-baseline. Piecewise linear mixed-effects modeling in Mplus (version 8.5) was conducted to evaluate the effect of the five AHEMD-IS variables and SES on developmental trajectories of GMFM and Bayley scores after controlling for children's treatment group, severity of motor delay, and SES (AHEMD-IS variables only). Results. Higher AHEMD-T scores were associated with better GMFM sitting and Bayley fine motor scores at baseline, steeper developmental slope on Bayley cognitive scores during intervention, and steeper post-intervention slopes for Bayley fine motor, cognitive, receptive language, and expressive language scores (Table 1). Higher AHEMD-PS scores related to higher baseline GMFM sitting scores, as well as steeper post-intervention trajectories for Bayley receptive and expressive language. Higher AHEMD-GM scores produced steeper post-intervention slopes in Bayley fine motor and receptive language skills. Higher AHEMD-FM scores were associated with more advanced Bayley fine motor skills at baseline, as well as steeper post-intervention slopes for Bayley fine motor, receptive language, and expressive language skills. Higher SES scores were related to steeper post-intervention slopes for Bayley gross motor and receptive language skills. Conclusions. Motor, cognitive, and language development of children with motor delays benefit considerably from enriched home affordances that support exploration and higher levels of stimulation. Specifically, physical space characteristics and availability of toys promoting children's fine-motor and gross-motor skills were significantly associated with more advanced sitting, fine-motor, cognitive, and language skills.

P1-A-17 - Sensorimotor development across the first year of life in infants with a familial history of autism (Smith)

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Caregivers and their infants communicate with one another long before infants are able to speak by sharing focus on an object, event, or person. This shared focus is known as joint attention (JA) and can be initiated through verbal and nonverbal communication. Recent eye-tracking research with typically developing 12-month-old infant-caregiver dyads showed that joint attention to an object was most often preceded by infants' gaze following their own hand movements to an object, in which the caregiver joined their gaze to the object (Yu & Smith, 2013). This evidence suggests that strong hand-eye coordination is linked to JA. Further, JA deficits are a defining feature of autism, often seen as early as 12-months-old in children later diagnosed with autism (Charman, 2003; Nyström et al., 2019). Understanding the emergence of JA in infants with a familial history (FH+) for developing autism is important for early detection. In the proposed study, we asked whether sensorimotor processes involved in JA might be linked to JA deficits for infants with a history of weak motor and attention abilities. The current study investigated the developmental trajectory of sensory and motor behaviors involved in JA by observing caregivers and their FH+ infants and comparing them to age matched infants with no familial history (FH-). Caregiver-infant dyads were asked to play as they normally would while on Zoom; the interaction was later coded for motor and attention behaviors. We observed infant and caregiver hand movements and eye gaze. Results are reported as a proportion of how often a behavior occurred out of the total codable video time for that dyad. Preliminary results from 17 FH- infants and

15 FH+ infants show a main effect of infant age on gaze at objects. Older infants spent more time looking at objects than younger infants, $F(1, 27) = 9.973$, $p = .004$, see Figure 1. There was also a main effect of familial history and gaze at objects. FH- infants looked at objects more than FH+ infants, $F(1, 27) = 5.309$, $p = .029$ (Figure. 1). There was also a main effect of familial history on how often infants touched objects, $F(1, 28) = 4.119$, $p = .049$ (see Figure. 2). FH+ infants touched objects less than FH- infants. These results indicate potential early differences in gaze and motor behaviors in FH+ infants during free play interactions. Further exploration will include JA measures and gaze following explicitly with a complete sample size of 24 infants per familial history group.

P1-A-18 - Effect of a single session of whole-body vibration on motor and cognitive function in children with Down syndrome: A pilot study (Wu)

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Down syndrome (DS) is the most common genetic condition and occurs in 1 out of 700 new births in the United States. Infants and children with DS often show developmental delays in the motor, cognitive, and language domains compared to their typically developing counterparts. Physical intervention targeting the motor domain has been shown to accelerate the development of motor skills in infants and children with DS and may have cascading effects on the development of other domains. Whole-body vibration (WBV) provides a promising intervention paradigm as it may elicit health benefits in children with DS. Previous studies have demonstrated the benefits of long-term WBV interventions on body composition and motor performance. However, the quality of movement has not been examined nor the potential impact of WBV intervention on cognitive function in children with DS. Therefore, the purpose of this study was to evaluate the effects of a single WBV session on the motor and cognitive domains in children with DS. We hypothesize that a single session of the low-frequency, low-amplitude WBV will improve locomotor ability and executive function (particularly attention and inhibition) in children with DS. Vibration was administered using a Galileo side-alternating WBV platform, set to 25 Hz, 2 mm. Subjects were asked to stand on the platform for 10 bouts of 30 seconds, with 1 minute of rest between bouts. A stair ascent task and a timed up-and-go (TUG) task were administered for motor assessment and a flanker test was conducted using the NIH Toolbox Cognitive Battery for cognitive assessment before and immediately after WBV. Four children with DS (2M/2F, 11.6 2.6 years) participated in this pilot study. Each child performed 5 trials of each motor task and 20 trials of the flanker test using fish and arrow stimuli to assess attention and inhibition. Two of the subjects were only able to tolerate 5 bouts of vibration due to skin sensitivity. For the stair task, subjects were asked to walk to a three-step staircase without siderails and ascend to the top. Two children demonstrated improvements in motor strategy to complete the stair ascent task such that they did not stop at the bottom of the staircase before ascending it and not rely on their hands to ascend the staircase following vibration. For the TUG test, subjects sat in a chair without arms. Upon the command "go", subjects rose from the chair, walked forward for three meters, turned around, walked back, and sat down in the chair as fast as possible. Two children demonstrated a shorter time to complete the TUG test following vibration due primarily to a faster turn-around phase. For the flanker test, three children demonstrated a ceiling effect for the fish stimuli, but two subjects showed increases in accuracy for both stimuli after vibration. The results from this pilot study indicate that WBV has potential to elicit acute benefits to adaptive locomotion and functional mobility in the motor domain and attention and inhibition of

executive function in the cognitive domain in children with DS. Further studies with a larger sample size are warranted to examine the developmental cascading effects of short- and long-term WBV intervention on motor and cognitive development in children with DS.

P1-A-19 - The relation between tool use and language skills during infancy (Babik)

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Introduction: Tool-use (TU) is a sophisticated manual skill that children develop during the first two years of life (Lockman, 2000; Lockman & Kahrs, 2017). While being engaged in TU, children develop their fine motor and sensorimotor skills, and learn to plan their actions. As a result, they learn object properties and affordances, relations between objects, and problem-solving strategies that allow sophisticated, goal-directed manipulation of objects. Gains in the areas of motor, sensorimotor, and cognitive development as a result of TU might positively affect the child's language development (Iverson, 2010). The purpose of this study was to determine whether TU performance and hand-use lateralization for TU during the second year of life can predict children's language performance at 24 months. Methods: Thirty six infants (18 males) have been tested for TU in 10 tasks monthly from 11 to 14 months and from 18 to 23 months. Actions with one object on another one without performing the intended goal action were counted as TU attempts, whereas the performance of the intended goal action was counted as a TU solution. The following outcome measures were used to evaluate infants' TU attempts and solutions: 1) the total number of actions; 2) hand-use lateralization z-scores [z = (R-L)/(R+L)1/2, where R and L represent the total number of performed right-handed and left-handed actions]; 3) absolute values of z-scores; resulting in 6 outcome measures for TU. Also, at 24 months, all infants were tested for their auditory comprehension and expressive communication skills using the Preschool Language Scales (PLS-5, PLSAC and PLSEC scales; Zimmerman et al., 2011); standardized scores were used in all analyses. SPSS software (version 26) was used to correlate children's bimonthly TU performance (averaged for 11-12, 13-14, 18-19, 20-21, and 22-23 months) to their language scores at 24 months. Bonferroni corrected α = .05/6 = .0083 was used to determine the significance of results. Results: The only significant Pearson correlations between TU outcomes and PLS scores were found for TU measured during 20-21 month interval. PLSAC scores positively correlated with the number of TU solutions ($p = .003$) and the absolute value of z-scores for TU solutions ($p = .005$). PLSEC scores positively correlated with the z-scores for TU attempts ($p < .0001$) and TU solutions ($p = .002$). Conclusions: Current results suggest that TU performance and hand-use lateralization for TU may predict later language skills. Note that TU assessed at 20-21 months is a better predictor of language skills at 24 months than TU recorded at earlier or later months. More advanced auditory comprehension was observed in children who succeeded in TU problem solving, potentially indicating the importance of problem solving for language development. More advanced auditory comprehension was also associated with higher magnitude of hand-use lateralization during TU, irrespective of its direction. More advanced expressive communication was associated with more pronounced right-handed hand-use preference in both TU attempts and solutions. Thus, both magnitude and direction of hand-use lateralization for TU may be important factors in language development.

P1-A-20 - Longitudinal changes in infants spontaneous rhythmic movements during parent-child interactions (Laudanska)

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Rhythm is a sequence of short repeated intervals, with regularities that allow us to build expectancies when the next beat will arrive (Jones, 1976). One of the rhythmic capacities is the ability to produce a regular beat, which infants from five months of age can produce spontaneously (Rocha et al., 2021). Infants' drumming becomes faster and more regular with age (Rocha et al., 2021), which is consistent with an increase in their movement control (Goldfield, 1995). Furthermore, the social context seems to improve rhythmic synchronization as it facilitates joint drumming in preschool children (Krishner and Tomasello, 2009). Yet, it is not clear how infants' spontaneous rhythmic behavior in social context changes across the first year of life. Here, we report the preliminary results of the longitudinal study of 12 infants playing with rattles during interactions with their caregivers at 4-, 6-, 9- and 12 months of age. Infants' hand movements were recorded using motion trackers, each interaction was video-recorded and the rattling episodes were later annotated in ELAN. Consequently, these episodes were used to estimate the average duration of each rattling episode, segment the movement data and identify the number of rattling movements. Finally, we estimated the wavelet coherence (WC, Grinsted et al., 2004) between the movements of both hands. Given the range of rattling frequencies (i.e., number of rattling movements /total rattling time), we calculated the average WC coherence between 0.5 and 2.5 Hz. The General Estimating Equations were used to assess the longitudinal changes. Preliminary results suggest that the number of rattling movements increases with age (Wald $\chi2$ (3) = 27.289, $p < .001$; Fig.1), with significantly fewer rattling movements at 4 months than 6,9 or 12 months. There was also trend of an increase in the rattling frequency with age (Wald $\chi2$ (3) = 6.904, $p = .075$). Furthermore, the average WC increased with age (Wald $\chi2$ (3) = 19.544, $p < .001$, Fig. 2) and was significantly shorter at 4 months than at 9 and 12 months and shorter at 6 months than at 12 months, suggesting an increase of coordinated rhythmic rattling movements with age. Comparisons of WC with a shuffled version of the hand movements showed that at 4 months coordination between both hands is not different from noise ($t(4) = 0.721$; $p = .511$), but from 6 months onwards rhythmic coordination is not a random process (6mo: $7(9) = 2.755$; $p = .022$; 9mo: $t(11) = 4.144$; $p = .002$; 12mo: $t(6) = 5.065$; $p = .002$). Overall, our preliminary data suggest an increase in rattling movements and hand movement coordination in the social context across the first year of life. Younger infants at 4 and 6 months seem not to make multiple rattling movements which could be explained by their immature motor control.

P1-A-21 - Developmental changes in infants interlimb coordination during book-sharing and rattling (Laudanska)

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Infants produce a variety of spontaneous arm and leg movements across the first year. The pattern of spontaneous movements seems to initially involve all the limbs simultaneously and refine with age to a more selective interlimb coordination (Piek & Gasson, 1999; Piek et al., 2002). There is a dissociation between arms and legs movements with age (Kanemaru et al., 2012), facilitating object manipulation and playing with toys (Watanabe & Taga, 2009). Moreover, the legs movement activity becomes more

repetitive and stable with age, while the inverse pattern is observed in the arms (Abney et al., 2014). However, it is not yet known how the overall interlimb coordination changes across different play contexts. Here, we report the preliminary results of 24 infants (a part of a bigger longitudinal study) playing with books and rattles during interactions with their caregivers at 4-, 6-, 9- and 12 months of age. Infants' limbs movements were recorded using motion trackers and analyzed using dynamical systems methods. Particularly, we focused on Multidimensional Recurrence Quantification Analysis (MdRQA, Wallot, 2016) measures (Entropy - a descriptor of the signals complexity, Recurrence Rate, which provides a general measure of the shared dynamics between limbs and Mean Line - an indicative of the system's stability) to investigate interlimb coordination patterns in both tasks. Changes in complexity over time were estimated by fixing the MdRQA parameters during the first visit to the lab and using these same parameters to calculate the complexity measures in consequent visits. Each limb data was z-scored prior to any calculation. Finally, we used the General Estimating Equations to assess the effects of age in each play type. We found that in the book-sharing task infants limb movements became more complex (higher Entropy, Wald $\chi2$ (3) = 15.119, p = .002), more stable (longer Mean Line, Wald $\chi2$ (3) = 10.809, p = .013) and showed more confined attractor state (higher Recurrence Rate, Wald $\chi2$ (3) = 19.741, p < .001). In contrast, in play with rattles we observed an age-related increase in Recurrence Rate (Wald $\chi2$ (3) = 8.701, p = .034), but not in Entropy (Wald $\chi2$ (3) = 5.900, p = .117) or Mean Line (Wald $\chi2$ (3) = 5.076, p = .166). Finally, no correlation was found between the MdRQA measures between both tasks (all r < .165 ; all p > .180). Overall, we observed the developmental changes in infants' interlimb coordination. These changes could be explained by the increase in infants' motor control. Furthermore, the lack of correlations between MdRQA measures in book-sharing and rattling suggests that infants adjust their motor behavior to the task constraints. Particularly, rattling promotes rhythmic repeated arm activity, constraining limb movements complexity and stability compared to book-sharing. A more mature motor system allows infants to adjust their movements to the task demands, which translates to an overall increase in complexity. Further analysis will expand these results to other tasks (e.g., free-play).

P1-A-22 - The relationship between object exploration and motor skills across the first year of life (Federico)

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Exploration of objects throughout infancy has been predictive of later gross and fine motor skills. However, understanding of how specific object manipulation behaviors relate to motor skills and how object manipulation changes over time in very early infancy is limited. Given the importance of early motor skill development for later childhood cognitive outcomes (Piek et al., 2008), this study examined (a) changes in unimanual and bimanual exploration and (b) the relationship between unimanual and bimanual object exploration with fine and gross motor skills. Participants (n=32) completed a brief object interaction at 6 and 9 months. At 12 months, the motor scales of the Mullen Scales of Early Learning were completed. Infant-object interactions were coded frame-by-frame for two types of object exploration: unimanual (touching object with one hand) and bimanual (touching object with two hands). Infants spent equal proportions of time engaged in unimanual exploration at 6 months (M=.43; SD=.35) and 9 months (M=.38; SD=.32), t(21)=.98, p = .336. However, bimanual exploration significantly decreased between 6 months (M=.36; SD=.37) and 9 months (M=.09; SD=.14), t(21)=-3.4, p<.01.

Multiple regressions were used to investigate the relationship between object exploration and 12-month motor skills. In the fine motor (FM) domain, unimanual exploration at 6 and 9 months was negatively associated with 12-month FM scores (6 months: R2 = .25; F(1,18)=5.92, p=.03; 9 months: R2= .25; F(1,20)=6.57, p=.02. Bimanual exploration at 6 and 9 months was unrelated to 12-month FM skills (ps > .05). In the gross motor (GM) domain, unimanual exploration at 6 and 9 months was unrelated to GM skills. On the other hand, bimanual manipulation at 6 months, but not 9 months, negatively predicted GM skills at 12 months (6 months: R2=.06; F(1,18)=5.14, p=.04). This study found that bimanual, but not unimanual, exploration decreased between 6 and 9 months, suggesting that bimanual exploration of this particular object may be a developmentally-sensitive skill that decreases with maturation. In regard to predictive associations, more time engaging in unimanual object exploration predicted lower fine motor skills while more time engaging in bimanual manipulation predicted lower gross motor skills. One interpretation of this finding is that infants who use two hands to obtain and hold objects do not yet have the underlying gross motor skills, e.g., truncal and postural stability, that support unimanual reaching and exploring. Thus, more bimanual manipulation at 6 months may in fact be an indicator of weaker gross motor skills that persists 6 months later. The finding that unimanual exploration negatively predicted fine motor skills is surprising and is likely related to object affordances. Diverse object characteristics afford different exploration behaviors. The object used in this interaction provides many places for infants to grasp and hold and does not require complex fine motor coordination. Thus, infants who spend more time engaged in simple, unimanual exploration may actually be less advanced in fine motor abilities. Future studies may investigate the difference between grasping and more complex actions such as fingering the object in relation to later acquisition of motor skills.

P1-A-23 - First-Look Results from a Genome-Wide Association Study of Infant Motor Milestones (Gui)

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Background Motor milestones reflect an infant's attainment of specific motor skills by a certain age. In the medical profession, delay in attainment of these milestones such as learning to walk, are commonly used as a signpost for abnormal motor development. Twin studies suggest that motor milestones such as learning to walk independently are highly heritable (Smith et al., 2017). However, genetic influences have not been investigated more widely using genome-wide molecular genetics methods. The goal of the Genetics of Early Milestones and Skills (GEMS) project is to investigate the genetic architecture underlying infant milestones and skills using genome-wide association meta-analyses (GWAS). We present first-look results of the first GWAS of age at first independent steps in one of the samples participating in GEMS, the Lifelines cohort. Methods Lifelines is a multi-disciplinary prospective population-based cohort study with a unique three-generation design. It focuses on the health and health-related behaviours of 167,729 people living in the North of the Netherlands (Scholtens et al., 2015). Parents of 12,034 children (6,223 females and 5,811 males) aged between 3 and 18 years of age (mean = 10.54, SD=3.63) were asked retrospectively to report when their children started to walk 3-5 steps without needing help. Children were genotyped using the Infinium Global Screening Array® (GSA) MultiEthnic Disease Version. Genotype data were imputed using the Haplotype Reference Consortium

(McCarthy et al., 2016) reference panel and filtered for low quality and rare Single Nucleotide Polymorphisms (SNPs). A total of 6,912,774 common SNPs and 3,420 children clustering as Europeans based on Principal Component Analysis (1,770 females and 1,650 males) were included in the final GWAS analysis. Association between genotype at each of the SNPs and age at first steps was tested with a linear mixed model implemented on the fastGWA method from the Genome-wide Complex Trait Analysis software (Jiang et al., 2019), which accounts for relatedness within the sample by calculating a Genetic Relatedness Matrix from SNP data. Linkage-Disequilibrium score regression was used to calculate SNP-based heritability for the trait (Bulik-Sullivan et al., 2015). Age of child at the time of parent report, sex, genotyping batch and 10 ancestry principal components were included as covariates in the model to control for possible confounding effects. Results Analyses revealed that a SNP heritability of 9.2% for age at first steps. As expected, based on the relatively small sample size, the GWAS analyses did not reveal any genome-wide significant SNPs associated with our key gross-motor milestone. However, promising signals were found at a suggestive threshold of $p<1 \times 10\text{-}5$ (Figure 1) on chromosomes 1, 2 and 14. Discussion The first gene discovery project on infant motor milestones suggests that part of the individual differences in age for learning to walk is explained by common genetic variation. Future steps in GEMS will include combining the summary statistics from multiple infant cohorts included in our planned meta-analysis of GWAS to increase power and to shed light on the genetic pathways underlying motor development, with possible implications on clinical interventions for children with motor impairment.

P1-B-24 - Infant EEG markers of novelty detection show longitudinal associations with preschool executive function outcomes in rural Gambia. (Katus)

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Background. Over recent years, neuroimaging is increasingly being used to assess neurocognitive development in young, at-risk infants from diverse settings globally. These measures have successfully been implemented in infants longitudinally from birth (Lloyd-Fox et al.,2019, Katus et al.,2020), and have shown concurrent associations with exposure to environmental adversity (Jensen et al.,2021, Wijeakumar et al.,2019, Xie et al.,2019). The next crucial step in assessing the potential of neuroimaging measures to support early identification of at-risk individuals is to examine whether early individual differences in response patterns during infancy are associated with long-term developmental outcomes. Here, we assess associations of infant EEG measures of habituation and novelty detection (1, 5 and 18months) with executive function (EF) outcomes at preschool age (3-5 years) in a cohort (N=204) in rural Gambia, West Africa. We hypothesised that strong habituation and novelty responses during infancy would be associated with higher EF scores at preschool age. Method. Data were collected as part of the Brain Imaging for Global Health project (BRIGHT, globalfnirs.org/the-bright-project), a prospective longitudinal cohort study which to date has examined N=118 infants from 0-5y). EEG markers of habituation (magnitude of response decrements to repeated stimuli) and novelty detection (magnitude of response to novel compared to standard sounds) were collected via an auditory oddball paradigm (Katus et al.,2020) at 1, 5 and 18m. EF (inhibitory control, cognitive flexibility and working

memory) were assessed via a tablet-based assessment (eytoolbox.com.au/) at 3-5y. Using Confirmatory Factor Analysis (CFA), we tested whether EF scores clustered into domain-specific subscales (3-factor-model) or represented one shared EF resource (1-factor-model). Bivariate correlations were used to assess associations between the EEG markers and EF latent variables. Our preliminary results are based on a subset of children who completed the 3-5y age point before February 2022. Results. CFA indicated all EF scales loaded onto a common latent EF factor. We found positive correlation between novelty detection at 5m (r=.21, N=87, pFDR=.026) and 18m (r=.222, N=83, pFDR=.037) and preschool the EF factor. No association were found between EEG habituation markers and EF. Discussion. Our results show an association between infant EEG markers of novelty detection, but not habituation, and preschool EF. Specifically, we found that children with a strong novelty response at 5m and 18m, but not at 1m, show higher EF scores at preschool age. Given our previous findings from this cohort (Katus et al.,2020) showed that a novelty response first emerges only for a subset of infants at 5m, before becoming robust by 18m, the current findings indicate that individual variance in our neural markers of novelty detection at 5m holds potential as a meaningful early biomarker for later development. In sum, our preliminary analyses highlight the potential of infant neuroimaging to inform identification of individuals at-risk for compromised long-term neurodevelopmental outcomes. Further analyses, once data collection on BRIGHT-Kids is completed, will include the full cohort. In future work population specific adversity related factors will be integrated to more fully interrogate these individual differences in developmental trajectories.

P1-B-25 - Do mutual gaze onsets play a role in establishing interpersonal neural entrainment? (Marriott Haresign)

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Temporal coordination of behaviour during parent-infant social interaction has been shown to be crucial in supporting early language acquisition and cognitive development (Carpenter et al., 1998; Donnellan et al., 2020). Despite growing confidence in theories suggesting that increased interpersonal neural entrainment supports social communication and coordination, little is concretely known about how interpersonal neural entrainment is established and maintained during social interaction. Here we aimed to take initial steps in addressing this deficit. We extracted EEG activity around naturally occurring gaze onsets from EEG hyperscanning recordings of parent-infant social interactions in N=55 dyads (mean age 11 months). Gaze was coded from video recordings offline frame by frame at 50fps. From this we defined two types of looks onsets; sender gaze onsets were defined as times when either the adult or the infant made a gaze shift towards their partner at times when their partner was either reciprocating their gaze (mutual) or not reciprocating their gaze (non-mutual). Receiver gaze onsets were defined as times when either the adult or the infant is already looking at their partner (mutual) or not looking at their partner (non-mutual) and their partner makes a gaze shift towards them. We used inter-trial coherence (2-18 Hz, over occipital electrodes) to assess whether significant phase resetting occurred around sender and receiver gaze onsets. We also examined whether this associated with changes in interpersonal neural entrainment (measured using Phase-Locking Value and Partial Directed Coherence) between the 'sender' and 'receiver' around gaze onsets. Lastly, we compared interpersonal neural

entrainment between mutual and non-mutual gaze. We predicted that changes in phase alignment around mutual gaze onsets would occur concomitantly in the sender and receivers brain activity. Further, mutual gaze onsets would result in more intra brain phase resetting and greater interpersonal neural entrainment (measured using PLV and PDC, in frequencies 2-18 Hz, over occipital electrodes) than moments of non-mutual gaze. Contrary to what we expected, no significant increases in interpersonal neural entrainment were detected during mutual gaze as compared to non-mutual gaze. We also observed no significant increases in interpersonal neural entrainment relative to either mutual or non-mutual gaze onsets. Although we found evidence for phase resetting around 'sender' gaze events, this did not differ between mutual and non-mutual gaze. Contrary to previous findings, no brain changes were observed around 'receiver' gaze events. One possible reason that our results are inconsistent with previous research, is our use of a novel paradigm. Here we extracted gaze onsets from a puppet play interaction. The presence of the puppet could have detracted from the salience of the adult's gaze and impacted IBE during mutual gaze. Our results could suggest that interpersonal neural entrainment is better looked at relative to events in our environment with more predictable inputs e.g., speech (Calderone et al., 2014) and further could also suggest that changes in interpersonal neural entrainment are not detected relative to mutual gaze in all social contexts, warranting further study into the conditions under which such entrainment does arise.

P1-B-26 - Neural correlates of infant social attention are linked to aspects of parent-infant interaction in autism (Papageorgopoulou)

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Background: Reduced eye contact and delays in social communication and interaction are among the core symptoms of autism, emerging in behaviour after 12 months of age. However, brain function measures have been able to identify subtle differences in social attention, such as eye gaze and face processing in the first year of life. Differences in the neural basis of social attention have been hypothesized to relate to behavioural social attention, and alter the child's interactions with their caregivers (Elsabbagh & Johnson, 2010; Klin et al., 2021). Here, we examine the relation between brain function and parent-infant interaction (PII) in a prospective cohort of infants with and without a family history of autism. Methods: Using a Structural Equation Modelling approach, we tested whether the amplitude and latency of infant brain responses (Event-related potentials, ERPs) to visual stimuli (P1, P400 and N290) were associated with specific features of PII in a group of 243 8-month-old infants with (at Elevated Likelihood, EL, N=166) and without (Typical Likelihood, TL, N=77) family history of autism. Event-related potential responses to faces with direct gaze vs/or averted gaze/non-faces and to dynamic eye gaze shifts directed toward vs away from the infant were linked with specific aspects of unstructured PII (infant attentiveness to caregiver, parent sensitivity: parent sensitive responsiveness and non-directiveness). The mediating role of infant behavioural attentiveness between brain function and parent sensitivity was also examined. Results: No direct associations were found between the brain measures and parent sensitivity. However, infant behavioural attentiveness to parent was associated with the P1, N290 and P400 components differentially in the EL and TL controls; the relationship between face processing amplitude (P1, N290 and P400 responses to faces with direct vs averted gaze

or vs non-faces) and parent sensitivity was significantly mediated by infant attentiveness to parent within play interaction only in the EL group (EL: β=-0.072, p=.043, TL: β=0.077, p=.301), while faster brain responses to both social and non-social stimuli were linked to greater attentiveness to parent in the TL group (TL: β=-0.32, p=.048, EL: β=0.14, p=.301). Conclusion: These results may reflect diverging neurodevelopmental pathways to visual social attention that relate to social attention within the context of play between the EL and TL groups, specific to the magnitude and the timing of brain response in EL and TL infants, respectively. They provide evidence that infants who are more interactionally attentive to their parent exhibit greater coupling between neural processing of faces and parent sensitivity. Further work employing a longitudinal design is needed to better understand the possible causal mechanisms between brain and caregiver-infant interaction processes leading to autism outcome.

P1-B-27 - Assessment of neurobehavioral consequences in children due to COVID-19 infection during pregnancy: Preliminary results of a study. (Kehdi)

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Introduction: The new coronavirus pandemic was initially dispersed in the city of Wuhan (China), where the first cases were detected. On March 11, 2020, COVID-19 was characterized by the World Health Organization as a pandemic (World Health Organization, 2021). In Brazil, the first confirmed SARS-Cov-2 acute respiratory syndrome (COVID-19) case occurred on February 26, 2020, in São Paulo. The scientific community then began an effort to understand how the virus behaved and its repercussions on more vulnerable groups, such as pregnant women and their offspring. To date, the consequences to children of pregnancy exposure to COVID-19 are not yet completely known. Indeed, the excessive immune activation induced by the virus, known as cytokine storm, can affect the child's development per si or function as a hit to unmask genetic predisposition to autism, cerebral palsy, and neuropsychiatric disorders such as schizophrenia (Knuesel et al. 2014) Objectives: To evaluate the development of children whose mothers were affected by Covid-19 during pregnancy. Methodology: 16 babies were captured between February and August 2021 whose mothers had a clinical picture and positive tests for Sars-Cov-2 during pregnancy, most in the third trimester. These children will be followed up to two years of age. Assessments were performed at six months of age using the Bayley III scale, and subsequent new evaluations will be conducted. Here, we present the preliminary results of the initial analysis of this population. Results: Of the16 children evaluated in the cognitive domain: 12 (75%) had no delay, 2 (12.5%) had a mild delay, and 2 (12.5%) had a moderate delay. 14 (87.5%) had no delay regarding the language domain, and 2 (12.5%) had a mild delay. Regarding the motor domain, 14 (87.5%) had no delay, 1 had a mild delay (6.3%), and 1 had a moderate delay (6.3%). No child evolved with severe delay. Discussion: Our results, although preliminary, point to the existence of a group of children born during the pandemic who manifested developmental delay in the motor, language, and cognition domains. A growing body of research points to delays in children born during the pandemic. Such studies found delays in motor and language domains at six months and at one year in children born during the pandemic, with no differences between children exposed to and not exposed to covid-19 in the perinatal period (Huang et al 2021; Shuffrey et al., 2022). It is still early to establish a direct correlation between the results and maternal exposure to the virus. However, the control subgroup is

still in the collection process, and subsequent evaluations may bring more data to the existing ones. Conclusion: Our results suggest that prenatal exposure to SARS-CoV-2 can lead to a neurodevelopmental delay in part of the exposed children.

P1-B-28 - Neural Correlates of Joint Attention and Language Among Infants with Emerging Autism Symptoms (Cohenour)

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Background: Language delays and impairments in joint attention are highly prevalent among infants and toddlers with or at-risk for autism spectrum disorder (ASD). Response to joint attention (RJA) is a social-cognitive skill foundational for language development (Bottema-Beutel, 2016). Despite the importance of RJA for social and language development, little is known about the neural correlates of RJA in infants with ASD symptoms. Alpha oscillations measured via EEG have been shown to index cognitive function in infants and toddlers with ASD (Dickinson et al., 2018), and alpha activity during this period is thought to provide necessary "infrastructure" for the development and refinement of neural circuitry subserving increasingly complex cognitive competencies. Thus, examining associations between alpha oscillations and emerging social-communication skills may shed light on risk and protective factors underpinning variable social-communication outcomes in ASD. The aim of the present study was to examine neural correlates of RJA and language in the second year of life among children with emerging autism symptoms. Method: Participants were N=70 (20% female; 55% non-White) 12-to-23-month-olds (M=18.07) enrolled in an intervention study (P50-HD055784, PI: Kasari) for children with ASD symptoms. The present study uses data collected at baseline. RJA was measured via the Early Social Communication Scales. Receptive (RL) and expressive language (EL) were assessed on the Mullen Scales of Early Learning. Resting EEG data were collected under task-free conditions using a high-density 128-channel system. Our analyses focused on relative alpha power (6-9 Hz) across four ROIs: left and right fronto-central and parietal/occipital regions. Spearman?s correlations were calculated to evaluate the strength of association between social-communication variables and relative alpha power in the four ROIs. Results: Analyses revealed that increased mean alpha power in the right fronto-central region was positively associated with RJA, RL, and EL (p's<.05), and stronger RL and EL skills were associated with increased power in left and right parietal/occipital regions (p's< .05). Increased power in left fronto-central regions was also associated with stronger EL skills (p=.03). See Table 1 and Figure 1. Conclusions: Consistent with previous work in neurotypical development, our preliminary findings indicate that increased regional alpha power (suggestive of more robust underlying neural circuitry) is associated with stronger social-communication skills among children with early autism symptoms. The relationship between RJA and right fronto-central alpha power is intriguing given that functional differences in the right prefrontal cortex have been noted in children with atypical attentional modulation due to ADHD (Arnsten, 2009). Our findings suggest stronger neural circuitry within the right fronto-central region supports the more sophisticated attention-shifting capabilities required for RJA. Associations between language and alpha power across the scalp suggests the recruitment of distributed large-scale networks are relevant for language skills in this specific population. These findings provide a foundation for further study of neural mechanisms driving varying trajectories of social-communication development in ASD, and brain-based predictors of response to an early intervention targeting joint attention and language in infants/toddlers at risk for ASD.

P1-B-29 - Extra motor stimulation and the development of speed perception in infants (Van der Meer)

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A high-density electroencephalography (HD EEG) study was carried out to investigate the effects of receiving extra motor stimulation on the development of motion speed perception during the first year of life. Infants having received extra stimulation in the form of baby swimming courses and control infants without baby swimming experience, were tested longitudinally at the age of 4-5 months prior to the onset of self-produced locomotion and again at 9-12 months with at least several weeks of crawling experience. Brain activity was measured in response to an optic flow pattern consisting of a virtual road with moving poles at either side of it, simulating structured forward motion at three different ecologically valid speeds. Visual evoked potential (VEP) and temporal spectral evolution (TSE) were analysed on EEG data recorded with a 128-channel sensor array. VEP results showed overall N2 latencies for motion to be significantly shorter for extra-stimulated infants than for control infants across testing sessions. The results further revealed a significant improvement in latencies with age, where crawling extra-stimulated and control infants at 9-12 months had shorter latencies for motion speed than when they were 4-5 months and still prelocomotor. In addition, only older infants with locomotor experience could significantly differentiate between low, medium, and high speed with shortest latency for low speed and longest latency for high speed. TSE results indicated a progression from low-frequency theta band activity to high-frequency alpha band activity in response to motion during the course of the first year. Only extra-stimulated infants at 9-12 months showed adult-like beta band activity in addition. It was concluded that the observed changes in brain electrical activity in response to visual motion during the first year of life are related to an interacting process between neurobiological development and increased self-produced locomotor experience, while extra motor stimulation contributed to an accelerated development of speed perception in extra-stimulated infants. For a better understanding of the association between extra motor stimulation and accelerated brain development, as well as possible long-term effects beyond infancy, further research in a life-span perspective is suggested.

P1-B-30 - Restricted and Repetitive Behaviors in Infants and Toddlers with Autism Spectrum Disorder: Initial Results from New Instrument (Towle)

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Background: Restricted and Repetitive Behaviors (RRBs) significantly influence downstream development for young children with Autism Spectrum Disorder (ASD) (Harrop, McBee, & Boyd, 2016). For this reason, accurate and efficient RRB instruments are needed for children under the age of 4 years, as current measures may miss the manifestation of RRBs in this age group (Gibbs et al., 2012; Barton et al., 2013). This study applied a new instrument for RRBs in infants and toddlers with ASD that (1) is more comprehensive than existing instruments, (2) utilizes a combination of clinician observation and caregiver report, since each method contributes to veracity of behavioral documentation, and (3) aligns with the DSM-5 RRB constructs to facilitate both research and clinical use. Past reports on an earlier version of the instrument used a chart-coding method, whereas the current study reports on the live

administration of the instrument, which is its intended application. Objectives: (1) Provide description of the most relative frequencies of RRBs in infants, toddlers, and young preschoolers in the areas of Motor Stereotypies, Insistence on Sameness, Restricted Interests, and Sensory Behaviors. (2) Compare clusters of items in terms of relative endorsement with parent report vs. clinician observation. (3) Examine sex differences across the Domain areas of RRBs. Method: Participants. 40 children with ASD, Mage =32 m, SD=7.3 m; 75 % male, 84% White/Non-Hispanic. Instruments: ASD diagnosis--Best Estimate Diagnosis based on clinical interview, standardized developmental measures, and ADOS-2 and ADI-R. RRBs--The Infant-Toddler Restricted and Repetitive Behavior Inventory (IRRBI), Research Version, a 129-item checklist; domains correspond to DSM-5 diagnostic ASD criteria, combined clinician observation and parent report. In a previous version of this instrument, acceptable inter-rater reliability was established with two coders applying the inventory to evaluation reports. Results: Aim 1: The most common behaviors endorsed occurred in two Domains: Stereotypies (97% of participants had one or more behaviors endorsed), and Sensory Behaviors (all participants had one or more sensory behavior endorsed). For the Sensory Domain, five sensory areas each had Seek and Avoid items. Three Seek sensory Subdomains had endorsements (one or more) in the 80s (percent): Motor/ Vestibular/ Proprioceptive, Visual, and Tactile. Insistence on Sameness (IS) and Restricted Interests (RI) domains were endorsed at lower rates; IS/daily routine Clusters from 26% to 37%. For RI, unusual preoccupation with letters, numbers, and shapes occurred at 35.9%. Other types of over-focus were reported at 65.9%. Aim 2: The greatest differentials occurring in clinician observation vs. parent report were as follows: Higher parent report: Insistence on Sameness and Sensory Behaviors. Higher Clinician report: Certain motor and visual items that parents are less likely to recognize as atypical. Aim 3: There were very few sex differences across the RRBs. Conclusions: The current findings were generally consistent with previous literature but provided several areas of more detailed information to advance understanding of early RRBs. The results are encouraging in terms of developing the IRRBI for research and clinical use.

P1-B-31 - THE HIDDEN PANDEMIC: A LONGITUDINAL STUDY OF THE EFFECTS OF COVID-19-RELATED PRENATAL STRESS ON INFANTS? SLC6A4 METHYLATION AT BIRTH AND TEMPERAMENT AT 3 MONTHS (Provenzi)

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Background. The COVID-19 pandemic dramatically hit Northern Italy in the first half of 2020. The healthcare emergency rapidly emerged as a collective trauma that may have enduring detrimental effects during special sensitive periods. Pregnancy is such a sensitive period for mothers and fetuses; prenatal stress may result in epigenetic signatures (e.g., increased DNA methylation) of stress-related genes that in turn contribute to program infants' behavioral development. The serotonin transporter gene (SLC6A4) is susceptible to epigenetic regulation by adverse environmental exposures. Aim. In April 2020, we launched a longitudinal cohort study to assess the behavioral and epigenetic vestiges of COVID-19-related prenatal stress exposure in mothers and infants. Methods. Retrospective maternal self-report measures of COVID-19-related prenatal stress were obtained at birth. SLC6A4 methylation was estimated in 13 CpG sites with Next Generation Sequencing in buccal cells obtained from mothers and infants between 6 and 12 hours from delivery. Infants' temperament was assessed at 3-month-age. Results. A sample of 108 dyads provided complete data. No effects emerged for maternal SLC6A4

methylation. COVID-19-related prenatal stress significantly and positively associated with infants' SLC6A4 methylation in 7 out of 13 CpG sites. These sites loaded on a single principal component (PC1) accounting for 35% of total variance. PC1 methylation was significantly and positively associated with COVID-19-related prenatal stress as well as with infants' temperamental positive affect at 3 months. Discussion. Pregnant women experiencing prenatal stress during the COVID-19 pandemic may give birth to infants who present higher levels of SLC6A4 methylation compared to counterparts born from low-stress mothers. This epigenetic signature may be an early marker of temperament dysregulation at 3 months. In a sample of healthy mother-infant dyads, pandemic-related prenatal stress emerged as risk factor for infants' development. Appropriate policy and clinical actions are needed to promote timely preventive strategies.

P1-B-32 - 2-Brain Regulatory Attunement: Impact of Neonatal Stress (2-BRA:INS) study protocol: towards Translational Hyperscanning (Roberti)

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Every year, 5% of infants in developed countries are born preterm, i.e., below 37 weeks of gestational age (Purisch & Gyamfi-Bannerman, 2017). Preterm infants face many challenges in regulating dyadic attunement and synchrony in naturalistic interactions (Anderson & Cacola, 2017), and they are at heightened risk for a diagnosis of autism spectrum disorders (ASD) (Behnia et al., 2015; O'Reilly et al., 2021). Due to the heterogeneity of preterm infants' clinical conditions and ASD phenotypes, previous research failed in providing a precise mechanism for this association. The cerebral circuits responsible for the emergence of interactive attunement and synchrony (Tokariev et al., 2019) might be vital to studying these processes. Therefore, we aim to delineate a new protocol that will allow the detection of possible early markers of lack of attunement through the recording of mothers' and infants' electrical brain activity (electroencephalography, EEG). In our project, 9-month-old preterm (PT, corrected age) and full-term (FT) infants will engage in a Still Face Paradigm (SFP) with their mothers while recording their brain activity with a hyperscanning paradigm (Leong et al., 2017) (Figure 1). The SFP lasts 6 minutes and includes three phases: Play, 2-min face-to-face interaction; Still-Face, 2-min maternal unresponsive behavior; Reunion, 2-min face-to-face interaction (Tronick et al., 1978). A previous study confirmed the feasibility of recording EEG during the SFP (Perone et al., 2020). To investigate emotion regulatory and motivational processes, we will analyze the Frontal Alpha Asymmetry (FAA), measured as the difference in alpha band power at left and right sites over frontal cortex (Coan & Allen, 2004; Reznik & Allen, 2018). We expect PT dyads to show reduced behavioral synchrony and evidence of lower FAA compared to FT dyads during the SFP. By summer 2022, we plan on having preliminary results collected from pilot data of a few mother-infant dyads. For the first time in literature, this study will provide proof of two-brain synchronization in dyads of mothers and preterm infants, compared to full-term age-matched controls. This comparison may reveal potential early neurophysiological markers of less-than-optimal socio-cognitive development in preterm infants. Finally, we open the way to a new field of investigation: Translational Hyperscanning, where research and clinical practice work together towards identifying brain activation patterns as early indicators of risk.

P1-B-33 - Evidence for sense of agency by means of sensory attenuation in 9-month-old infants (Hinz)

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The sense of agency - the sense of being in control of one's own actions and their effects - is assumed to be an important part of a "minimal self" (Gallagher, 2000). An implicit marker of this concept in the adult literature is the sensory attenuation effect, in which neural sensory processing of self-produced sounds is attenuated in comparison to externally produced sounds. This effect remains present even when it is controlled for the motor activity of the action in the self-produced condition. So far only one study from Meyer & Hunnius (2021) investigated this effect in 3-month-old infants and reported only a trend towards sensory attenuation for self-elicited compared to irregularly presented audio-visual stimuli, but not compared to regularly presented stimuli. Also the effect vanished when controlling for motoric activity. Indeed, it has been hypothesized that for computing a sense of agency, one needs to be able to predict the effects of one's own actions (Blakemore, Wolpert & Frith, 2000). This ability can only be reliably shown in infants from 9 months of age (Verschoor & Hommel, 2017). Therefore, the sensory attenuation effect should be stronger in 9-month-old infants, which is what the study investigated. Data from 39 9-10-month-old infants (17 female; mean age: 293 days) were analysed. They participated in three conditions: a self-produced-condition, in which their button press elicited a 1.5s long audio-visual stimuli; an external condition, in which they had to passively watch the same audio-visual stimuli being presented on the screen; and a motor-condition, in which their button press elicited only the visual stimuli without sound. On average, the infants contributed 28.69 (SD = 11.76) trials, 68.38 (SD = 14.68) and 14.41 (SD = 6.56) trials respectively. Differences between conditions in any electrode were detected with the cluster-based permutation test implemented in the MATLAB Fieldtrip toolbox, using a two-tailed dependent-samples t-test (i.e. significance was reached with a $p < .025$) with the monte carlo-method. Overall, the self-produced condition had a significantly smaller amplitude ($p < .001$ for positive clusters, $p = .005$ for negative clusters) than the external condition. Rather frontal electrodes showed a more positive amplitude in the external condition from around 300ms to 800ms, while rather centro-parietal electrodes showed a more negative amplitude from around 350ms to 550ms (see Figures 1 and 2). When controlling for motoric activity by subtracting the signal of the motor-condition from the self-condition and comparing the resulting difference wave against the external condition, the effect was not significant anymore ($p = .026$). As there were even less trials in the motor-condition than in the self-produced-condition, adding the motor-condition to the comparison probably increased the signal-to-noise-ratio of the signal, erasing the effect from the comparison of the self- and external condition. Taken together, the results show that already 9-month-old infants process self-produced effects differently from externally-produced effects. Although flipped in polarity our results closely mirror topographies from adult studies using comparable paradigms (Baess, Jacobsen & Schröger, 2008; Hughes & Waszak, 2011). Together, this indicates that infants show sensory attenuation demonstrating that they have a sense of agency.

P1-B-34 - Early human behavior simulation in soft uterus environment (Kim)

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Due to the technical and ethical constraints of fetal and infant research, it is difficult to examine how sensorimotor experience induced by their behavior guides early human development and learning. From

the view of constructivist developmental science that experiments and interprets human development based on modeling and simulation, we have examined the mechanism in the acquisition process of body representation in the brain or the risk of developmental disorders in preterm infants focusing on differences in sensorimotor and tactile experiences due to differences in environment (e.g. Mori & Kuniyoshi, 2010; Yamada et al., 2016). However, since the simulation in previous studies was implemented with rigid fetal skin and the uterine model was mimicked as a simple sphere, the sensorimotor and tactile experience in the actual elastic uterine environment may not be adequately reproduced. Hence, we implemented a fetal musculoskeletal simulation running on MuJoCo, the latest physical simulator, to build a soft uterine environment based on a more realistic 3D morphology of the uterus (Dahdouh et al., 2014; Bibin et al., 2010), and get closer to generating the sensory feedback that a real fetus gets through its interaction with the environment. The design of the model was done in OpenSim, which is mainly used in the biomechanical field, and this was converted to be used in the physical simulator MuJoCo. The bones of the model were 3D scanned from a fetal skeletal model, and the skin was extracted from the fetal MRI data. Muscles were based on the OpenSim adult model (Lai, Arnold & Wakeling, 2017; Saul et al., 2015) and scaled to the size of the fetus. The dynamic muscle pathways and the coordinated coupling of joints such as the patella and scapula were also implemented in the MuJoCo wrapper. To examine the effects arising from the soft uterine environment, we compared the differences in tactile information structure of the intrauterine and extrauterine (hard floor) environments. A fetal model exhibiting spontaneous bodily movements, driven by spinal neural circuits including neural oscillators, was simulated in each environment to generate tactile information. Then we calculated the pairwise correlation of the tactile information between environments. We found the increased correlation within the body parts was observed in the intrauterine environment compared to the extrauterine one (Mdn = 0.14 vs Mdn = 0.07, $p < 0.01$, rank-sum test). We also converted the tactile data into the firing rates of Merkel cells. The average firing rate was higher in the intrauterine environment than in the extrauterine one (46.30 ± 10.09 Hz vs 16.39 ± 27.20 Hz, $p < 0.01$, rank-sum test). These results suggest that the soft uterus environment provides structured and richer tactile information than the hard floor environment. Implementing the soft model described above allows us to simulate more flexible activities involving early human development. For example, by changing the flexibility, it becomes possible to implement nesting with towels for preterm infants, which would contribute to the verification of postural support in actual perinatal care. We are also developing a model that reproduces the sensorimotor experience of twins, which has not been possible with the conventional spherical uterus model and expect to be able to verify how the environment that induces contact between twins causes different sensorimotor experiences compared to that of a singleton.

P1-B-35 - Frontal asymmetry assessed using functional Near Infrared Spectroscopy is associated with later emotional and behavioral problems. (Kelsey)

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Frontal asymmetry (FA) assessed during resting testing conditions using electroencephalography is a well-established biological correlate of approach (greater relative left FA) and avoidance (greater relative right FA) behavior and is considered a marker for psychopathology risk (Peltola et al., 2014). However, little work has assessed FA using other neuroimaging modalities, such as functional Near

Infrared Spectroscopy (fNIRS), which allows for more precise understanding about the localization of the response in the brain. Additionally, FA has rarely been studied during varying testing conditions, such as during the presentation of emotional content (e.g., positive, negative faces), which would allow for understanding of how approach/avoidance motivation changes in response to varying environmental cues. The current study had three major objectives: 1) examine whether FA responses in infancy assessed using fNIRS and localized to the dorsolateral prefrontal cortex (dlPFC) differ at the group level between positive (happy) and negative (angry and fearful) emotional faces, 2) test if FA responses to emotional faces at the individual level predict the presence of emotional and behavioral problems at 5 years of age, and 3) explore if and how asymmetries in other (i.e., non-frontal) areas of the cortex are associated with later emotional and behavioral problems. Ninety children (46.7% female; 83.3% White) were included in the current analytic sample. Participants were recruited during infancy and invited to participate in a larger longitudinal study of the development of emotion processing. During infancy (M age = 7.6 months, SD = 3.0; range = 4.0-12.0 months), fNIRS data were acquired (see Figure 1), and when the children were 5 years of age (M age = 62.1 months, SD = 2.0; range = 60.0-70.0 months), maternal report data regarding their child's mental health status (n = 88 questionnaire completion; n = 71 clinical interview completion) were collected. We found no differences at the group level in FA responses to positive versus negative faces. At the individual level, greater relative right FA in infancy in response to happy, but not to negative emotion (anger, fear), stimuli was associated with increased internalizing (B = 2.26, SE = .80, p = .006, η2 = .085), and externalizing (B = 2.01, SE = .86, p = .022, η2 = .059) problems at 5 years of age (see Figure 2). Greater relative right FA in infancy in response to happy faces was also associated with greater likelihood of a lifetime clinical anxiety diagnosis (B = .80, SE = .34, p = .018, Odds Ratio 95% CI [1.15-4.29]). Moreover, these responses appeared to be localized to the dlPFC, as they were not observed in other social brain areas. In conclusion, these findings suggest the dlPFC is involved in social-emotional functioning and that FA assessed in a positive social context in early life may be informative to early identification and prevention of later psychopathologies. These findings also support the use of fNIRS in early development as a method for assessing risk.

P1-B-36 - Emotion in motion: neural correlates of emotional face dynamics in infancy (Quadrelli)

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The ability to quickly recognize emotions from others' facial expressions is foundational for successfully managing multifaceted social interactions and for developing relationships with others. This is especially true early in life, when infants cannot rely on language to understand others' behaviors, but mainly observe and interpret gestures and facial expressions to grasp others' intentions and feelings. Indeed, the ability to detect and attend to facial emotions develops rapidly over the first year of life and is an essential step for recognizing others' emotions and subsequently navigate human social interactions throughout the lifespan. A considerable amount of behavioral and electrophysiological studies details the ontogeny of the ability to process others' emotions from the first months of life (e.g., Peltola et al., 2009; Rayson et al., 2017). However, while emotions are usually expressed in a dynamic way in everyday life, the majority of existing research in infancy is based on static stimuli with only a few studies exploring how dynamic information affects the processing of emotional faces (Rotem-Kohavi et al., 2017). In adults, neurophysiological evidence has shown that facial dynamics influence the perception of facial expressions, and that naturally moving faces provide more ecological stimulus material, compared

to static faces, for the investigation of the neural correlates of facial expression perception (Recio et al., 2011). The current contribution aims to expand our knowledge regarding the neural basis involved in the processing of facial emotions in infancy by 1) examining the modulation of attentional and perceptual event-related potential (ERP) components, 2) probing the involvement of sensorimotor areas, 3) and exploring brain functional organization in response to dynamic and static emotional expressions. Thirty-eight 7-month-old infants were included in the final sample and were randomly assigned to the static (n=19) or dynamic (n=19) condition. Stimuli consisted of color videos or photographs of female Caucasian actresses posing neutral, angry and happy facial expressions presented for 1000 ms. Statistical analyses were performed on amplitude and latency values of the Negative Central (Nc), N290 and P400 ERP components. In addition, activity of the sensorimotor cortex, as indexed by μ rhythm suppression (6-9 Hz) over central left (C3) and right (C4) clusters of electrodes, was analyzed and graph theory analysis was also used to investigate to which extent neural activity was functionally localized in specific cortical areas. Results revealed that happy and angry faces elicited a larger attentional Negative Central (Nc) component compared to neutral faces in the dynamic condition ($t17 < -2.29$, $ps < .05$; $ds > .45$), while in the static condition happy faces evoked a faster Nc compared to angry expressions ($t17 = 2.34$, $p = .03$; $d = .45$). Happy expressions also elicited greater sensorimotor activation compared to angry faces ($t18 = -4.11$, $p < 0.001$; $d = .94$) selectively in the dynamic condition. Furthermore, dynamic faces elicited higher global efficiency and lower networks' diameter compared to static ones ($t108 > 2.35$, $ps < .05$, $ds > .43$). Taken together, current results provide evidence of differential modulation of attentional and sensorimotor activity to static and dynamic faces and suggest that dynamic faces elicit a more efficient activation of networks as early as 7 months of age.

P1-B-37 - Are hands special in the first year of life? A study using oddball fast periodic visual stimulation with electroencephalography (Quadrelli)

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The early preference for looking at faces is well established (Mondloch et al., 1999; Turati et al., 2006) and neuroimaging studies revealed that infants' face perception depends on activity in specific regions within the right ventral and lateral occipito-temporal cortex (Conte et al., 2020). In addition, the Fast Periodic Visual Stimulation (FPVS), a paradigm developed to obtain an objective index of neural categorization, allowed to demonstrate that infants' EEG activity differentiate between visual non-face objects presented at a rapid rate (i.e., 6 Hz) and face stimuli presented at a lower rate (i.e., 1.2 Hz), indicating a right-hemisphere categorization response for faces vs non-face objects at 4 months (de Heering & Rossion, 2015). Much less is known about infants' early visual preference and neural sensitivity for hands. Existing research demonstrated that hands are salient stimuli starting from the first months of life, proving that infants intentionally spend most of their waking time looking at their own hands by actively trying to control arm movements in order to keep their hands visible (von Hofsten, 2004). Infants also show a preference for their hands in motion (van der Meer, 1997) and for biomechanically possible versus impossible hand movements (Longhi et al., 2015). From a neurophysiological perspective, the P400 event-related potential component, proposed to index social processing in early infancy (Senju et al., 2006), was reported to be sensitive not only to the processing of faces (de Haan et al., 2002), but also to the observation of grasping hands in 6-month-old infants who are proficient at grasping (Bakker et al., 2015) and to the observation of congruent pointing between 6

and 8 months of age (Gredeback et al., 2010). Based on these premises, the aim of the current study is to use a FPVS oddball paradigm coupled with EEG recording to investigate the neural discrimination of naturalistic hand images from other objects at 4 and 8 months. The deviant/oddball stimulus (i.e., hand) was introduced in the sequence, creating categorical changes (i.e., hands vs objects) at a frequency of 1.2 Hz. To date, twenty-seven 4-month-old and eleven 8-month-old infants have been tested and data collection is still ongoing. FPVS responses will be analyzed over occipital and occipito-temporal electrode clusters to identify the neural signature of hand categorization response early in life. Additionally, the role of experience in modulating the processing of hands will be evaluated by exploring the relation between infants' experience with manual actions (e.g., power or pincer grasps) and their ability to categorize hands. Furthermore, in order to track the neural correlates subtending the developmental trajectory of hand categorization, data from the two infant samples will be compared to an additional set of data that will be collected from a group of adult participants. Findings from the current study will be discussed with respect to the use of FPVS as a valid measure for investigating the neural correlates of infants' ability to categorize hand stimuli across the first year of life and the potential role of sensorimotor experience in shaping this capability.

P1-B-38 - Social reward anticipations in 7-month-old infants: An ERP study (Ishikawa)

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Looking at the same object or event with others, joint attention (JA), has been suggested as a key of the social cognitive development predicting future socio-cognitive abilities. It has been suggested that JA is rewarding for infants because infants are innately motivated to share interest and attention to the same object/event with other people (Tomasello 2007). Recent theoretical studies have suggested that human social decision-making based on reward prediction plays a critical role in engaging with social interactions (Gangopadhyay et al., 2020; Suzuki & O'Doherty, 2020). However, it remains unclear whether infants' brains can anticipate rewarding events before JA. Also, the neural mechanisms of infants' reward expectations have not been tested. A recent study revealed that pre-school children aged from 3- 4-years-old show the stimulus preceding negativity (SPN), an ERP component reflecting reward anticipations, before the presentation of social reward (Engle et al., 2021). Thus, we hypothesised that infants would also show the SPN during social reward anticipations after learning the reward predictivity of others' gaze. Fifteen infants aged between six- and ten-month-old completed and contributed the data analysis. Infants repeatedly observed that a female predictively looked toward the reward position (valid condition) or another female looking away from the target (invalid condition, see Figure 1). We named the first half of the task "before learning" and the second half "after learning." For each condition, 32 trials were presented, leading to a total of 128 trials (2 gaze conditions x 2 learning phases). It was posited that infants learn associations between female faces and the reliability of gaze cueing toward the reward position. To test ERP responses during the reward anticipation, ERP responses before the presentation of animation was analysed (Figure 2a). We observed a significant interaction effect between the gaze cueing and learning phases in SPN amplitudes ($F(1,14) = 13.674$, $p = .002$, $\eta p2 = .51$). Post-hoc t-tests revealed that a greater amplitude of SPN was found after the learning phase than before it in the valid condition ($p < .001$). In the invalid condition, there was no significant difference in the SPN amplitudes before and after learning ($p > .05$). Also, we analysed ERP responses after the presentation of a face (Figure 2b). We observed a significant interaction effect between the

gaze cueing and learning phases in SPN amplitudes ($F(1,14) = 13.674$, $p = .002$, $\eta p2 = .51$). Post-hoc t-tests revealed that a greater amplitude of N290 was found after the learning phase than before it in the valid condition ($p < .001$). In the invalid condition, there was no significant difference in N290 amplitudes before and after learning ($p > .05$). These results suggest that infants could anticipate social reward events from gaze cues, and learning the cue-reward association may affect not only reward anticipation but face perception. After learning the validity of gaze cueing, infants recognize which face induces valid cueing and can anticipate a social reward event (JA).

P1-B-39 - Can maternal touch lower infants' attentional bias towards fearful facial expressions? (Guida)

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Maternal touch is a non verbal cue that can regulate infants' internal states when facing distressing situations. For example, touch can lower infants' stress responses when maternal facial or vocal communication is interrupted (e.g., still-face paradigm) (Feldman et al., 2010). Furthermore, mothers' touch can lower children's vigilance to social threats (i.e. angry facial expressions) (Brummelman et al., 2019) and modulate 7-month-olds visual attention towards happy and angry faces (Addabbo et al., 2021). To date, no study explored whether maternal touch can lower the infants' attentional bias towards fearful expressions, which develops by the second half of the first year. Specifically, it has been consistently shown that fearful face modulates 7-months-old infants disengament of attention, as infants make slower saccades toward peripheral targets when the central stimulus is a fearful face as compared to targets following a happy or neutral face (Peltola et al., 2008). The objective of this study, whose data collection is still ongoing, is to understand if maternal touch can affect infants' attentional disengagement from fearful facial expressions. For this aim, we employ an overlap task recorded with the eye-tracking system. The eye tracking systems have provided laboratories with more objective indices of infant gaze behaviour and infants' visuospatial orienting (Gredeback et al., 2009). During the task, the infant is first presented with an emotional face (happy, neutral, and fearful) on the centre of the screen followed by a peripheral target stimulus (i.e., a checkerboard pattern) acting as an exogenous cue to orient attention to its location (Peltola et al., 2008). 7-month-old infants are divided into two groups for a total sample of 50 participants: in the No-Touch group (N=25), mothers are asked to stand still next to the infant without touching their child; in the Touch group (N=25), mothers were asked to stand next to their children touching their leg in a static way. Eye-tracking data will be analyzed using the measure of infants' disengagement latencies from the central to the lateral stimulus (i.e., saccadic reaction time). Data collection and analysis is still ongoing. To test for effects of emotion on disengagement latencies in the two experimental groups, a repeated-measures Analysis of Variance (rmANOVAs) with Emotion (Fear, Happy, Neutral) as within-subjects factor and Group (Touch, No-Touch) as between-subjects factor will be conducted. We expect to find a decreased attentional bias towards the fearful facial expressions and, thus, faster disengagement latencies from the fearful face in the Touch compared to the No-Touch group. We hypothesize that, by signaling safety, maternal touch would lower infants' attention to fearful faces, favoring disengagement from this negative facial emotional expression.

Thematic Poster - Innovative Psychophysiological Measures and Analyses that Inform Affective and Cognitive Development in Infancy (P1-B-40, P1-B-41, P1-B-42, P1-B-43)

P1-B-40 - Microstate Analysis in Infancy (Brown)

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The infant brain undergoes significant foundational and structural growth in the first year of life that has lasting impacts on the adult brain (Gilmore, Knickmeyer, & Gao, 2018). It has become evident that functional networks, rather than isolated structures, are what drive cognition (Biswal et al., 1995; Raichle et al., 2001). Additionally, the resting state has emerged as a complex cognitive phenomenon. These major shifts in neuroscientific paradigms have led to much research in connectivity and global brain networks. Most of the research has examined this global connectivity using fMRI. However, there are limitations that accompany fMRI, such as lack of temporal resolution and required stillness, that impact the ability to examine connective networks, especially in infancy. Electroencephalography (EEG) provides answers to these limitations, as EEG has superior temporal specificity and has less importance in remaining completely motionless, allowing for greater ecological validity. EEG also has the capability to examine both local and global aspects of brain activity. Microstate analysis is an emerging method for investigating global connections. Microstates have been colloquially referred to as the "atom of thought," meaning that from these underlying resting-state microstates comes cognition and neural processing (Lehmann et al., 1998).

The present study examined microstates across the second half of the first year of life, at 6, 8, and 10 months of age. It was hypothesized that infants will show distinct microstates that can be compared to previous adult literature as well as resting state networks identified in adults and infants using fMRI. This study found that microstates can be extracted from infant EEG data (Figure 1). Using a baseline task comprised of a stimulating video with dynamic images and sound, three microstates emerged that appear comparable to the underlying networks identified in the adult microstate literature (Michel & Koenig, 2018) as well as infant fMRI studies (Gao et al., 2017; Fransson et al., 2007). These networks were found in the previous literature to correspond with auditory and visual processing as well as the default mode network. Microstate 3, thought to correspond with auditory/language processing, increased across parameters at 10-months compared to 6- and 8-months of age. At 10 months of age, Microstate 3 was becoming activated more often, for longer periods of time, covering significantly more of the entirety of the task, and was more likely to be transitioned into. This finding is thought to correspond with language acquisition and phonological processing that comes online around this age (Morgan & Wren, 2018).

This line of research could act as a foundation for microstates research across the lifespan and is necessary to understand their emergence and the underlying resting state networks. Upon this foundation, many questions can be answered regarding connective states in infancy that would be impossible with currently utilized methods, such as stimulus tasks and a wakeful resting state.

P1-B-41 - Neurodevelopment of Functional Connectivity is Related to Temperament and Socio-Affective Interactions During the First Year (Mize)

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Models of infant temperament have pointed to the behavioral variation inherent to individuals and their physiological concomitants that are developing in concert within socio-interactive context. While studies have shown that EEG asymmetry and power are associated with temperamental qualities (Gartstein et al., 2019), there are only a handful of studies examining the development of EEG coherence and cognitive skills (Cuevas et al., 2012) and none to date on socio-emotional processing abilities. Logically, EEG coherence reflects developing brain synchrony (Hardin et al., 2021) yet researchers have not satisfactorily coupled early behavioral-brain synchrony. Seeking to rectify this oversight, measures of EEG coherence, temperament and socio-emotional interaction patterns within mother-infant dyads will be examined to understand neurophysiological plasticity across the first year of life.

In two sets of studies, infant EEG was analyzed to examine power and coherence measures. 115 infants were examined across age from newborn to 4-months and 200 infants were assessed across the 6- to 12-month period. IBQ-R scores as well as mother-infant socio-emotional responses during play and a distress task were also analyzed.

EEG coherence is a measure of the squared cross-correlation between two scalp electrode locations utilizing a specific frequency band. Since infant EEG frequency patterns shift across development, we analyzed the data using individual frequency bins from 0 to 20 Hz to find the spectral peak at each age. Frequency bands at 3-6 Hz and 6-9 Hz were used for younger and older infants respectively. The values for the coherence ranges between 0 and 1 and higher scores are theoretically related to greater functional connectivity between two neuronal groups (Thatcher et al., 1987; Pizzagalli, 2007). We examined coherence separately for each hemisphere (F3+F7, F3+C3, F7+C3, F3+P3, F7+P3, F3+O1, F7+O1, C3+P3 C3+ O1, P3+O1 and F4+F8, F4+C4, F8+C4, F4+P4, F8+P4, F4+O2, F8+O2, C4+P4 C4+ O2, P4+O2 using James Long Inc. software) in relation to temperament and social-emotional experiences.

Preliminary MANOVA analyses showed changes across age for Regional coherence pair by Hemisphere, F values ranged from 2.75 to 5.31, ps < .05. Further examination, revealed that frontal leads developed coherent relationships with more posterior regions and more predominantly with temperamental approach in the left compared to the right hemisphere.

Utilizing temperament ratings and mother-infant interactive emotional behaviors to predict EEG coherence, multiple regression analyses revealed that approach motivation and positive temperament as well as positive synchrony during play interactions unique¬ly predicted greater left frontal coherence from anterior to posterior regions, R2 values ranged from .31 to .39, ps<.05 At younger ages, multiple regression analyses showed higher coherence values in distant pairs (frontal to parietal, central to occipital, and frontal to occipital) in left hemisphere. Significant effects were also uncovered in the older infants in the left hemisphere along with associations with the baseline- to socio-interactive behavioral responses.

These findings will be discussed in relation to infant neurophysiological development and temperament across the first year as well as brain-behavior ties to socio-affective synchrony contributing to functional intra-hemispheric connectivity and neurodevelopmental plasticity.

P1-B-42 - Temperamental and Physiological Regulatory Capacity in Infancy: Prospective Links with Toddler Problem Behaviors (Hassan)

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Temperamental regulatory capacity in infancy sets the stage for later effortful control in childhood and has been negatively associated with problem behaviours. Infant's state-related changes in physiology in response to an environmental stressor (i.e., reactivity) and ability to return to a baseline state following the removal of a stressor (i.e., recovery) are also related to socio-emotional functioning. Polyvagal theory posits that cardiac vagal withdrawal, operationalized as baseline respiratory sinus arrythmia (RSA)-to-task decreases, signifies high levels of flexibility and a readiness for appropriate behavioral responses in difficult situations. Although correlates of effortful control during childhood have been well established, work integrating dispositional and state-related changes in infant's regulatory capacity in the prediction of prospective behavioral problems has received relatively less attention. The goal of the present study was to examine whether infant's physiological regulation and recovery indexed via changes in RSA from baseline to a task and to a recovery period moderated the association between infant regulatory capacity at 8 months and prospective problem behaviors at 14 months.

Participants were 50 healthy 8-month-old infants (Mage = 8.51 months, SDage = 0.28 months, girls = 25) who were exposed to the three phases of the Still Face Paradigm. During the play phase, mothers were instructed to play with their infants as they normally would in the home. This phase acts a baseline. During the still-face phase, mothers were instructed to display a neutral face and refrain from touching or speaking to the infant. This phase acts as a stressor. During the reunion phase, mothers were again instructed to interact with their infant as normal. This phase acts as a recovery period. Infants had their RSA measured during each of these three phases, and mothers reported on their infant's regulatory capacity using the Infant Behavior Questionnaire. At 14 months, mothers also completed the problem behaviors subscale of the Brief Infant and Toddler Social Emotional Assessment. We found that cardiac vagal regulation from baseline to still face, and cardiac vagal recovery from still face to reunion at 8 months, moderated the relation between infant regulatory capacity at 8 months and problem behaviors at 14 months. In infants who displayed relatively high cardiac vagal regulation from baseline to still face, and in infants who displayed relatively high recovery from still face to reunion, regulatory capacity was negatively associated with prospective problem behaviors. The relation between regulatory capacity and problem behaviors was non-significant in infants who displayed relatively low cardiac vagal regulation and relatively low cardiac vagal recovery.

We speculate that high levels of cardiac vagal withdrawal and recovery may support the negative relation between temperamental regulatory capacity and problem behaviors by allowing infants to focus their attention outward and cope with environmental demands as they arise, and upon removal of the environmental stressor, return to their baseline. Findings from the present study contribute to our larger understanding of temperament by physiology interactions in predicting behavior problems and will be discussed in the context of polyvagal theory.

P1-B-43 - Mother-Infant Dyad Behavioral and Physiological Synchrony at 36 Months: Infant Predictors and Concurrent Toddler Outcomes (Bell)

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Optimal development of self-regulation (SR) is promoted not only by bottom-up processes (behavior and physiology associated with temperament) and foundational top-down mental and biological processes, but also by co-occurring socialization experiences within the family (Sameroff, 2010). Socialization experiences critical to well-regulated infant and child outcomes go beyond the traditional focus on maternal warmth and scaffolding to include infant's and toddler's synchronous behavioral and physiological processes with their caregivers, known as dyad synchrony (DS; Bell, 2020; Feldman, 2012).

Thirty-four mother-toddler (36m) dyads cooperated on a puzzle while undergoing EEG hyperscanning. EEG was processed for task-related frontal EEG asymmetry (FA), an indicator of SR capacity in context (Coan et al., 2006). Offline we coded for maternal and toddler interaction behaviors (Smith et al., 2004). We divided FA into 1s epochs and used causal dynamic regression equations to model parent and toddler EEG data or intra-and inter-subject dynamic correlations as lagged coefficients LC). This Causal Synchrony Analysis (CSA) showed child FA responded to mother FA at a 2-sec lag. For girls, the FA LC was .042 (se=.014; p=.002). For boys, the FA LC was -.068 (se=.021; p=.001). Each second-by-second change in mother FA resulted in a 2-sec lag change in girl FA in the same FA direction as mother. Each change in second-by-second mother FA resulted in a 2-sec lag change in boy FA in the opposite FA direction as mother. Mother FA did not respond to toddler FA. Similar analyses were conducted with mother and toddler behavior.

Next, we conducted Full Interaction Synchrony Analysis (FISA) to examine dyads as an interacting system by combining behavioral and FA analyses. Specifically we used the sum of squares of the cross-correlations as aggregate measures of the strength of the DS between mother and toddler contemporaneously and in each direction. Our most robust mother-behavior analyses showed that the mother's directing behaviors ("let's see if it fits here") depended on boy FA during active non-compliance behavior at a 1s lag, with point estimate b= -.046, 95% CI [-.116,-.016], adjusted Rsqr=.81 in the CSA. Figure 2 (left) quantifies this association using FISA cross-correlogram CIs, with significant cross-correlations at a 1-sec lag. Our most robust child behavior analyses showed that boy compliant behaviors depended on mother's FA during mother's encouraging behavior at 1s lag, with CSA point estimate b = .025, 95% CI [.014, .082], and adjusted Rsqr = .80. See Figure 2 (right) for the FISA cross-correlogram CI plot, displaying significant concomitant cross-correlations across lags up to 5-sec.

FA recorded at 5m during baseline context (bottom-up reactivity) correlated with behavioral DS: toddler compliance after maternal encouragement (1s lag; r=.399, p=.029), and mother responsive encouragement after toddler passive non-compliance (1s lag; r=.451, p=.012). Concurrent toddler neurophysiological DS was related to toddler top-down behavioral SR: cognitive flexibility task (r=.613, p<.001; effortful control, r=.403, p=.025).

We propose that DS may be the mechanism by which early infant bottom-up reactivity and developing top-down SR processes are behaviorally and biologically related.

Thematic Poster - Advancing Methods in Infant Neuroscience (P1-B-44, P1-B-45, P1-B-46, P1-B-47)

P1-B-44 - Latent Profile Analysis as a Data-Driven Approach to Characterize Infant Baseline Electroencephalography (EEG) (Pierce)

Lara J. Pierce[1], Charles A. Nelson[2]

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Electroencephalography (EEG) is a powerful tool for probing neurodevelopment. Decomposing the oscillatory EEG signal into component frequency bands can reveal properties of cortical maturation and functional organization from the earliest stages of life. However, determining experiential contributors of individual variation in the EEG power spectrum is constrained by statistical power requirements necessary to test associations between multiple environmental variables and power in multiple frequency bands (e.g., delta, theta, alpha, beta, gamma). Moreover, considering patterns across frequency bands (versus individual bands in isolation) might reveal important new insights into neurodevelopmental processes. We demonstrate how a data-driven statistical approach - latent profile analysis (LPA) - can be used to isolate unique neurodevelopmental profiles from infant EEG. This technique provides a powerful data reduction strategy and facilitates identification of variables that modify early neurodevelopment.

We will begin by briefly introducing EEG as a method for exploring early neurodevelopment and will then provide an overview of the LPA approach. Using both cross-sectional and longitudinal data collected from infants at high risk for exposure to early life stress, we demonstrate how this approach can isolate subgroups of infants with relative risk or resilience for long term consequences of early adverse experience. We also suggest how profile membership could be used to predict developmental outcomes.

Data were collected from mother-infant dyads (n = 116) enrolled as part of a longitudinal project designed to explore effects of early adversity on development. Family demographic variables and exposure to stress were assessed using maternal-report questionnaires. Five minutes of baseline EEG was collected from infants at 2, 6, 9, 12, 24, and 36 months of age. Data were processed using the Harvard Automated Processing Pipeline for Electroencephalography (HAPPE; Gabard Durnam et al., 2018), and power in six frequency bands (delta, theta, low alpha, high alpha, beta, gamma) was extracted using the Batch Electroencephalography Automated Processing Platform (BEAPP; Levin et al., 2018). Latent profile analysis was used to fit latent class models to whole-brain EEG power in each frequency band (both log10-transformed absolute and relative power). Each analysis began with a 2-class model, with successive models adding more classes until model fit no longer increased. At 2-months, we found two unique profiles derived from absolute EEG (one profile displaying high, the other displaying low power across all frequency bands), and two unique profiles derived from relative EEG (one profile displaying low power in high frequency bands and high power in low frequency bands; the other displaying the reverse pattern; Pierce et al., 2019). Multinomial logistic regression determined that maternal perceived stress and maternal education, adjusting for other socioeconomic variables, predicted membership in unique EEG profiles. Comparable profiles were identified at later time points, suggesting stability of unique EEG profiles over time. Applications to both cross-sectional and longitudinal analyses will be discussed. We demonstrate how this novel use of LPA can be used to isolate unique infant EEG profiles that are a) associated with variation in infants' early experience, and b) indicative of relative risk/resilience for subsequent development.

P1-B-45 - Advantages of Linear Mixed Effects Models for Analyzing Event-Related Potentials in Infants and Young Children (Heise)

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Event-related potentials (ERPs) are advantageous for investigating cognitive development. However, their application in infants and young children is challenging given infants' difficulty in sitting through the multiple trials required in an ERP task. Common ERP analytic approaches (e.g., ANOVA) involve averaging trials within subjects, and excluding subjects with too few trials due to low signal-to-noise ratio in averaged ERPs. We demonstrate an alternative approach--linear mixed effects (LME) modelling--which offers unique utility in developmental ERP research. LMEs include all artifact-free ERP trials and have clear advantages over ANOVA. We will first briefly introduce the ERP method and then provide an overview of LMEs and their advantages. We then demonstrate with both simulated and real ERP data from 3-year-old children that commonly employed ANOVAs yield biased results, with increasing bias as subject exclusion increases. This bias is particularly relevant for infant ERP studies, which have the highest percentages of subject exclusion in child ERP research. In contrast, LMEs yield accurate, unbiased results even when subjects have low trial-counts, and are better able to detect real condition differences. We also present data examining the utility of LMEs for analyzing 'difference waves' (i.e., a waveform that represents the difference in ERP amplitude across conditions) and 'ERP latencies' (i.e., the time from trial onset until peak ERP amplitude). These additional types of ERP analyses pose challenges for LMEs, and thus we explore the potential utility of LME for latency and difference wave analyses. Difference waves are typically calculated by averaging condition amplitude across trials, and then subtracting average amplitude in one condition from another. Given that LMEs require trial-level data, it is unclear how single trials across conditions should be paired for difference wave analysis. We present results from 3 novel methods for trial-level difference wave pairings for LME analyses: (1) exact-trial pairings (e.g., trial 1 in condition A paired with trial 1 in condition B, etc. and any trials without an exact match would be excluded), (2) nearest neighbor pairings (e.g., trial 1 in condition A paired with nearest available trial in condition B), and (3) random permutations (e.g., equal probability of trial 1 in condition A being paired with any other trial in condition B).

It is also unclear how to analyze ERP latencies with LME, because unlike with analysis of ERP amplitude (in which the mean of all single-trial amplitudes is equal to the amplitude extracted from the mean-averaged waveform), the latency of a single trial may not reflect the average latency across trials because latency describes a single peak within the ERP waveform, which is affected by high amplitude noise in single trials that is 'averaged-out' in the mean-averaged waveform. Thus, in this talk we also examine whether LMEs are able to detect true estimates of latency in the presence of single-trial noise. In sum, we demonstrate in simulated and real pediatric ERP data that, in contrast to mean-averaging for ANOVAs, LMEs provide a more accurate and robust estimate of mean ERP amplitude. We further explore the potential utility of the LME method to accurately measure ERPs and prevent data loss for other types of ERP analyses (latency and difference wave).

P1-B-46 - Magnetic Resonance Imaging (MRI) Techniques to Explore Early Brain Development (Riggings)

Tracy Riggings[1]

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Magnetic resonance imaging (MRI) provides a safe and unique opportunity to explore the structure and regional activation of the developing brain. Recent advances in image acquisition combined with developmentally informed approaches and innovative paradigms have allowed these tools to be used successfully in infants and young children. The goal of this talk is to highlight several of these advances,

which I hope will ultimately encourage infant researchers to see MRI as a useful and feasible methodology to explore the development of the neural bases of their domain of interest. In this talk I will briefly review multiple types of scans that are currently available and what they reflect about the developing brain (i.e., structural MRI, functional MRI, diffusion MRI, and quantitative MRI). I will also highlight breakthroughs in image acquisition that allow for shorter scan durations, which are critical for scanning young individuals with limited attention spans and increased propensity to move (i.e., multi-band acquisition and compressed sense). I will present several strategies and techniques that promote the collection of high-quality data (swaddling infants, scanning toddlers during natural sleep, and the use of fabric play tunnels to acclimate toddlers and preschoolers for awake scanning). I will present behavioral paradigms from my lab and others that allow for the exploration of brain-behavior relations. These paradigms include 1) exploring visual learning in awake infants (e.g., Ellis et al., 2021), 2) presenting sound stimuli to sleeping toddlers to explore memory (e.g., Prabhakar et al., 2018), and 3) passive-viewing or movie paradigms to explore functional networks in preschoolers and relations with behaviors outside the scanner (e.g., Geng et al., 2021).

Finally, I will articulate the need for longitudinal data and appropriate analytic approaches. In older children and adolescents it has recently become apparent that cross-sectional findings often vary from longitudinal findings (c.f., Geng et al., 2019; Geng et al., 2021). This may be due to vast individual differences in metrics of interest. Thus, longitudinal data are critically needed. These data can be collected by individual labs but also will become available with large initiatives such as the NIH-sponsored Baby Connectome Project (Howell et al., 2019), which used a hybrid accelerated longitudinal and cross-sectional study design to characterize brain and behavioral development in typically developing infants across the first 5 years of life and the HEALthy Brain and Child Development (HBCD) study, which will follow 6,000 infants longitudinally for their first decade of life to investigate the associations of adverse environments and socioeconomic disadvantage with the development of both brain and behavior throughout early childhood (Volkow et al., 2021).

P1-B-47 - Improvement in Wearable High-Density fNIRS Probes Advances Infant Brain Imaging (Bortfeld)

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Functional near-infrared spectroscopy (fNIRS) has become a recognized tool in research on infant development. fNIRS provides unique spatial specificity for tracking changes in cortical blood oxygenation in the brain. Thus, researchers can use fNIRS to characterize the relationship between patterns of brain activity and emergent behavior in infants and young children. Moreover, fNIRS' robustness to motion relative to other neurophysiological methods commonly used with human participants, such as EEG and fMRI, makes it ideal for use with awake, behaving infants. In the two decades during which fNIRS has been applied to answer questions about infant brain development, the technology has improved in leaps and bounds. Nowhere is this more notable than in changes in the hardware itself. This talk highlights the particular advantage of one such hardware innovation: high-density optode arrays (i.e., the number of and distance between fNIRS emitters and detectors that are applied to the scalp to measure underlying brain activity).

The talk begins by providing a brief overview of the fNIRS method and its advantages for studying infant development, and then describes conventional low-density optode arrays, including commercially available products. We highlight our own recent efforts to increase optode density, and present work demonstrating the utility of these high-density arrays in examining brain activity in cochlear implant users (Pollonini et al., 2014; Olds et al., 2016), detailing the challenges of applying these arrays to infants and addressing how such challenges can be overcome. We then discuss new research in which high-density arrays have been developed for use with infants (Frijia et al., 2021). This new generation of wearable, modular, high-density diffuse optical tomography (HD-DOT) probes generally consist of multiple independent modules that can be grouped together in different configurations to create unique networks of optodes for measuring different cortical regions. Because the modules remain independent despite being grouped, the system comfortably conforms to the infant scalp and can easily accommodate the changes in head size of infants of different ages. We review findings demonstrating that these high-density probes achieve superior spatial localization of underlying brain activity, and improve the signal-to-noise ratio of the data obtained. Further, we discuss how these high-density probes register more consistent responses across participants due to their easier placement and increased comfort.

In sum, this new generation of high-density fNIRS probes promises to improve the spatial specificity of the data collected from infant populations, and to localize activation more precisely per the anatomy of the infant brain. We encourage researchers to adopt these advantageous optode arrays in their research.

P1-D-48 - 5-month-olds are not (yet) sensitive to vowel phonotactic constraints in English (Katsuda)

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Introduction: Since Saffran et al.'s (1996) seminal work, numerous studies have explored the development of infants' sensitivity to (syllable) transitional probabilities and its interaction with other potential cues to word segmentation, such as stress and coarticulation (Thiessen & Saffran, 2003; Johnson & Jusczyk, 2001). Research shows that when transitional probability cues are pitted against stress cues (most English disyllables begin with a stressed syllable), 7-month-olds rely on transitional probability, whereas 9-month-olds rely on stress, showing a developmental shift in cue-weighting. We extended Thiessen & Saffran's (2003) experiment to 5-month-olds and pitted transitional probability cues against vowel phonotactic constraints to identify the cues prioritized by infants when they first begin to segment words. Method & Prediction: We tested monolingual English-learning 5-month-olds (n=22) using a modified version of Thiessen & Saffran's experiment implemented with the central fixation procedure. Infants were tested in two phases. First, they were exposed to either one of two 2.5-minute familiarization speech streams. In the cooperating-cue condition, transitional probabilities and phonotactic constraints signaled identical word boundaries. Specifically, the stream was created by concatenating four disyllabic words whose first vowel was lax and the second was tense ([dɪbi], [gɛdu], [bɛdi], [gɪbu]); these are all possible sequences in English. In the conflicting-cue condition, the two cues signaled different word boundaries. This stream was created by concatenating four words whose first vowel was tense while the second was lax ([bigɛ], [dudɪ], [digɪ], [bubɛ]). English words cannot end in lax vowels, and adults use this restriction to segment words (Skoruppa et al., 2015). In the test phase, all infants heard the same four items consisting of two permissible sequences in English ([dɪbi], [gɛdu]) and

two that are disallowed ([bigɛ], [dudɪ]). Crucially, in the cooperating-cue condition the permissible sequences were also statistical words; in contrast, in the conflicting cue condition, the disallowed sequences were the statistical words. If 5-month-olds are sensitive only to transitional probabilities, they should listen longer to statistical non-words over words in both conditions, as has been demonstrated in many AGL experiments. If they are sensitive to the phonotactic cues, an interaction is predicted; infants should listen longer to words in the conflicting-cue condition, because they are disallowed in English. Results: Looking time was log-transformed and analyzed with a Bayesian linear mixed effects model (Bürkner, 2017). Trial-type (words vs. non-words), condition (cooperating vs. conflicting) and their interaction were fixed effects, with random intercepts for subjects and words, and a by-subject slope for trial-type. Only the main effect of trial-type was credible (β = -0.11, 95% CrI [- 0.24,0.01], pd = 96), suggesting that 5-month-olds are sensitive only to the transitional probabilities (Fig 1, in seconds). Thus, we extend Thiessen and Saffran's (2003) findings to show that 5-month-olds rely on transitional probabilities not vowel phonotactics. In addition to increasing the sample size, we are currently testing older infants to uncover when infants become sensitive to vowel phonotactic constraints.

P1-D-49 - Word Learning in Environments that Highlight Distinct Features of Objects (Breitfeld)

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Why do babies learn the words they do? Parents' language input and infants' idiosyncratic interest in objects matter for word learning (e.g., Cartmill et al., 2013; Ackermann et al., 2020). However, words and objects are not encountered in isolation. Thus, information in the surrounding environment may also influence how easily infants map words to objects (e.g., Roy et al., 2012). Furthermore, infants are better able to learn words for objects with distinctive features (Engelthaler & Hills, 2017; Taxitari et al., 2020). What is the role of the environment in drawing attention to objects' distinct features? Objective: The current study examines whether word learning is affected when objects are labeled in environments that highlight their distinct features. Methods: In an eye-tracking paradigm, 21-24-month-olds learn labels for four novel objects in two within-subjects conditions: a Distinct condition where objects are presented in an environment that highlights the unique shape of each object and a Non-Distinct condition where the environment does not highlight the unique shape of each object (see Figure 1). During the Labeling Phase, in the Distinct condition, infants hear two objects labeled by novel words and see videos of the objects being placed into a box through openings that match their shape. In the Non-Distinct condition, infants hear the other two objects labeled and see videos of the objects being placed into a box through a single circular opening that does not match the shape of either object. Then, in the Test Phase, infants' word learning is measured in a looking-while-listening paradigm. We predict that infants will learn words better for the novel objects presented in the Distinct condition. Data Analysis Plan/Results: We measure word learning by examining accuracy and reaction time. Accuracy is measured based on infants' looking towards the target objects in the test phase. Specifically, accuracy is calculated based on the amount of time an infant fixates on the target object compared to the total amount of time they spend fixating either the target object or the distractor object on each trial during a critical window (300-1800ms after target word onset; Fernald et al., 2008). Reaction time is measured based on the time at which infants first shift their gaze to the target object. To address our main hypothesis, the primary analyses will be carried out with linear mixed effects models regressing infants' word learning accuracy on condition and infants' reaction time on condition. We will also examine the

intercept of the accuracy model to assess if infants' word learning accuracy is significantly different from chance within each condition. Visual inspection of the eye-gaze data collected thus far (N=29 to date, N=36 preregistered) indicates that infants' word learning accuracy is higher and reaction time is faster for object labels taught in the Distinct condition compared to the Non-Distinct condition (see Figure 2). Implications/Conclusions: This emerging trend suggests that environments that highlight distinct features of objects--in this case, shape--may be beneficial for word learning. Additional exploratory analysis will examine how infants' word learning relates to their gaze behavior during the Labeling Phase videos as well as the structure of their vocabulary to investigate potential mechanisms and individual differences in the hypothesized effect.

P1-D-50 - Using daylong recordings to characterize sleep and speech activities in three subsistence populations (Scaff)

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Daylong recordings offer one of the best tools for identifying infants' everyday speech input. However, children are rarely fully attentive to all speech surrounding them (e.g., when they are sleeping). Infants sleep frequently throughout the day, often at unscheduled times. Knowing when sleep bouts occur, how long they last, and what kinds of events precede and follow them is crucial for understanding (a) how much ambient speech infants may attend to and (b) how cycles of waking language activity followed by sleep may impact early processing of linguistic information. Using daylong audio, we investigate the sleeping and waking activities of infants in three remote subsistence contexts where infants dictate when and for how long they sleep (i.e., there is no fixed naptime) and where children have been reported to hear infrequent directly-addressed speech (Cristia et al., 2019; Casillas et al., 2020, 2021). In this proof-of-concept study, we explore inter-individual variation in the distribution and duration of sleep bouts throughout the day and investigate what activities tend to precede and follow sleep. Based on previous studies on infant sleep over the first year of life (Henderson et al., 2011), we first predicted that daytime sleep patterns would gradually change during development from longer periodic distributions to shorter, more bursty ones. Second, in the short time window preceding sleep, infants would experience talk from others at a higher rate than expected based on their average across the day. We did not predict differences between recording sites. We manually annotated one recording (6.4-17.4hrs, M=8.9, total=107.3) for each of 12 infants (up to 0;6): Tseltal Mayan (N=4), Rossel Island Papuan (N=7), and Tsimane' (N=1). We listened to the recording from start to finish, noting the start and stop of 5 mutually exclusive activity codes: (1) sleeping, (2) silent but within earshot of others' talk, (3) vocalizing with others, (4) vocalizing alone, or (5) doing some other activity (e.g., crying, feeding). Codes were added in this order of priority (e.g., if there was nearby talk but the infant was sleeping, the code would be 'sleeping'). This annotation task is arduous and the data are still undergoing quality checks, so the following results are preliminary. Infants spent 18.4-60.2% of their day sleeping (M=40.8%). We detected 3-20 sleep bouts per infant (M=10.0), lasting 0.01-2.7hrs each (M=0.4). We calculated Goh and Barbási's (2008) B measure of burstiness and found that the timing of sleep bouts was close to random, trending toward periodic (M=-0.11, SD=0.13, range=-0.34-0.07). As predicted, there was a trend of increasing burstiness with age (*r*=0.52 [-0.45, 0.67]), but the change was subtle. We found that infants may hear proportionally more talk in the 10 minutes preceding sleep, relative to following sleep, but not

more than their typical amount of talk across the day. The accuracy and stability of these patterns remain to be tested upon further data annotation on a wider range of ages. Overall, these preliminary results suggest substantial inter-individual variability in daytime sleep patterns, with little evidence for inter-cultural variability or changes over the first six months of life. This study offers the first window into sleep/wake patterns and their association with surrounding speech activity in non-WEIRD settings and highlights the promising use of daylong recordings for this line of research.

P1-D-51 - Using visual speaker cues to disambiguate minimal pairs in infancy (Provencher)

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Background: Visual input is considered an integral component of speech perception, and may be particularly important in the challenging task of learning minimal pair words. Minimal pairs are words that differ solely by one phoneme (e.g., boat and goat). Previous studies have found that 14 months old confuse similar-sounding words, but succeed by 17-20 months (Werker et al, 2002). The additional context of seeing the mouth of the speaker (Fais, et al., 2012) aided minimal pair learning at 14 months, but this cue only worked in a live condition and not when seeing a videorecording of the speaker. The current study extends this work by examining if infants of 14-17 months show learning of minimal pairs with visual cues from the speaker's mouth via a recording when using a more sensitive testing procedure. The studies above all used the Switch task, which depends on infants showing surprise to a word-object mismatch at test. Yoshida, et al. (2009) showed that the visual preference procedure was a more sensitive test of minimal pair learning than the Switch task at 14 months. Methods: Note that, due to COVID, this study is being conducted online. Thus far, 14 infants have participated; however, 7 were excluded due to fussing/inattentiveness (perhaps exacerbated by the online method). Participants completed up to 24 habituation trials where they saw one of two unknown objects on one side of the screen and a female speaker producing its novel label on the other side (green stapler = /gos/; blue funnel = /bos/). After habituation, participants completed 8 test trials where the speaker was no longer present and both objects appeared on the screen simultaneously while infants heard one of object labels. Target location was counterbalanced across trials. Results: Our target sample size is 16. Preliminary results are promising. We examined test trials in blocks of four due to our concern that the online nature of the task may have decreased attentional focus. Infants' looking time dropped significantly from the first block to the second ($p=0.04$), confirming attentional issues. We examined participants' looking to the correct object versus the incorrect object across the two blocks. In the first block, infants looking to correct over incorrect approached significance ($p=0.07$) whereas no significant relationship was found in the second block ($p=0.54$). Conclusion: This preliminary study, using a more sensitive testing procedure, indicates that seeing visual cues from the mouth of the speaker, even when pre-recorded, may facilitate the challenging task of learning minimal pair words. Our necessary use of online testing shows that this testing procedure works even in the more uncontrolled home environment in comparison to that of a lab. However, our attrition rate thus far and the significant decrease in looking across test trials may indicate that only those infants with stronger attention control are contributing to the final sample. We are thus planning on reducing the demands in a follow-up study (e.g., reducing the number of training trials). Finally, a full sample is necessary to confirm our initial findings.

P1-D-52 - Exploring the rhythm of mothers' speech to infants across Canada and Vanuatu (Yeung)

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Speech utterances in infant-directed speech (IDS) are often thought to be shorter, slower, and/or more spaced-apart than in adult-directed speech (Fernald et al., 1989). However, this conclusion may not hold when we consider globally representative research samples. For example, other work examining IDS intonational pitch has shown drastic differences across diverse global samples (Berstein Ratner & Pye, 1984; Ochs & Shiefflin, 1984). Like for intonational pitch, differences in the rhythm of speech utterances for IDS may be particular to different cultures and languages. We analyzed the IDS and ADS of urban infant caregivers from Vancouver, Canada versus rural infant caregivers from Tanna, Vanuatu. Prior work from fathers had reported gross similarities IDS rhythms across North America and Vanuatu (i.e., similar changes in IDS-ADS speech rate; Broesch & Bryant, 2018), but here we report a more detailed analysis from mothers of infants from 6 to 18 months of age (Canada, n = 25; Vanuatu, n = 34), which delve beyond speech rate. We began by hand-annotating speech utterances during 1-minute excerpts of spontaneous speech--either directed to infants (IDS), or directed to adult peers (ADS)--from each mother in our study. These excerpts were identified during recordings previously made for a different study (McClay et al., 2022), which focused on the pronunciation of individual words rather than speech utterances. In all the analyses below, we predicted the dependent variable using linear-mixed effects models, with location (Canada / Vanuatu), register (ADS / IDS), and their interaction as predictors in the lme4 package from R (Bates et al., 2015). Models were initially specified with a maximal random effects structure that was reduced until the model converged, with Satterthwaite estimates for degrees of freedom. First, we examined utterance length in syllables, and speech rate (i.e., the total number of syllables divided by the total duration of all the utterances within the 1-minute window). Results did not show any interactions between register and location, although utterances in both locations were shorter in IDS (i.e., had fewer syllables). Second, we also examined the length of pauses between utterances, which is classically considered to be longer in IDS (Fernald et al., 1989). As shown in Figure 1, this was only true in the Canadian sample ($p < .001$). Finally, we also examined the degree of utterance-final syllable lengthening, something which is commonly found in both ADS and IDS, and which contributes to perceivable differences in utterances rhythms across these registers (Martin et al., 2015; White et al. 2014). As shown in Figure 2, mothers in both locations had longer utterance-final than utterance-initial syllables, but this effect was reduced in IDS from mothers in Vanuatu versus Canada ($p < .01$). These results show some similarities across Canada and Vanuatu in IDS-ADS comparisons for speech rate (echoing work from Broesch & Bryant, 2018). However, there were also some key differences when looking beyond this one measure of speech rhythm. We argue that very few phonetic features of IDS may be similar across many communities around the globe (e.g., shorter utterance length), and most of the details of what makes IDS phonetically distinct from ADS is going to be specific to a particular culture and/or language.

P1-D-53 - Using data from bilinguals to test models of online word comprehension (Sander-Montant)

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During the first years of life children develop the ability to understand familiar nouns (Bergelson & Swingley, 2012; 2015). During these early years children also mature and are incrementally exposed to

language. Most theories highlight the importance of both maturation and experience in word learning, but typically view one factor as more important (Bergelson, 2020). Especially prominent are accumulator models, wherein changes in word learning are explained by a relatively simple accumulation of experience with words over time (e.g., McMurray, 2007). Nevertheless, testing models with empirical data has been challenging because children mature at the same time as they accrue language experience, making each factor's contributions hard to disentangle. Here we propose an avenue for testing word learning models using bilingual data from the looking-while-listening task, as bilinguals accrue different levels of experience with two separate languages at the same time as they mature. Method We used archival data from 5 different looking-while-listening studies conducted between 2012 and 2019. Children saw two images on a screen: a target (e.g., a dog), and a distractor image (e.g., a book). The target was labeled (e.g., "Look at the dog!") and infants' eye gaze was recorded (Figure 1). We excluded trials with experimental manipulations and kept only trials in which infants heard one object labeled in typical, fluent, infant-directed speech. We retained data from 152 bilinguals and monolinguals (14-48 months of age) - with experience with the target language ranging from 10% to a 100% (e.g., a child could hear 20% French, 80% English and be tested in one or both). We then constructed linear mixed-effects models in which looking accuracy was predicted either by age, proportion of experience with the testing language, the additive effects of both factors, or both factors plus their interaction (i.e., including the accumulation of experience over age). Older children performed better than younger children, and children with more experience performed better than those with less experience. The best fitting model was the additive model, where age (p=<.001***) and experience (p=.001**) independently predicted performance. A 25% increase in experience was roughly equivalent to 4 months of maturation in terms of its effect on looking accuracy (see Figure 1). Notably, we did not find support for accumulator models, as adding the interaction between age and experience accounted for nearly zero additional variance (Estimate = -.0001, p=.97). Discussion Contrary to what has been previously assumed in the literature, our results suggest that age and experience with language have non-interactive but independently important contributions to the development of online noun comprehension. Accumulator models have been able to explain patterns of vocabulary production such as the vocabulary spurt (McMurray, 2007), but here we show that such models are not well-suited to explain the development of online word comprehension. Our results point to a need to develop unified models of word learning that account for both vocabulary development and online word recognition, and open a window to test these models using empirical bilingual data from different types of experiments.

P1-D-54 - Infant vocalizations elicit simplified speech in childcare settings (Albert)

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Contingent responses to infant's pre-linguistic vocalizations have immediate (Goldstein & Schwade, 2008) and long-term impacts on infant language development (Tamis-LeMonda et al., 2001). The moments following an infant's vocalizations appear to be a prime time for infant learning, and parents capitalize on these periods by using fewer unique words and more single-word utterances in contingent speech than non-contingent speech (Elmlinger et al., 2019), which may serve to scaffold infants' attention on the most salient speech input. Much of the research about infant language development has been conducted in the context of parent-infant interactions, yet many infants spend significant

amounts of time in childcare settings. Interactions with childcare teachers create another prime opportunity for infants to develop language skills. Do childcare teachers have the same response tendencies to infant vocalizations as parents? While a single infant typically shapes parents' responses, childcare teachers are consistently exposed to multiple infants. This could make the task of responding contingently to any one infant more difficult as it may be more cognitively demanding to keep track of each individual infant's vocal capabilities. In this study, we compared the rates and complexity of contingent and non-contingent verbal interactions of childcare teachers interacting with a single infant. Methods: We analyzed video recordings of 34 teacher-infant dyads in a five-minute free play session with toys. The sample came from a larger dataset on toddler socio-emotional development (Woldarsky et al., 2019). Infants were 10-15 months at the time of recording (M=12.6 months). Teachers' contingent and non-contingent speech was transcribed to calculate the mean length of utterance in words, the number of unique words spoken, and the proportion of single-word utterances (c.f. Elmlinger et al., 2019). Infant vocalizations were classified by their phonological properties into two categories: vowels and consonant-vowels (Oller, 2000). Results: We replicated Elmlinger and colleagues (2019) findings with teachers to demonstrate that like parents, childcare teachers also simplify their speech when responding contingently. Contingent utterances used less unique words ($t(33) = -11.173$, $p<.001$, $d=-1.92$), a higher proportion of single word responses ($t(33)=5.243$, $p<.001$, $d=.899$), and had a shorter mean length of utterances ($t(33) = -6.400$, $p<.001$, $d=-1.098$) than non-contingent utterances (Figure 1). Infant vocal quality did not impact contingency rate or the characteristics of contingent speech. Unlike parents, teachers were equally likely to respond to infant syllables containing only vowels as syllables with consonant-vowels, $p = .321$. Individual differences in teacher age, education, and professional experience did not predict response patterns. Conclusion: Our results suggest that pre-linguistic infant vocalizations create learning opportunities for infants in childcare settings by eliciting simplified and more learnable linguistic information during teacher-infant interactions. That teachers also show this simplification effect when responding to infant vocalizations suggests the power of infant pre-linguistic vocalizations for organizing caregiver attention in a variety of settings to elicit conversational turn-taking. These findings add to a growing body of work demonstrating the social functions of babbling for promoting early language development.

P1-D-55 - Picture book reading by mothers and experts: differences in the acoustic features (Kajikawa)

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It is not always easy to attract the attention of infants during picture book reading. When parents read books to their preverbal infants, they frequently create attention-getting utterances (Senechal et al., 1995). It has been shown that speech prosody is a factor that maintains infants' attention. Prosodic characteristics related with the positive affect of a speaker, such as high pitch and large pitch range, attract an infant's attention (Singh et al., 2002). Furthermore, pitch contours influence toddlers' word learning (Nencheva et al., 2020). Mothers of 14-month-old infants emphasize target items in picture books with exaggerated pitch peaks in utterance-final position (Fernald & Mazzie, 1991). However, there are individual differences in the ways these prosodic cues are used (e.g., Mady et al., 2018). We assumed that the factors related with the individual differences included reading skill and the knowledge acquired through reading experiences. This study explored how mothers and experts read picture books to infants. A total of 20 native Japanese speaking mothers of first-born infants aged 5 - 8

months (10 males and 10 females) and 20 female experts participated. The experts were Ehon Senmonshi (picture book experts) certified by the National Institution for Youth Education in Japan after taking a series of book-reading seminars. Of these, 12 had worked in nursery schools for 1 - 24 years. The stimulus book was a Japanese picture book titled "ii okao (good face)" (story by Miyoko Matsutani, and drawing by Yasuo Segawa). The story included four agents (a girl, a cat, a dog, and an elephant) who successively had a cheer on their face (ii okao) and finally the girl's mother gave them biscuits. The key phrase, ii okao, appeared seven times. The participants read the book at home and used a PCM recorder and pin microphone. The first reading condition was adult-directed speech (ADS), and the second was infant-directed speech (IDS) as the participants imagined reading the book to a 6-month-old infant. The recorded vocalizations were analyzed with an acoustic analysis software Praat (Boersma & Weenink, 2021. The speech rate (mora/s), mean pitch (Hz), and pitch range (Hz) were calculated. The results showed that the experts read with slower speech rate ($F(1,38) = 20.324$, $p = 0.000$), higher pitch ($F(1,38) = 4.531$, $p = 0.04$) and larger pitch range ($F(1,38) = 4.973$, $p = 0.03$) than the mothers. Both the mothers and experts tended to read at a slow speech rate at the beginning of each page in both the ADS and IDS conditions. They read with a higher mean pitch at the end of each page, especially in IDS. The experts read the key phrase, ii okao, and sounds of the animals (nya, mew, wan, bowwow, and nosshi nosshi, lumbering) more slowly in IDS than ADS. The mothers read the agents more slowly in IDS than ADS. It is suggested that Japanese reading experts focused on different points compared to mothers, when they read a picture book in IDS. It was also indicated that the difference emerged especially in speech rate, which may have promoted infants' recognition of the key phrase.

P1-D-56 - Assessing the interplay of prosodic and syntactic boundary cues in speech segmentation across the first years using pupillometry (Schreiner)

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Segmenting continuous speech into meaningful units is an important prerequisite for acquiring a language. During the first year, infants show high sensitivity to prosodic boundaries which often coincide with syntactic clause boundaries (Hirsh-Pasek et al., 1987). Prosodic boundaries usually consist of three boundary cues: pre-boundary lengthening, pre-boundary pitch rise, and pause (the combination of the three cues is henceforth called "well-formed" boundary). In children and adults, speech segmentation seems to be increasingly influenced by syntactic knowledge (Männel et al., 2013). However, little is known about how infants' speech segmentation relies on bottom-up perceptual processes (driven by prosodic boundary cues) and top-down knowledge-based processes (driven by lexical and syntactic knowledge). We plan to use pupillometry to determine whether infants rely more on bottom-up prosodic well-formedness of boundaries to segment speech streams, and at which age top-down syntactic knowledge is integrated. Participants will be German-monolingual children at the ages of 8- (n=24) and 42-months (n=24). Sixteen naturally-recorded children's stories will be cross-spliced in order to create a 2x2 within-subjects design with the factors prosodic well-formedness (well-formed vs. ill-formed) and boundary position (syntactically expected/end of clause vs. unexpected/within clause). Each story will consist of four sentences, with each sentence containing a well- or ill-formed prosodic boundary at a syntactically expected or unexpected position. During auditory presentation, videos of moving shapes will be displayed, in which illumination will be held constant while pupil size will be recorded by an automated eyetracker (Tobii Pro Spectrum). Pupil size will be baseline-corrected to the

500 ms preceding stimulus onset, and the analyses will be time-locked to the onset of the boundary. We will quantify changes in pupillary response over time using growth curve models including third-order orthogonal polynomials (Mirman, 2017). Prosodic well-formedness, boundary position, age, and their interaction will be added sequentially to the model and model fit will be assessed using log-likelihood model comparisons. Models will also include linear and quadratic time terms as random slopes across subjects, prosodic well-formedness, and boundary position. We hypothesize age-dependent differences in the interplay of the factors prosodic well-formedness and syntactic boundary position. In 8-month-old infants, we expect a main effect of prosodic well-formedness, indicating that their processing should be guided primarily by prosodic well-formedness independent of syntactic position of the boundary (Wellmann et al., 2012). In contrast, the more advanced lexical and syntactic knowledge of 42-month-old children should lead to an increased impact of the position of a boundary and hence a main effect of boundary position or interaction of prosodic-well formedness and boundary position (Männel & Friederici, 2016). The current study is a novel adaption of pupillometry, which will allow for a finer grained examination of infants' responses to top-down and bottom-up cues during speech segmentation. By investigating responses to these cues across the first years of life, we can better understand the mechanisms that drive the development from a reliance on bottom-up signals at 12 months to an integration of these signals with acquired top-down knowledge at 42 months.

P1-D-59 - Impact of Maternal Smartphone Use on Language Output (Casar)

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Smartphones have not been critically assessed to the same extent as television to determine their potential impact on infant language development. Twenty-eight mother-infant dyads (Female = 17, Male = 11) 6 to 9 months-old (N = 13, M = 7.46 months, SD = 1.05) or 12 to 15 months-old (N = 15, M = 12.8 months, SD = 0.77) were recorded for 4 hours using the Language Environment Analysis device while maternal smartphone usage was tracked using a third-party application (RealizD or QualityTime). Previous research indicates that social media is frequently used by mothers for interpersonal support (Duggan et al., 2015), therefore it was critical to determine how these types of applications might impact infant language development. Mothers with 6 to 9 month-old infants used their smartphones about the same as mothers with 12 to 15 month-old infants. Maternal smartphone usage did not affect the amount of language when analyzed across the whole 4 hours but corresponded to less language heard by infants when examined at the 5-minute level in the 12 to 15 month age group. Finally, maternal social media use was not associated with decreases in the language heard by infants in the study. These results suggest that both general and social media specific smartphone usage had less impact on the amount of language an infant heard when compared to infant age. While maternal smartphone usage impacted the amount of language heard by infants at the 5-minute level, age was the most important determinant in how often a mother spoke to her infant.

P1-D-62 - The impact of spectrally degraded speech on the word segmentation abilities of 6-month-old infants with normal hearing (Nazzi)

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Monica Hegde 1*, Irene de la Cruz-Pavía2,3* , Thierry Nazzi 1, Laurianne Cabrera 1 1. Université de Paris-CNRS (France) 2. Universidad del País Vasco UPV/EHU (Spain) 3. Basque Foundation for Science Ikerbasque (Spain) *These authors contributed equally to this work Introduction: While cochlear-implants have high clinical success rates in postlingual adults, the signal sent by these devices remains spectrally degraded with the current technology. Furthermore, albeit cochlear implants are currently being fitted to infants below 12 months of age, very little is known regarding the effects of receiving such spectrally degraded information on early language acquisition. The current study explores the effect of acoustic degradation on lexical perception in 6-month-old infants with normal hearing. This study adopts a psychoacoustic approach according to which the auditory system decomposes the spectral and temporal components of speech. Experimentally these acoustic cues can be selectively manipulated using vocoders, to assess their role in speech perception and processing for listeners with normal hearing. Methods: Three vocoder experiments were conducted using a sentence-word segmentation task via the Headturn Preference Procedure (HPP) on French-learning 6-month-old infants. In all three experiments, infants (N=24) first completed a familiarization phase in which they accumulate one minute of looking time to target word(s) presented in a passage of 6 sentences (e.g. Target: but: Le but est de trouver le dernier élément...). In the following test phase, infants' preference for familiar v. novel words presented in isolation is measured by their looking times. Experiment 1 used an 8-band vocoder to process original stimuli and presented two target words and two novel words in the test phase. Experiment 2 also used an 8-band vocoder, but presented only one target word and one novel word at test. Experiment 3 (N=21/24) used a less-degraded 16-band vocoder and presented one target and one novel word at test. Previous studies using natural stimuli in a similar sentence-word HPP paradigm showed preferential looking toward familiar stimuli in 6-month-old infants. A similar pattern is thus expected if infants of this age are able to rely on spectrally reduced speech signals. Results: No difference in preferential looking time is found between familiar v. novel stimuli in the two 8-band vocoder conditions (Experiment 1: p=0.426; Experiment 2: p=0.128, in which a preference for familiar words is observed in 16 infants out of 24). Preliminary analyses of the 16-band condition also show no preference between familiar v. novel stimuli in Experiment 3 p=0.66). Conclusions : The null results in the three current experiments suggest that fine spectral information may be necessary for lexical processing in word segmentation tasks at 6 months of age. Older infants and other vocoder conditions are planned in future studies to better understand how spectral information of speech plays a role in word segmentation abilities during early development.

P1-D-64 - The processing of syllable structure in early infancy (Santolin)

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Syllables are the building blocks of early language learning. Pioneering studies show that, from birth onwards, infants preferentially segment, process and represent the speech into syllabic units (e.g., Bijeljac-Babic et al., 1993; Jusczyk & Derrah, 1987; Bertoncini et al., 1988). Young infants can also form quite detailed representations of phonemes composing syllables, and the patterns involving such phonemes (e.g., Cristia et al., 2011; Mersad et al., 2021). Little is known, however, about the type of computations infants are able to perform on syllables, especially whether they can form abstract

representations of the syllabic structure as a whole, regardless of its individual constituents (e.g., phonemes). In the present study, we explored this issue by asking whether 4-to-5 month-old infants can encode the abstract, internal structure of syllables (which determines the ordering of its constituents) and recognize such structure instantiated in several different syllables. We implemented a generalization task that required infants to detect syllables' abstract structure from lists of syllables, at a target age that precedes the establishment of native phoneme categories (Kuhl, 1979; Werker & Tees, 1984), and native-languages phonotactics (Jusczyk et al., 1993; Mattys & Jusczyk, 2001). Two groups of infants were first familiarized with a list of either CVC or CCV syllables (e.g., bor as CVC, plu as CCV), then all infants were presented with new CVC and new CCV syllables (e.g., pal vs. tro). The Head-turn Preference Procedure was used to assess learning at test. Looking time measures revealed a significant condition (familiarization to CVC vs. CCV) by test structure (CVC vs. CCV) interaction ($F(1,46) = 8.812$, $p = 0.005$, $\eta p2 = 0.161$), suggesting that infants' looking times at test differed as a function of familiarization (see Figure 1). Paired-samples t-tests showed that infants familiarized with CVC syllables looked significantly longer to CVC test items than to CCV test items ($t(23) = 2.750$, $p = 0.011$, $d = 0.561$) whereas infants familiarized with CCV failed to show a significant familiarity preference ($t(23) = 1.666$, $p = 0.109$, $d = 0.340$). This research shows that 4-to-5 month-olds can track and generalize syllabic structures, and prefer test syllables that match the familiar syllabic structure, especially the group of infants familiarized with CVC. Processing phonetic information cannot account for infants' performance because test syllables are implemented by novel combinations of (familiar) phonemes, forcing infants to encode some abstract properties of the familiarization stimuli (i.e., the internal syllabic structure). To the best of our knowledge, this study provides the first evidence of abstract processing of syllables as whole speech units in the first months of life, extending previous findings demonstrating that infants process syllables very early in development (e.g., Jusczyk et al., 1995; Eimas et al., 1999). In addition to preferentially processing the speech into syllabic units, young infants seem also capable of performing some fine-grained computations on such units. This could shed light on the nature of the privileged status of syllables as basic units of early speech perception.

P1-D-65 - Maintaining Attention to Bimodal Speakers Support Better Word Learning in Toddlers (Taylor)

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In a recently published study, we tested 24-mo-olds' ability to match a speaker with its concurrent voice track as well as a falling object with its concurrent sound track, both while non-matched speaker and non-matched object appeared on the opposite side of a screen. In the middle of the two events, a rotating geometric distractor was played. Overall toddlers significantly attended more to the matched event in both conditions (speaker; object) but only attention to the matched speaker (compared to the non-matched speaker) significantly correlated with their expressive vocabulary ($r = +.49$, $p = .004$). Moreover, the degree of sustained attention to the speaker+voice match when the distractor was present significantly predicted expressive vocabulary ($ß = 0.474$, $p = .01$). Is this relationship due to an overarching boost in attention when viewing people v. objects? Preliminary analyses suggest a more nuanced relationship between multisensory attention and language depending on how attention was measured. In this study, toddlers' behavior was measured in four ways: (1) total looking time to either lateral event (regardless of match) divided by trial time (Attention), (2) time of the first fixation shift

away from the distractor to either lateral event (Latency), (3) looking time to the match divided by that value + looking time to the non-match (Match Ratio), and (4) looking time to the match divided by that value + looking time to the distractor (Distractor Ratio). First, Attention to the screen was significantly higher when speakers were present (51%) than when objects were present (40%; t(31) = 3.42, p = .002), and Attention was significantly correlated with expressive language (r = +.43, p = .01). Second, the Latency from the distractor to a lateral event at the start of a trial was not significantly faster with speakers (M = 1.55 s) compared to objects (M = 2.13 s; t(24) = -1.71, p = .10), and it was not significantly correlated with expressive language (r = -.29, p = .16). Last, in a regression model with expressive vocabulary as the dependent variable, and with Attention, Latency, Match Ratio, and Distractor Ratio as predictors, only Distractor Ratio significantly predicted expressive vocabulary (ß = 0.82, p = .008). Using a protocol that assesses multisensory integration in young children for speakers and objects, the general finding that participants attend more to the people is not sufficient to explain the predictive relationship between such integration and emerging language. Preliminary analyses suggest that it is the specific ability to maintain attention to a matched speaker+voice when competition for the toddler's attention is high that is predictive of vocabulary. We will discuss this finding in the context of infants'/toddlers' social experiences that may lead to individual differences in their multisensory integration skills that affect their development generally as well as specifically (i.e., learning words).

P1-D-66 - An online replication of a lexical-semantic priming task with toddlers (Wang)

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Adults and two-year-olds connect related words such as "sock" and "shoe", which facilitates language processing. However, little is known how these types of word relations develop. Wojcik and Werker (2016) found a correlation between semantic priming and vocabulary size in two-year-olds. Because the correlation was a novel finding, the current study aimed to replicate the results with a larger sample size and a more comprehensive vocabulary questionnaire for a more precise measure of vocabulary size. Due to COVID-19, we transferred our looking time priming paradigm to an online platform. Thus, our replication also tests the feasibility of running toddler looking time studies (and in particular studies that do not have exciting visuals or narrative components) via an online, unsupervised platform. Method. 22- to 32-month-old monolinguals (n = 66) were tested using a looking time paradigm that measures semantic priming without any referential or contextual cues. Participants were recruited and participated in the study via the Lookit platform (Scott et al., 2017), and thus completed the study on their own devices without researcher supervision. There were four blocks of four test trials, each separated by a short attention getter (trial order counterbalanced across participants). On each trial, a neutral visual stimulus appeared on the left or right side of the screen. The DV was looking time to the side from which the words were played. The IV was whether the alternating word pair contained related (e.g. dog-kitty) or unrelated words (e.g., dog-juice; 8 trials each). The paradigm was the same as the original in-person study except that different attention getters were used between blocks. Afterwards, parents completed a Qualtrics survey of the MCDI long-form (Fenson, et al,., 1994). Results. ELAN (Lausberg & Sloetjes, 2009) was used to code where participants looked on each frame from videos recorded by participant webcams. Trials in which participants looked to the screen for less than one second were excluded, and participants were excluded if they contributed data to fewer than 8 trials, resulting in a final sample size of 51. A paired-samples t-test revealed no significant difference in looking

time between related and unrelated trials, t(50) = -1.69, p = 0.097, d = 0.24. For the participants that contributed vocabulary data, there was no significant correlation between looking time difference and productive vocabulary size, r(43) = 0.023, p = 0.88 (see Figure). Using an online data collection platform and a larger sample size, we failed to replicate the vocabulary-priming effect correlation found by Wojcik and Werker (2016). The replication failure may indicate that there is no true correlation between vocabulary size and semantic relationship development. However, unsupervised data collection may have resulted in noisier data, making it more difficult to pick up small effects. Ongoing analyses are exploring differences in looking behavior (i.e. number of looks, average looking time across trials, block effects) in order to better understand the differences between online and in-person data collection. These analyses will provide useful information for researchers who are moving looking time studies online.

P1-D-67 - Audio-visual integration abilities in infants at elevated likelihood of autism: what is the link with communicative development? (Capelli)

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Advances in the identification of early markers of neurodevelopmental disorders have occurred and are crucial to provide timely intervention programs to be applied at very young ages. There is a growing interest in identifying reliable brain-based and behavioral predictors, which may constitute useful tools for early detection on at-risk cases. Individuals with autism spectrum disorder (ASD) perform poorly during conditions that require integrating information from visual and auditory modalities (Audio Visual Integration, AVI), a skill that is a key building block for higher-level skills (as language and communication). However, few studies have examined neural and behavioral processing of AVI in infants at higher likelihood of autism (HL-ASD), i.e. siblings of children with a diagnosis of ASD. The aims of the study are: (a) to explore whether and to what extent differences in AVI skills can differentiate HL-ASD from TD infants, applying eye-tracking and EEG/ERP techniques and, (b) to assess the association between early AVI abilities and clinical measures of infant communicative skills. For these aims, in our ongoing longitudinal study following HL-ASD infants, we have implemented and already piloted an experimental protocol testing both speech/non-speech and social/non-social AVI skills. Recruitment is ongoing. We are planning to follow 2 groups (between the ages of 6 and 12 months): HL-ASD infants and typically developing infants (TD). AVI skills are measured using two approaches: (1) an eye-tracking (ET) preferential looking paradigm and (2) an integrated EEG/ET paradigm (Figure 1). (1) The ET preferential looking paradigm is presented in 3 conditions: (a) social/speech condition (based on the McGurk effect); (b) social/non-speech condition (synchronous/asynchronous hands clapping), and (c) non-social/non-speech condition (synchronous/asynchronous drumming). Infants at 6, 9, and 12 months of age are taking part in the study, allowing the observation of looking preference differences between groups, conditions, and ages and providing new insights into the role multisensory functions in early developmental trajectories of ASD. (2) The integrated EEG-ET paradigm (measuring the McGurk effect) is recorded at 12 months of age in the two groups. Video stimuli of faces pronouncing /pa/ and /ka/ syllables are presented: 2 AV matched (congruent) and 2 mismatched (fusion and incongruent) conditions, arranged in a block design. Both EEG brain responses and looking behaviours are simultaneously recorded. In addition, clinical measures of sensory, language and communicative development are available for all infants. Preliminary data are shown in Figure 2. Longitudinal results for

the ET experimental task will be presented for the 2 groups and association with clinical measures will be shown. We expect to highlight significant differences in preferential looking patterns (differences in looking preference between groups towards synchronous stimuli and also differences in looking behaviours towards specific areas of interests, i.e., eyes vs mouth). Finally, we expect to find associations between early AV integration abilities and clinical measures of infants' development. This study could offer a better understanding of behavioural and neural/oscillatory correlates of AVI and new insights to catch critical time windows and consequently useful information for early and individualized interventions in ASD.

P1-D-68 - Word Networks: Temporal Structure of Semantic Connections in Input to Toddlers (Masek)

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Growing a vocabulary is more than learning words. As infants build lexicon they create rich interconnected semantic networks (Collins & Loftus 1975; Wojcik 2018) that organize words in conceptually meaningful ways (Beckage et al. 2010). Researchers have documented the developing structure of infants' semantic networks (e.g., Arias-Trejo & Plunkett, 2009) and associations to word learning (e.g., Borovsky et al., 2016). Yet understanding how infants build networks requires careful specification of the structure of semantic networks in language input. Temporal structure is crucial to learning. Infants are more likely to link events together when they occur close together in time (Rovee-Collier, 1995). Here we delve into the raw data--words directed to infants during everyday activities--and quantify the temporal distances within and among word categories to illuminate the structure of semantic networks in language input. Participants were 78 mothers with an infant between the ages of 12 and 24-months (36 girls). A trained experimenter video-recorded mothers and infants interacting in their homes for 1 to 2 hours. Mothers were instructed to go about their daily activities, but to remain inside the home. Interactions were transcribed in Datavyu and exported to CLAN to generate a list of unique words used during the home visits. The 8,064 unique words were sorted into 21 taxonomic categories (14 categories of concrete nouns, 6 categories of action verbs, and 1 category of adjectives, Table 1). Words across all categories were frequent and spread across the sample. Of the 78 mothers, 63 used at least 20 of the 21 categories and on average, mothers used between 2 and 22 words types per category. To quantify the temporal structure within and between categories, we selected the five words most frequently occurring words for each category across transcripts (Table 1). To measure within categories latencies, we calculated the differences in onset time between every identified word and all subsequent words of a category within each participant. To measure between category latencies, we calculated distances between each word in the first category and every word in the second category within each participant. Within- and between-category word distances were analyzed with the median distance (in minutes) and the proportion of distances that fell within 1 minutes across participants. Analyses indicated that words within a semantic category occur close together in time (Table 1). Some categories were more likely to co-occur closer in time than others (see Figure 1 for select comparisons). For example, when mothers referred to eating and feeding verbs, they were more likely to also talk about food than clothing, revealing temporal uniting of words that are functionally related. Data suggest that semantic connections between words are evident in the temporal structure of the language to infants. This structure has implications for how infants begin to understand semantic relations among

words in the process of word learning. In ongoing analyses, we will compare latencies among words within and across categories to build a model of semantic networks in language input to infants.

P1-D-69 - Weighting of Referential Labeling and Statistical Learning in the Development of Lexical Tone Perception (tsao)

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Diverse trends in discriminating lexical tones among non-tonal language-learning infants were apparent between 6 and 12 months of age. Although studies started to explore developmental trends of lexical tone perception in infancy, it remains unclear whether infants would prioritize developmental mechanisms, e.g., statistical learning, music-to-lexical tone transfer, and referential word learning, to rapidly extract native lexical tones from speech inputs. This study aimed to explore whether referential word learning would be a priority over distributional learning in the development of lexical tone perception. Experiment 1 assessed the effects of music-to-lexical tone transfer and statistical learning on lexical tone perception, by exposing 7- (n = 39, M age = 7.30 months) and 11-month-old (n =36, M age = 11.20 months) infants to music tones from two musical instruments (violin and erhu, Chinese violin), and in a unimodal or bimodal distribution. For 7-month-old infants, their accuracy to distinguish acoustically less distinct tone contrast (Tone 2 vs. 3 in Mandarin) increased after listening to melody of mixed erhu and violin tones, $F(1, 37) = 19.504$, $p < .001$. The statistical learning condition was not significant, $F (1, 37) = 1.969$. The Time (pre- and post-music exposure) X Statistical learning interaction effect, $F(1, 37) = 5.358$, $p = .026$, was significant, showing that the bimodal distribution was more effective than unimodal distribution to enhance tone discrimination. For 11-month-olds, they were more accurate in discriminating lexical tones after being exposed to music melody, $F(1, 34) = 7.619$, $p = .009$. Neither statistical learning, $F (1, 34) < 1$, nor Time X Statistical learning effect, $F(1, 34) < 1$, was significant.Experiment 2 examined whether referential labeling was more effective than statistical learning for infants in learning lexical tones. In addition, pupil dilation responses were used to assess the ability to discriminate lexical tones. Forty 7-month-old (M age: 7.16 months) and 40 11-month-old infants (M age: 11.15 months) participated in this experiment. Infants were randomly assigned to one of referential labeling groups, the one word-referent paired (i.e., novel tone continuum paired with one novel object) or two word-referent paired (i.e., novel tone continuum paired with two novel objects) group. Infants were exposed to novel tones of unimodal distribution while watching novel objects. Figure 1 depicts time courses of pupil response to distinguish lexical tones. The pupil size data were analyzed with generalized additive models (GAMs). Results showed that 7-month-olds (Figure 1a) in two-word condition performed better than infants in one-word condition. For 11-month-olds, both the one-paired and two-paired groups improved their perceptual sensitivity to novel lexical tones (Figure 1b). Conclusion Results demonstrated how statistical learning and referential labeling processes enhance perception of lexical tones. Additionally, unimodal distribution is less effective than bimodal distribution for 7-month-olds to learn lexical tones. Furthermore, unimodal distribution would not hinder referential labeling to facilitate lexical tone learning at 7 months of age. In contrast, 11-month-olds improved their sensitivity in both labeling and statistical learning conditions. Therefore, the superiority of referential labeling over statistical learning varied with infants' ages.

P1-D-70 - Investigating changes in daycare arrangements and English exposure during the COVID-19 Pandemic (Bulgarelli)

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It is widely accepted that parents' speech plays a foundational role in infants' language learning (Hart & Risley, 1995; Hurtado et al., 2008). Similarly, the quality and quantity of input in settings such as daycare also critically contribute to language outcomes (McCartney, 1984). For bilingually-raised children, the total amount and the proportion of speech they hear in each language affect their proficiency (Marchman et al., 2017; Place & Hoff, 2016). Moreover, bilinguals' learning of each of their languages is shaped by the community's language use (Hoff et al., 2014), highlighting the importance of considering broader environmental influences on language development (Bronfenbrenner & Morris, 2006). We explored another contextual influence that may produce unexpected changes in infants' language development: disruptions caused by COVID-19. Due to the pandemic, ~38% of US families with children under 5 reported changes in childcare arrangements (Patrick et al., 2020), drastically changing the people with whom infants spend their waking hours. Here, we investigated whether infants have experienced corresponding changes in the language(s) they hear by characterizing changes in infants' daily experience with different languages over the course of the pandemic. Participants to date are 109 caregivers of children born between 2016 and 2019 in the US. Children were on average 24 months old (SD = 13.5, range = 3-50) at the start of the pandemic in March 2020. 57 infants were reportedly exposed to at least one language other than English. Participants responded to questions about childcare arrangements and the child's language exposure at 4 time points spanning different phases of the pandemic, enabling us to measure pandemic-related changes over time (Feb 2020, April 2020, Oct 2020, Sept 2021). As predicted, participants reported changes to childcare arrangements as a result of the pandemic., In February 2020, 24% of participants reported that children only received care inside the home, while in April 2020, the number had risen to 79%. This percentage had returned to its pre-pandemic average by October 2020 (28%), see Figure 1. Contrary to our hypothesis, preliminary analyses suggest that the overall percentage of exposure to English did not change over the course of our four sampled time points ($t = 1.02$, $p = .31$), see Figure 2. Ongoing analyses will investigate whether 1) changes in childcare arrangements and/or 2) demographic variables such as parent education and language background may have resulted in changes in English exposure. There has been much speculation about how pandemic-related disruption may be affecting children's development, and these preliminary findings illustrate both discontinuity and stability in infants' lives. Thanks to a linguistically and demographically diverse sample, future analyses may be able to describe individual and community differences in children's experience with language among this unique cohort. More generally, quantifying changes in infants' language experience as a result of the pandemic will illustrate how language development is shaped by complex environmental systems.

P1-D-71 - Social network characteristics predict vocabulary size among infants in the United States (Okocha)

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Cultural practices in middle-class nuclear families prioritize relationships between infants and biological parents, and this structure has informed virtually all hypotheses about how language input shapes language learning (e.g., Hart & Risley, 1995; Rowe, 2018). Yet, many American families deviate from the

nuclear model, and such deviations are becoming increasingly common (Cross, 2018). In a distributed model of childrearing, biological and nonbiological kin share child-care responsibilities, which may increase opportunities for diverse language interactions and, in turn, shape infants' language growth. To begin addressing this idea, we conducted an extensive survey and examined whether the number of close relationships within children's social networks positively predicts their vocabulary size. Participants in our pre-registered study were parents of infants in the U.S. (n = 372; age range = 12-37 months; M = 24.9). Infants' race/ethnicity was approximately Census-matched (69% White, 11% Black, 6% Asian, 2% Native, 10% Hispanic, 2% other race/ethnicity). Annual household incomes ranged from <$25,000 to >$200,000, and 44.3% of participants had annual household incomes less than $50,000. Using an online survey administered through Cint (survey informed by Burke et al., under review), we collected information about infants and the people they see regularly - including family and non-family. For each person, participants reported demographic information and answered two questions about the strength of the relationship from the perspective of the infant, which focused on both observed and expected behaviors (e.g., "Does your child show signs of missing this person when they are not around?"). We calculated total network size and then used these questions to calculate the number of strong ties. We measured vocabulary size using the MacArthur-Bates Communicative Development Inventory (CDI; Fenson, et al. 2009). A multiple linear regression model testing the effects of number of strong ties, age, and income on vocabulary was significant (Adj. R squared = 0.275, F(4, 367) = 36.1 , p = < .0001). Results showed a significant positive relationship between vocabulary size and quantity of strong ties as measured by two different questions about closeness (1: r = .17, p = .01; 2: r = .14, p = .02), and a composite score representing their average (r = .17, p = .008). There was no relationship between total network size and CDI (r = .09, p = .1). Income did not predict network size overall (r = .09, p = .098), but when we excluded two extreme outliers (network size > 25), the relationship was significant, and infants from higher-income families had larger networks (r = .11, p = .02). Income did not predict the number of strong ties (r = .06, p = .23). This study examines the relationship between infants' social networks and their vocabulary development and extends the reach of research on early communication to include diverse family structures. These findings suggest that distributed models of childrearing are likely to be an important factor in early language growth. Investigations into the complex dynamics of larger childrearing networks and kinship structures will be broadly useful for enhancing knowledge about early cognitive development.

P1-D-72 - Pragmatic Contexts and Acoustic Characteristics of Infant-Directed and Adult-Directed Adult Speech in Daylong Audio Recordings (Neer)

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Prior research has documented acoustic differences in infant-directed speech (IDS) and adult-directed speech (ADS), including higher and more variable pitch contours for IDS (e.g., Fernald et al., 1989). Recent data from day-long child-centered audio recorded in children's home language environments have supported many of those prior findings, but with some differences, which may be partly due to the greater range of pragmatic contexts included in day-long home recordings (Pretzer et al., 2019; MacDonald et al., 2020). We used the IDSLabel dataset (Bergelson et al., 2018; Bergelson, 2017; McDivitt & Soderstrom, 2016; VanDam, 2018; Warlaumont et al., 2016) available in HomeBank (VanDam et al., 2016). It includes adult utterances, tagged by human listeners as sounding infant-directed or

sounding adult-directed, sampled from LENA recordings of sixty 3- to 20-month-old infants. We also used each utterance's mean pitch and pitch standard deviation provided for the IDSLabel dataset by MacDonald et al. (2020); pitch measurements were log-transformed prior to inclusion in our statistical models. The present study adds human listeners' judgments of the pragmatic contexts/functions of each adult utterance. We pre-registered three a priori hypotheses motivated by previous findings that pitch differences were attenuated in home audio compared to lab recordings, and exploring whether that might be due to the inclusion of comfort utterances in the day-long home data. We hypothesized that (1) IDS produced in comfort contexts would have lower and less variable pitch than IDS in other contexts (2) IDS that provided explicit information to the addressee would have higher and more variable pitch than information-providing ADS utterances, and (3) comfort utterances would be proportionally more frequent in IDS than ADS. In addition, exploratory analyses examined other possible relationships between context, addressee, and pitch. A pilot dataset of 490 utterances (305 IDS; 185 ADS) from one LENA "conversational block" from each of the 60 participants was annotated and analyzed. Mean interrater agreement between the two research assistants who performed the pilot annotation of pragmatic contexts was 91.1% (Mkappa = .58, Rangekappa = .51 - .82). Disagreements were resolved by the lead researcher. Linear mixed effects models did not find mean pitch for IDS comfort contexts vs. other IDS contexts to differ significantly (b = .10, p = .12). Pitch in comfort IDS was more variable than pitch in other IDS contexts (b = .46, p = .002), contrary to our pre-registered hypothesis. As expected, pitch was higher (b = .18, p <.001) and more variable (b = .26, p < .001) for IDS inform contexts than for ADS inform contexts. Finally, a logistic mixed effects model found a non-significant trend for comfort utterances to be more frequent in IDS than in ADS (OR = 459.62; p = .09). Exploratory analyses revealed additional differences in pitch features related to pragmatic contexts in IDS and ADS (see Tables 1 and 2). This study will provide a more fine-grained understanding of how adult speech differs between addressee and context. Our pragmatic codes will also be made available via HomeBank to facilitate future research with this dataset.

P1-D-73 - The role of word frequency differences in noun comprehension of German-learning infants (Steil)

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English-learning six-month-old's showed early noun comprehension within a looking-while-listening task (LWL; Bergelson & Swingley, 2012). This was indicated by their enhanced fixations on the picture of the named target (e.g. spoon) compared to the distractor picture. However, infants' LWL-performance might be modified by the target language or the availability of extra-linguistic cues, such as word frequency difference of the target and distractor word (see Kartushina & Mayor, 2019, for Norwegian-learning infants). Data of a recent study in our lab supported these conclusions (Steil, Friedrich, & Schild 2021). German-learning 6- to 14-month-olds showed no overall evidence for noun comprehension. Post-hoc comparisons suggested that infants' performance was higher for stimulus pairs where the word frequency of the target and distractor word differed compared to pairs with target and distractor words of the same word frequency. In the present pre-registered online study (via e-Babylab, see Lo et al., 2021, PsyArXiv, doi: 10.31234/osf.io/u73sy), we followed up on these mixed findings by testing German-learning infants and toddlers of a wide age range (6 to 24 months) by systematically controlling for word frequency differences between the target and distractor word. We established word frequency based on

age-matched 160 parental ratings and the CHILDES database of English-learning 6- to 24-month-olds (as German data in this age group was limited, MacWhinney, 2000). In contrast to previous work, we tested the same target words paired with a distractor of the same and of different word frequency. Our preliminary analysis of 34 participants (M = 14.80 months, SD = 5.22 months, 19 female) indicated noun comprehension for the whole sample, M = 0.15, V = 545.00, p < .001, BF10 > 100. Here, participants below 14 months (n = 17, M = 10.30 months) showed evidence of noun comprehension, M = 0.053, V = 121.00, p < .05, BF10 = 1.50, as well as participants above 14 months (n = 17, M = 19.30 months), M = 0.24, V = 150.00, p < .001, BF10 > 100 (see Figure 1 A). This confirms early noun comprehension for German-learning infants and toddlers between 6- to 24-months of age. For now, there is no LWL-performance difference between stimulus pairs with different word frequencies (M = 0.14) and same word frequencies (M = 0.16), V = 301.00, p > .99, BF10 = .20 for all children between 6 to 24 months (see Figure 1 B). It seems that when we kept target words constant across word frequency conditions, infants and toddlers showed no higher performance for stimulus pairs with different word frequencies. However, data collection is still pending, to allow a more fine-graded analysis on the of interest age group between 6 to 10 months in regards to potential word frequency effects.

P1-D-74 - Testing children?s word learning using a fast-mapping app (RUJAS)

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Research has shown that vocabulary size is related to new word learning and retention (Kucker et al., 2020) since it helps the mapping between the new words and its referents. During language assessment, the number of labels stored in children's lexicon is usually the focus of typical standardized measures of lexical development. However, there are few instruments for early language development assessment that pay attention / measure/ study the processes involved in word learning and test children's referent selection abilities. At the same time, previous research has shown that fast-mapping tasks are a useful method to examine children's word learning from a developmental point of view (Rujas et al., 2019). They are easy to administer, and the procedure followed during these tasks allows an assessment beyond the quantification of vocabulary. In this study, we present an Android app that tests referent selection abilities needed during the process of word learning. The task is adapted from previous fast-mapping tasks in which children must select the referent of known and unknown object labels (Carey, 2010; Golinkoff et al., 1996). For 20 trials, the child has to tap the screen in order to select the referent of the words and nonwords audio recorded. The app registers latency, the number of correct answers, and the number of repetitions needed. Results show that the task presented in an app can be administered to children from 18 months old. The applications for educational and clinical contexts and the interpretation of the data are discussed.

P1-D-75 - Vowel Hyperarticulation in Infant-Directed Speech: A Meta-Analysis (Lovcevic)

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One of the most-debated features of infant-directed speech (IDS) is vowel hyperarticulation, which refers to parents' tendency to produce acoustically exaggerated vowels. This exaggeration might result in clearer speech sounds that are easier for infants to discriminate and might be positively related to

infants' linguistic outcomes. However, the universality of vowel hyperarticulation in IDS has been debated with research evidence suggesting contradictory findings. Therefore, we undertook a meta-analytic approach to investigate the current state of literature regarding the presence of vowel hyperarticulation in IDS, and to identify factors that might moderate it. Our meta-analysis was conducted in two steps, with the first step including only methodologically consistent studies (17 studies), while the second step included all studies on vowel hyperarticulation in IDS no matter the method (33 studies). Thus, in Step 1, we included the studies that followed Kuhl et al. (1997) method conducted with typically developing infants from birth to 24 months of age. Additionally, we assessed the infant- and method-related factors differing between studies: native language, infant's age, and measurement scale. In Step 2, we included studies on vowel hyperarticulation in IDS regardless of the method conducted with both typically and infants at risk for sensory or cognitive impairment from birth to 24 months of age. To obtain a comprehensive overview of factors that may influence the presence of vowel hyperarticulation in IDS, the following factors were assessed: infant-related factors (age, native language, risk status), method-related factors (scale, recording context, recording order of IDS and ADS (adult-directed speech), type of elicitation stimulus, interlocutor, method of formant measurement, and recording duration) and vowel-related factors (whether assessed vowels are corner vowels, number of vowels used for vowel space calculations, number of word types analysed for each target vowel, do analysed vowels carry word stress). Both Frequentist and Bayesian approaches were implemented, and Hedge's g was calculated as a measure of effect size. The results of both steps demonstrated a higher degree of vowel hyperarticulation in IDS than ADS with medium to large effect sizes (Frequentist approach: Step 1: Hedge's g = .62, 95 % CIs: .36 .86; Step 2: Hedge's g = .45, 95 % CIs: .21 .68; Bayesian approach: Step 1: Hedge's g = .34, 95 % CIs: .21 .50; Step 2: Hedge's g = .60, 95 % CIs: .30 .91). Furthermore, our results suggest differences in the presence and degree of vowel hyperarticulation as a result of different measurement scales (e.g., Hertz or logarithmic scales) with implications regarding the cause of vowel hyperarticulation (lowering or heightening of formants). Additionally, our results demonstrate the presence of great variability that was due to vowel-related factors warranting the further investigation of these effects due to their theoretical importance. Hence, our results indicate the robust presence of vowel hyperarticulation in IDS supporting the proposal that IDS is aimed at scaffolding infants' language acquisition. Also, due to an observed great heterogeneity some of the ways to tackle this are recommended including clearly reporting and justifying methodological decisions wherever possible.

P1-D-76 - Vowel bias in German-learning 9-month-olds: Perceiving consonant and vowel skeletons (Schmandt)

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We explore whether German-acquiring 9-month-olds show asymmetrical detection of consonant versus vowel repetition across auditorily presented pseudowords. The task is inspired by the finding that English-learning 9-month-olds prefer listening to lists of CVC pseudowords that share the initial CV (fed, feg..) or C (e.g. mod, mib..) over unrelated lists, but not when the pseudowords share the final VC (e.g. mad, lad..) or V (tiz, bis..) (Jusczyk, Goodman & Baumann, 1999). These previous results could indicate an early expression of the C-bias, with consonants being privileged in (pre)lexically-related processing

(Nespor, Pena & Mehler, 2003). To test the C-bias hypothesis more systematically, and determine whether it extends to German, we presented 9-month-olds with lists in which disyllabic pseudowords share their consonantal skeleton (tufo, tafe..) and lists with unrelated pseudowords (tufo, lake..; Exp C), or with lists in which they share their vowel skeleton (tufo, luko..) and unrelated lists (Exp V). We measured their listening times using the Headturn Preference Procedure. 44 German-learning 9-month-olds were tested (Exp C: N=24; Exp V: N=20; data collection is still ongoing for Exp V). Each experiment consisted of 20 trials divided into 2 blocks of 10 trials (5 related and 5 unrelated). Each trial consisted of 20 naturally spoken pseudowords. Pseudowords were constructed with 5 different consonants and 5 vowels, combined into 20 vowel skeletons (*V*V) and 20 consonant skeletons (C*C*), rendering 400 different CVCV pseudowords. Each token was presented in each condition and block (between subjects) in order to avoid any potential item bias. Mean looking times (LTs) to the related and unrelated lists were calculated for each block and experiment (see Figure 1). A 3-way ANOVA with the between-subject factor Experiment (C versus V) and the within-subject factor of Block (1 versus 2) and Condition (related versus unrelated) yielded a significant three-way interaction ($F(1,42)= 5.82$, $p= .02$). Results of a 2-way ANOVA (Block x Condition) for each experiment separately showed a significant interaction in the Vowel ($F(1,19)=4.32$, $p= .05$), but not in the Consonant Experiment ($F(1,23)=2.21$, $p= .15$). Follow-up one-sample t-tests (two-tailed) in the Vowel Experiment revealed that infants preferred listening to the vowel-related over the unrelated trials in the second block ($t(19)=2.35$, $p= .03$), but not in the first block ($t(19) < 1$, n.s.). These preliminary results demonstrate that infants are able to spot a vowel skeleton repetition in potential words, but only in the second half of the experiment which could be indicative of a learning process. Importantly, and contrary to the results found in English-learning 9-month-olds (Jusczyk et al., 1999), consonant repetitions could not be detected at that age. Considering the phonology of German, we will discuss how this vowel bias is best explained by the phonetic-acoustic hypothesis (Floccia, Nazzi, Delle Luche, Poltrock & Goslin, 2014) according to which infants initially pay more attention to the more salient and periodic sounds in the speech stream that is, vowels, and why acquisition of the C-bias might be delayed in German.

P1-D-77 - The Influence of Speaker Characteristics on Toddlers' Semantic Learning (Tupper)

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In addition to mapping a label to its referent, infants and children must also determine how newly learned information relates to other already known information. Much of word learning literature focuses on the former; however, the mechanisms which allow young language learners to integrate new information into existing semantic representations are just as crucial to understanding the mechanisms of word learning (Wojcik & Saffran, 2013; Hadley et al., 2019). Research has demonstrated that 2-year-olds attend longer to pairs of semantically connected words (like dog and cat) over pairs of unrelated words (like dog and sock). While past research has focused on factors that mediate semantic learning, less attention has been given to how talker-specific knowledge influences this process. Infants as young as 11-months track talker-specific specific word labels and use this information to interpret new utterances (Weatherhead & White, 2016; 2021). In the present study, we investigate whether speaker characteristics influence the semantic connections between newly learned words. 22-30-month-old toddlers' semantic learning was assessed using a preferential looking paradigm on the online experiment platform Labvanced. Familiarization: participants saw 16 familiarization trials, in which they

learned four novel word-object pairs. Two words were taught by a speaker of a familiar race (e.g., mito and dax) and two words were taught by a speaker of an unfamiliar race (e.g., tepu and nim). Test: participants viewed a minimum of 12 20-second audio-only test trials. There were two types of test trials, Within-Speaker trials, including familiar race speaker trials (mito/dax) and unfamiliar race speaker trials(tepu/nim), and Between-Speaker trials (tepu/dax). Prior to beginning the study parents self-selected the combination of speakers they saw based on their child's daily experiences (options included a Black, White, and East Asian speaker). Results: If toddlers interpret words taught by the same speaker to be more related than words taught by different speakers, they should attend longer to Within-Speaker trials than Between-Speaker trials (Wojcik & Saffran, 2013). A preliminary paired sample t-test (N=18) comparing Within-Speaker vs. Between-Speaker trials suggested that there may be an effect of trial type, p = .054, conf. int = -0.0299, 2.33, d = .485. These preliminary results suggest that a speaker's characteristics are used by toddlers to guide their semantic learning, adding to a growing body of research suggesting that talker-specific and group-level sociolinguistic knowledge is integrated into word representations from their inception (e.g., Weatherhead & White, 2021). Follow-up experiments will further explore the extent to which talker-specific knowledge influences semantic relations between words. Figure: Violin and box plots demonstrate the looking time difference between the Within-Speaker and Between-Speaker trials. Y-axis = infants average looking time across trials (20 seconds maximum).

P1-D-78 - Does infant-directed speech develop? Comparison of infant-directed and adult-directed speech produced by siblings of infants (Venditti)

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Infant-directed speech (IDS) is used by caregivers from many cultures (Kuhl et al., 1997). IDS is characterized by high and exaggerated pitch and simplified lexical characteristics (Fernald & Simon, 1984; Newport, Gleitman, & Gleitman, 1977) and is thought to facilitate attention and learning (Fernald, 1985; Graf Estes & Hurley, 2013). Most of our understanding of IDS comes from adult-produced speech. Older siblings of infants, however, are also a ubiquitous part of infants' social worlds, but their speech to infants has received little attention. Does IDS undergo developmental change? Do siblings of infants use IDS in the same ways as adults? Twelve children (6 female, mean age=5;5, range=3;3-8;6) and their infant siblings (5 female, mean age=0;7, range=0;6) were included in our analyses. The mean difference in age between siblings was 4 years, 10 months (range=5;5, SD=1;10). We recorded children's interactions with their infant siblings and an adult experimenter in a series of matched tasks. We compared the prosody and lexical characteristics of their infant-directed and adult-directed speech to assess whether they made changes consistent with adult-produced IDS. We asked them to describe how to use a Fisher-Price Tumble Tower (a multi-step toy, Figure 2), and to tell a story from a wordless picture book, Good Dog Carl. Children engaged in these tasks with two interaction partners: first with an adult experimenter and then with their infant sibling. This procedure provided matched interactions that we then used to conduct within-subject comparisons using linear mixed-effects models. These structured interactions were unscripted. Children produced and average of 40.67 utterances to adults and 21.67 to infants (average difference=19). We found a significant main effect of interaction partner (adult, infant) on the fundamental frequency of children's speech ($F(1, 742.4)=53.529$, $p<0.0001$) such that their speech to infants had a higher pitch (M=302 Hz, SD=9.12) in comparison to their speech to the

experimenter (M=273 Hz, SD=8.86) (Figure 1A). We also found a significant main effect of interaction partner on fundamental frequency variation (F(1, 742.5)=37.649, p<0.0001) (Figure 1B). In addition, we found a significant main effect of interaction partner on lexical diversity of speech (F(1, 13.09)=24.045, p<0.0003) and speech rate (F(1, 1058)=63.976, p<0.0001). Speech to infants was less lexically diverse and slower. These modifications were stable over the age range (5 years) of our sample. We did not find developmental effects, giving support to the idea that IDS is robust over development. However, it is possible that the lack of developmental effects is due to the low number of children in this study. These findings demonstrate that children make modifications to their speech to infants that are similar to those of adults. Children exaggerate their pitch characteristics and simplify their lexical content when speaking to infants. Because these modifications have been found to organize attention and facilitate learning in infants, the speech of siblings may be an important force in early development.

P1-D-79 - The effect of mother-infant physiological synchrony on speech processing (Vanoncini)

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Infants start experiencing rhythm before birth, for instance when they hear mother's heartbeat, her voice and the sounds around her (Ullal et al., 2013). After birth, they experience recurrent cycles of behaviors during the interactions with their mothers. These rhythmic patterns might elicit the temporal alignment of cardiac and respiratory patterns in mother-infant dyads (i.e., physiological synchrony). Physiological synchrony emerges early in life supporting the development of infants' self-regulation (Feldman et al., 2007). A biomarker to examine parent-child self-regulation is respiratory sinus arrhythmia (RSA), where two consecutive heartbeats shorten during inspiration and prolong during expiration (Fuchs et al., 2021; Nguyen et al., 2021). On the same line, rhythm plays a crucial role in language development because infants, in order to segment speech, first need to develop sensitivity to the temporal organization of phonemes, syllables, words within the speech flow. However, little is known about potential links between physiological rhythm experience (e.g., cardio-respiratory synchrony) and language development. The present study examined whether and how mother-infant physiological synchrony, measured by RSA synchrony, predicts early word segmentation (for the preregistration, see https://aspredicted.org/LDZ_8NT). We hypothesized that higher levels of mother-child physiological synchrony will be associated with higher word segmentation performance. Data of 37 9-month-old infants (M=300.57 days, SD=12.96, 21 females) and their German-speaking mothers (M=32.83 years, SD=5.03) were included in the preliminary analyses. In order to measure physiological synchrony, the mothers and their infants performed a 5-minutes of free play while their cardiac activity is measured using dual-electrocardiogram. With an eye-tracking-based central fixation paradigm, we tested infants' word segmentation. During familiarization, infants heard text passages containing two target words (i.e., familiar words). At test, infants were presented with familiar words and novel words. Differences in looking times (LTs) to novel and familiar words suggest that infants segmented the words during familiarization. Physiological synchrony was examined with Cross-Recurrence Quantification Analysis, and the predictability of the time-series in percentage (i.e., % DETerminism) was used as metric to evaluate RSA time-series (Nguyen et al., 2021). RSA was previously calculated on inter-beat-intervals (Abney et al., 2021), which were based on R-peaks detection (Makowski et al., 2021). For statistical analysis, log transformed LTs by trial at test were used as dependent variable. Trial type (novel vs. familiar) and physiological synchrony were included as fixed effects. Participant was included as random

effect. Preliminary results revealed that physiological synchrony significantly predicts LT at test (p = .02): the higher infants' level of physiological synchrony with their mothers, the longer were their LTs (Figure 1). Nevertheless, physiological synchrony did not interact with trial type (p = .08, Figure 2). Hence, results do not reflect that physiological synchrony is associated with word segmentation performance. However, the overall effect of physiological synchrony on looking times indicates that physiological synchrony between mothers and their infants might be associated with infants' interest in listening to speech. Our study highlights the importance of investigating the link between cardiac rhythms and speech perception due to their shared rhythmic nature.

P1-E-80 - Testing early grammatical development in Spanish language: longitudinal evidence from a Sentence Repetition Task (Rujas)

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Sentence repetition tasks (SRTs) have been widely used in language development research in the last decades. Specifically, they have been used as a diagnostic tool in developmental language disorder (Conti-Ramsden, Botting & Faragher, 2001; Pham & Ebert, 2020; Seef-Gabriel, Chiat & Roy, 2010). However, most research has been conducted in English speakers older than 4 years of age (Rujas et al., 2021). In this context, the aim of this study is to explore the properties of a SRT in Spanish (Bravo et al., 2021), focusing on its predictive validity. Thus, we conducted a longitudinal study including 20 monolingual Spanish-speaking children. Data were collected twice: participants aged 24 to 42 months old at T1 and aged 40 to 48 months old at T2, six months later. At both times they completed a SRT (Bravo et al., 2020), a nonword repetition task (Mariscal & Gallego, 2013) and the Spanish version of the Merrill-Palmer-R Scales of Development (Sánchez-Sánchez et al., 2011). Results show that: a) the performance in the SRT at T1 significantly and strongly correlates to performance in the nonword repetition task and in the Merrill-Palmer-R; b) the SRT is sensitive to changes in performance between T1 and T2; c) there is a significant and strong relationship between the accuracy in the SRT at T1 and both the accuracy in the SRT at T2, and the MLU in the SRT at T2; d) performance in the SRT at T1 is a significant and strong predictor of expressive language (Merrill-Palmer-R) at T2. These results support the predictive validity of this new Spanish sentence repetition task, pointing out that it can be a useful tool to early assess language abilities in very young children and, thus, to promote the detection of early language difficulties before 4 years of age.

P1-E-81 - Using Proportion of Speech-like Vocalizations to Differentiate ASD Diagnosis in Toddlers Born at Term and Premature (Stone)

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Background: Autism spectrum disorder (ASD) is a developmental disorder identified in 1 out of 44 children; and is likely present in the perinatal period (Elsabbagh et al., 2012; Wolff et al., 2012). A recent meta-analysis found that infants before 36 weeks gestational age were over 25% more likely to develop ASD (Wang et al., 2017). The most prevalent challenges autistic children face are associated with social

skills and atypical communication. Research has found that early vocalizations can provide insight into developmental trajectories, with subgroup differences forming as early as the first year of life. In our previous work (Tenenbaum et al., 2020), we showed that a lower proportion of speech-like utterances relative to all vocalizations in toddlers was predictive of ASD diagnosis. Here we investigated whether the proportion of speech-like vocalizations as measured during a standardized presentation of videos on a tablet in health care settings can be used to identify ASD status in toddlers born full and preterm. Objectives: (1) To replicate our previous findings that autistic toddlers produce lower proportions of speech-like vocalizations relative to non-autistic toddlers. (2) To assess whether this pattern is specific to ASD or associated with developmental delays, such as those often observed in premature infants. Methods: During their 18- or 24-month healthcare visit, full-term (>38 weeks) and premature infants (< 32 weeks) with and without autism were recorded using the camera in a tablet while they watched engaging and developmentally appropriate videos designed to elicit behaviors associated with ASD. Videos from seventy-four children were recorded (Full-term with ASD: n = 25, 18 male, M = 23.0 months, SD = 2.9; Full-term without ASD: n = 24, 13 male, M = 22.8 months, SD = 3.1; Premature: n = 25, 14 male, M = 23.4 months, SD = 2.5). Videos were coded offline for proportion of speech-like vocalization relative to all vocalizations based on the methods used by Tenenbaum et al., (2020). Results: Coding has been completed for 13 participants from each group (Full term with ASD, Full term without ASD, and Premature), and data collection is near complete. An ANCOVA test was considered to examine between- group differences in the proportion of speech-like vocalizations, while controlling for age. Based on our preliminary data, we found a significant effect of ASD diagnosis on the proportion of speech-like vocalizations, $F(1,33) = 4.39$, $p = .04$, but no significant differences in the number of speech-like, $F(1,34) = 1.974$, $p = .27$, or non-speech-like vocalizations, $F(1,34) = 1.353$, $p = .25$. Conclusions: This preliminary evidence suggests that we have replicated our previous findings that toddlers with ASD produce lower proportions of speech-like vocalizations when compared to non-autistic toddlers. Further, it appears that lower proportions of speech-like vocalizations are indicative of ASD specifically rather than general delays such as those often observed in premature infants. This work was supported by Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health [P50HD093074, R01 MH121329, R01MH120093] and the Duke Institute for Brain Sciences.

P1-E-82 - Language profiles of low-risk preterm and full-term late talkers (Zuccarini)

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Introduction A wide heterogeneity characterizes late talkers, i.e., children showing an expressive vocabulary size at or below the 10th percentile with respect to standardized tools - up to three years of age, that deserves to be more deeply investigated (Bello et al., 2018; Desmarais et al., 2010; Rescorla, 1989; Thal et al., 2013). We aimed to identify language profiles of late talkers differing in their birth condition (either low-risk preterm or full-term) according to both their receptive and expressive vocabulary. We also aimed to further characterize each profile concerning a set of communicative, linguistic, cognitive and motor skills. In addition, we explored the relationships of potential biological and environmental risk factors with profile membership. Methods Sixty-eight late talkers, including 33

low-risk preterm and 35 full-term borns, were identified through a language screening at 30 months (corrected age for preterm children). All late talkers had been exposed to the Italian language from birth, and had no neurological damage, congenital malformations, sensory impairments, or cognitive deficits. Parents filled out the Italian version of the MacArthur Bates Communicative Development Inventories Infant and Toddler Short Forms (MB-CDI word comprehension, word production, sentence production, and indexes of communicative and linguistic skills, Caselli et al., 2015). Children were assessed with the Picture Naming Game test (PING, lexical, i.e., noun and predicate, comprehension and production, Bello et al., 2012) and the Italian version of the Bayley Scales of Infant and Toddler Development, Third Edition (BSID-III, language, cognitive, and motor composite scores, Ferri et al., 2015). A two-step cluster analysis was used to identify language profiles of late talkers according to their receptive (word comprehension) and expressive (word production) vocabulary. Chi-square tests and ANOVAs were conducted to examine differences among profiles concerning children's communicative, linguistic, cognitive, and motor skills. A multinomial logistic regression investigated potential biological and environmental predictors of profile membership. Results The cluster analysis identified three distinct profiles: severely late (25%), with limited word comprehension and word production, absent or limited verbal imitation, lexical and sentence production, and phonological accuracy; moderately late (35%), with average word comprehension but limited word production, mostly present verbal imitation, limited lexical and sentence production and phonological accuracy; slightly late (40%), with average word comprehension and slightly limited word production, presence of verbal imitation, slightly limited lexical and sentence production, limited phonological production. Lower scores in cognitive skills characterized the severely late with respect to the other profiles. Male gender and not attending a child care centre increased the likelihood of being respectively assigned to the severely late and moderately late profiles. Conclusions These findings suggest the relevance of assessing receptive and expressive vocabulary and several communicative, linguistic, and cognitive skills in late talkers and considering biological and environmental risk factors to trace their profiles and implement tailored interventions.

P1-E-83 - 9-month-olds' pointing is linked with parental sensitivity but not vocabulary (Nicoladis)

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Infants often start pointing toward the end of their first year of life, between the ages of seven and 11 months (McGillion et al., 2017). Infants' pointing shows a strong link to both their current and later language abilities (Rohlfing et al., 2017), particularly after their first birthday. The most likely reason for this link is that parents label what infants point at, allowing the infants to learn those labels (Begus et al., 2014). In the present study, we tested this explanation with infants younger than included in most previous studies: 9-month-olds. Specifically, we predicted that parents of infants who were pointing at this age would be respond more sensitively and the pointing infants themselves would have larger vocabularies, both at the age of nine months and later. We observed 88 nine-month-old infants in free-play situations with their mothers. Following methodology of Brooks and Meltzoff (2008), we classified the infants as either pointers (n = 37) or nonpointers (n = 51). We coded maternal sensitivity following the scheme of Ainsworth (1974). As predicted, the mothers of the infants who pointed were less directing and responded more contingently than the mothers of the infants who did not point. However, there was no difference in vocabulary scores of pointers and non-pointers, either concurrently or at 12 and 18 months of age. Moreover, maternal sensitivity scores did not correlate with their children's

vocabulary at any age. These results raise some questions as to how pointing is linked to language abilities. One possible interpretation of these results is that the link between pointing and language can only become established after children have attained a critical mass in vocabulary and can therefore interpret parents' labels. In support of this interpretation, Lucca and Wilbourn (2018) found that children's pointing predicted their ability to learn new words in an experimental setting for 18-month-olds but no 12-month-olds.

P1-E-84 - Under-resourced or overloaded? Rethinking working memory deficits in developmental language disorder (Jones)

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Developmental language disorder (DLD) involves deficits in language acquisition and use in the absence of any clear biomedical cause, and affects approximately 7.5% of English-speaking children (Norbury et al., 2016). Solid mechanistic understanding of this condition is valuable not only from a theoretical standpoint, for instance by improving our understanding of typical brain function, but is also essential to providing effective support for affected children, many of whom will face significant social, educational, and employment challenges. Dominant theoretical accounts of DLD are almost unanimous in assuming working memory capacity limitations, both in the central executive and verbal short-term memory subsystems defined in Baddeley and Hitch's (1974) model (e.g., Montgomery et al., 2019). This has motivated the development of programmes of intervention that aim to target working memory capacity and in doing so improve the child's language ability. Here, however, we present a radically different view: That working memory in DLD is not atypically capacity limited but is instead overloaded due to operating on speech representations with low separability. Under this view, apparent working memory task performance deficits among young children are understood as the downstream consequence of low-level deficits in frequency discrimination. Our theoretical framework is developed through computational simulations involving neural networks trained on spoken word spectrograms in which frequency information was either retained or degraded to mimic spectral processing deficits identified among children with DLD (McArthur & Bishop, 2005). We simulated a speech recognition task in which 5000 recorded spoken exemplars were classified as one of 35 words. We monitored not only speech recognition accuracy and predictive probability and entropy (i.e., predictive distribution spread), but also used mean-field-theory-based manifold analysis to assess; (i) the dimensionality of the internal speech representations or 'manifolds' formed by the networks (see Figure 1), and (ii) network classification capacity; a proxy for executive control operationalized as the number of linearly separable word manifolds per artificial neuron, per network layer (Stephenson et al., 2020). This latter metric is appropriate as the retrieval of speech representations within an activated cohort is a key feature of executive control. We show that instantiating a low-level frequency discrimination deficit results in the formation of speech representations with atypically high dimensionality, and that classification capacity (i.e., executive control) is overwhelmed as a consequence of low representation separability (see Figure 1). These representation and control deficits underpin not only 25% lower performance accuracy in a simulated spoken word recognition task, but also greater uncertainty even when making accurate predictions (i.e., predictive distributions with high entropy and low maximum probability); a finding that we argue parallels the response delays and word finding difficulties seen in young children with DLD. Overall, these simulations illustrate how irregularities in long-term speech representation may be the

cause of apparent, rather than the consequence of real, working memory capacity limitations, challenging the status of such limitations as an indispensable feature of causal theories of DLD.

P1-E-85 - Age Changes and Gender Differences in Mothers? Provision of Internal State Categories from 17 to 21 Months (Olson)

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Previous studies report that mothers use internal state words differently with preschoolers based on gender. Preschool boys receive fewer and reduced diversity of internal state words and more words referencing negative dispositions (e.g., Fivush, Brotman, Buckner, & Goodman, 2000). The literature is less clear for toddlers. There is evidence that 13 and 17-month-old boys and girls receive a similar number of internal state words overall, but that girls hear a greater variety of different internal state words and that variety relates to their internal state vocabularies (Olson & Masur, 2020). However, it is not known whether the diversity of internal state words might vary by age or category. To answer these questions, the current study examined age changes and gender differences at 17 and 21 months in a natural play context in four different categories of mothers' internal state words: volition, perception, disposition, and cognition. Twenty-three mother-infant dyads participating in a longitudinal study were videotaped for 18 minutes during laboratory toy play with a standard toy set when infants were 17 and 21 months old. With Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias, 2012) we calculated the number of different internal state words--categorized as volition (want, need), perception (see, hear), disposition (like, happy), and cognition (think, know) (Slaughter et al., 2008)--in mothers' speech at 17 and 21 months. Disposition words were further categorized as having positive (e.g., happy, nice, like, fun) or negative (e.g., sad, scared, yucky) emotional valence. Proportions of unique positive and negative dispositions words for boys and girls at each age were analyzed. Changes with age in mothers' production of unique mental state words were assessed with a 2 (Gender) x 2 (Age) x 4 (Category: Volition, Perception, Disposition, Cognition) mixed measures ANOVA. See Table 1 for descriptive statistics and ANOVA F values. There was a general increase in mental state terms over time and considerable variation across categories. Moreover, the developmental changes in mental state word production differed markedly by category. Mothers' expanded their provision of perception, disposition, and especially cognition words from 17 to 21 months. The increases in perception and cognition words were even more pronounced for mothers of girls, while increases in disposition words were most evident in mothers of boys. A 2 (Gender) x 2 (Age) x 2 (Valence: Positive, Negative) mixed measures ANOVA of mothers' disposition words revealed a main effect of valence, $F(1,18) = 25.54$, $p < .001$. For both girls and boys mothers overwhelmingly used more positive (M=75%) disposition words than negative (M=26%). These findings illuminate the value of examining the diversity of mothers' internal state words across the second year of life. They suggest that gender differences reported for preschoolers are beginning to emerge in toddlers as girls hear more perception and cognition words and boys hear more disposition words. However, contrary to reports of preschoolers, gender differences in the valence of disposition words were not yet observed.

P1-E-86 - Does bilingualism affect gesture use at 14 months? (Germain)

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Gesture is an important communication tool that provides insight into infants' early language and cognitive development and predicts later language skills (Iverson & Goldin-Meadow, 2005). While bilingual school-age children and adults have been reported to gesture more relative to monolinguals (Krauss & Haddar, 1997; Nicoladis et al., 2009), there is a lack of studies examining the early development of gesture use in infants exposed to more than one language. Gesture facilitates word retrieval, decreases cognitive load (Goldin-Meadow et al., 2001; Nicoladis et al., 2009) and could be used as a strategy to compensate for bilinguals' smaller vocabulary size in each language relative to monolinguals. Thus, we predicted that greater exposure to a second language would result in the production of more gesture types among 14-month-olds who are at the early onset of vocabulary production. Participants included 139 infants (age range: 13.5 to 15.5 months, 47% female) learning French and/or English: bilinguals (hearing the second language at least 25% of the time, n = 47), exposed (hearing a second language 10-24% of the time, n = 18), and monolinguals (hearing one language 90% of the time or more, n = 74). Language exposure was measured via the Language Exposure Questionnaire (Bosch & Sebastian-Galles, 2001) using the Multilingual Approach to Parent Language Estimates (MAPLE, Byers-Heinlein et al., 2019). Gesture data were gathered through the MacArthur-Bates Communicative Development Inventories: Words and Gestures (CDI), a parent-report checklist. As bilinguals had two CDI forms available (reliability analyses showed high reliability between the two forms, $\kappa = .81$), we included data reported in the infant's dominant language for statistical analyses, because this was likely to be completed by the primary caregiver. Our analyses focused on the CDI's section that assesses infants' gesture use (Part II). We were interested in sections A, C, D, and E, excluding B as it asks about language and culturally-specific songs/games. Contrary to our predictions, a series of factorial ANOVAs examining the effects of language group, gender and their interaction, showed that the three groups produced a similar number of gesture types, suggesting that language exposure did not affect gestural development at this age. However, we replicated a previously-reported finding that girls produced more gesture types than boys (see Figure 1). Overall, these results suggest that gender, but not bilingualism, contributes to differences in gesture development amid infancy. Furthermore, contrary to vocabulary size outcomes, differences in gesture types are not observable at this age between bilinguals and monolinguals when a single-language CDI form is used. Future work is needed to examine differences in gesture as a function of second language exposure at older ages, where gesture and vocabulary might be more tightly intertwined. Moreover, the CDI assesses the number of gesture types, and not frequency of gestures, which will be another important future direction. Taken together, these and future results will allow to better understand the outset of early differences in gesture abilities in the developmental trajectories of bilingual children and their contribution to the development of oral language skills.

P1-E-87 - Objective measurement of ASD sex differences in infants' classroom social networks (Fasano)

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Autism spectrum disorder (ASD) is often characterized by deficits in communication and social interaction, and has a higher prevalence rate in boys than girls, with an approximate diagnosis rate of ~4:1. Given the difference in diagnosis rate, the majority of research on ASD has focused on boys, leaving questions remaining about how girls with ASD may differ from their male counterparts in their

social communication and interactions. Here, we objectively examine preschool classroom social networks to assess how girls and boys with ASD differ from each other and their typically developing (TD) peers, both in general and between those of the same sex, in their language and social interactions. Participants included 98 infants (42 girls, 56 boys; 66 ASD, 32 TD) enrolled in 12 inclusive classrooms. During monthly observations, infants wore lightweight vests equipped with Language ENvironment Analysis (LENA) to measure vocalizations and two Ubisense tags to measure location/orientation. Ubisense measures of proximity/orientation were used to determine social contact, and synchronized to LENA data to assess each infant's social language output to peers and input from peers. Each infant's language abilities were assessed by the Preschool Language Scales (PLS-5). Data were aggregated to create classroom social networks based on the frequency of dyadic language-mediated interactions (Figure 1). Social network analysis yielded measures of the modularity, or cohesiveness of groups (i.e., ASD/TD) within the class, and each child's degree centrality to their network, or the social ties children have to their peers based on the sum of language input and output to and from peers (cotalk). We also assessed how children's assessed language abilities (PLS-5 scores) influenced their interactions and role in the classroom network. We compared group modularity, individual degree centrality, and the effect of assessed language abilities between girls and boys with and without ASD. Preliminary findings from 77 participants showed that in general, infants with ASD had lower modularity than their TD peers ($p=.04$), but specifically TD girls have significantly higher modularity than any other group ($p=.005$). This finding could indicate that it is more difficult for girls with ASD to interact with TD girls, because the TD girl group is so modular on its own. For degree centrality, TD infants were more central to classroom networks than peers with ASD ($p=.01$), indicating that TD infants produce more output and receive more input from peers than infants with ASD. Further, when accounting for PLS-5 scores, an interaction exists between TD boys and assessed language abilities ($p=.01$), suggesting that language abilities may be an especially important for supporting cotalk for boys, while language abilities matter less for girls (Figure 2). Overall, the preliminary results suggest that there are ASD-related group differences in social communication and interactions, but that those group differences vary with sex. Thus, both group and sex are crucial for understanding infants' social communication and interaction, and how classroom social networks form. Such findings may lead to important insights of differences between girls and boys with ASD that are relevant for diagnosis and intervention.

P1-F-100 - Toddler vocabulary and object processing: Data from a new test of memory for visual paired associates (Bakopoulou)

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Learning names for concrete objects relies on visual processes such as object recognition and memory for previously named objects. This is reinforced by recent research demonstrating that children's first word productions are best predicted by the number of times an object is seen rather than the number of times a word is produced for the child (Clerkin et al. 2017), and by demonstrations that performance on cross-situational word learning tasks is correlated with multiple object memory measures (Vlach and DeBrock, 2017). Furthermore, Collisson, Grela, Spaulding, Rueckl & Magnuson (2015) demonstrated that preschoolers with SLI, but not typically developing children, failed to learn simple visual paired associates and that individual differences in this ability predict the children's attention to shape when generalizing novel nouns (i.e., the "shape bias"). The goal of the current work is to test a simple visual

paired associates task for younger children we developed. The task uses a preferential-looking procedure and an eye-tracker, rather than the detailed instructions used by Collison et al. (2015). We present data from two experiments using the new task to examine the relation between visual paired associates learning and early vocabulary development. Experiment 1 presented children a pair of objects (e.g., a sun and a spoon, Figure 1), followed by a probe object and then a test slide with one of the initially presented objects (target) and another object (foil, e.g., a glass). In a blocked design, successive trials became harder including novel, rather than familiar name-known, stimuli and previously seen foils as distractors. Thirty-one 20- to 26-month-old children (M=23 months, 12 boys) with a mean productive vocabulary of 270 (range 54 to 414) on the Oxford Communicative Developmental Inventory (OCDI) participated. Trials with old distractors ($p = .001$) and familiar objects ($p = .011$) led to more target looking. However, children with more words in their productive vocabulary looked more to the target during novel trials with old distractors ($p < .001$) suggesting they remember more novel object pairs than children who knew fewer words. Experiment 2 tested whether the probe stimulus drove looking to targets via probes that were either "random" (not previously seen with either test slide stimulus) on half the trials. In addition, all stimuli were pre-familiarized and the block structure eliminated. Fifty 14- to 24-month-old children (M=20 months, 25 boys) with a mean productive vocabulary of 149 (range 2 to 365) participated. Knowing more words ($p = .0002$) and associated trials ($p < .001$) led to more looking to the target. Vocabulary group also interacted with familiar/novel ($p = .005$) and associated/regular ($p = .002$) indicating that the probe did drive looking to the target and more so for older children on familiar trials with familiar objects. Our new task provides a good measure of the relation between young children's memory for object pairs and early vocabulary development. We are now using this task to examine relations between visual paired associates memory, and the development of the early vocabulary and word learning biases.

P1-F-101 - Content of competing stimuli influences attention orienting to rapidly presented facial expressions from infancy to toddlerhood (Lasch)

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Background and Objective: Prioritized processing of salient and biologically relevant information shapes functional specialization throughout early development. While little is known about the minimal amount of information needed to bias visual attention, previous work (Lasch & Elison, 2021) has established early visual attentional biases towards fear faces as compared to scrambled faces present as early as 4 months, but this bias towards fear faces compared to inverted fear faces emerging only around 10 months. The objective of these analyses was to extend earlier analyses to a broader age range and further examine the effect of competing stimuli on the development of biases towards rapidly presented fear faces in the first years of life. Methods: Two hundred and thirty six participants completed an eye-tracking task at 1-5 visits at ages 3 to 69 months, for a total of 332 visits. In this variant of a spatial cuing task, competing cues are briefly presented (24 ms) within the parafoveal visual field and then backward masked (126 ms) before the presentation of a peripheral target. Facilitation and cost due to cue-target congruent/incongruent trial-types are captured via eye tracking (Tobii TX 300). Cue combinations included 1) a fearful face and a gaussian filtered 'scrambled' version of the fearful face; 2) a fearful face and the same fearful face inverted; 3) a fearful face and a neutral face of the same identity (Figure 1). Participants contributed a mean of 28 valid trials across four cue X target stimuli

combinations. Multi-level nested models (trials within visits within participants) were run to predict response time to targets (i.e., time to initiate eye movement to target happy face), with separate models for each of the three presentations. Models assessed the main effects of participant age, target direction (left vs. right), fear cue location (left vs. right), and relevant interactions between these variables (most importantly the cue x target interaction which indicates an attentional bias). Models were assessed for best fit based on AIC. Results and Implications: In the scrambled condition, best fitting model included a significant cue X target interaction (b=-60.4, p<.001), a main effect of age (b=-.65, p<.001), and an age X target interaction (b=-.29, p=.020). In the best-fitting model in the inverted condition, the cue X target interaction was only marginal (b=-6.82, p=.083), with a marginal main effect of age (b=-.23, p=.096), and a significant age X target interaction (b=-.61, p<.001). In the neutral condition, the best fitting model included a significant cue X target interaction (b=-31.6, p<.001), as well as a significant main effect of age (b=-.72, p=.025). As seen in Figure 2, attention bias was generally largest in the scrambled condition, and smallest in the inverted condition. Significant effects of age emphasize the importance to investigating early visual attention to socially relevant stimuli, and varying effects between the three presentations highlights the early attention system's prioritization of fearful faces in competition with varied stimuli.

P1-F-102 - Toddlers' engagement with in-and out-group members: Does mimicry increase imitation? (Seehagen)

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From infancy, humans engage in different ways with members from their own versus a different group. For example, 14-month-old infants preferentially imitated novel actions from a person who spoke their own language versus a foreign language (Buttelmann et al., 2013). So far, however, it is unclear how stable such differences in social interaction are. Prior research has shown that being mimicked can change 18-month-old infants' subsequent social behavior by leading to increased helping behavior towards the person who mimicked them (Carpenter et al., 2013). We tested if being mimicked by an in- or an outgroup member alters imitation of this person's actions in 26- to 30-month-olds. Thirty-three toddlers were randomly assigned to an in-group model (n = 17) or an out-group model condition (n = 16). The assessment consisted of four parts: 1) Group membership indication, 2) Imitation Phase 1, 3) Mimicry, and 4) Imitation Phase 2. For Group membership indication, the experimenter read a short text, in either German (in-group model condition) or in Latin (out-group model condition). In each imitation phase, toddlers participated in two imitation tasks, based on Konrad et al. (2019, Fig. 1). During Mimicry, toddler and model had several simple toys in front of them lying on the table. There were two exemplars of each toy, with one exemplar in front of the child and one exemplar in front of the model. For 2 minutes, the model mimicked the toddlers' actions with the toys but also facial and other gestures. There were three main findings (Table 1). First, contrary to previous studies, there was no difference in imitation from the in-group versus the out-group model, $F(1,31) = 0$, $p = .977$ Second, there was a significant increase in imitation scores from Imitation Phase 1 to 2, $F(1,31) = 5.86$, $p = .022$, $\eta p2 = .159$. Third, the increase in imitation scores from the first to the second imitation phase did not vary as a function of condition, $F(1,31) = .434$, $p = .515$. Toddlers' increased imitation after mimicry could indicate that brief playful interactions including mutual imitation are an efficient way of increasing imitation from different models. Future studies will have to show if time spent together in general, or

mimicry in particular, increases imitation scores. The lack of differentiation between the in-group versus out-group model might be due to the nature of the model (real-life vs. televised, Howard et al., 2015). Additionally, data collection occurred during the pandemic and was guided by social distancing and use of masks/visors. Possibly, these special circumstances overshadowed indicators of the model's group membership.

P1-F-89 - Object manipulation during naming scaffolds toddler attention to referents: early findings from at-home wearable eye tracking (Schroer)

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Parent-toddler dyads coordinate their behaviors across modalities during an interaction - looking at, touching, and talking about objects. This coordination, such as joint attention and looking at each other's hands, supports toddlers' sustained attention to objects (Suarez-Rivera et al., 2019) and predicts later vocabulary (Yu et al., 2019). But missing from even highly naturalistic experiments is knowledge of whether these behaviors truly exist in toddlers' daily lives. The goal of the present study is to push the boundaries of home observations by collecting dual wearable eye tracking data during everyday activities to explore how parents and toddlers coordinate their multimodal attention in the real world.

The presented findings are from the new FIELD Project (Family-Infant Eye tracking and Language Dataset). English- and Spanish-speaking families were recruited from Austin, TX. 4 toddlers (27-31 months, 3 male) and a parent (2 fathers) wore Pupil Labs Invisible eye trackers for 30-60 minutes while going about their everyday activities (Figure 1). Each family contributed 1-3 recordings. Other family members, but no experimenters, were present during the recordings.

We first annotated the activities dyads engaged in. For preliminary analyses, we focused on play (54 minutes of recording) and mealtime (20 minutes). We transcribed all parent speech and identified naming utterances (play=305, mealtime=84). We then coded parent and toddler behaviors during naming. The Invisible eye trackers automatically generate gaze-estimation data, which we used to code toddler attention frame-by-frame to different categories of objects (based on Long et al., 2021; e.g., food, animal toys, people, utensils, books). We then determined whether parents and toddlers looked at or touched a potential referent during the naming utterance (assigning yes/no values). We tested whether the presence of multimodal attention (toddler holding a referent), coordinated attention (parent looking at a referent), or parent touch predicted the proportion of a naming utterance that toddlers attended to objects in the named category (likely referents).

During play, we found that toddler's multimodal attention predicted a greater proportion of attention to likely referents (With=0.568, Without=0.358, $p<0.001$, Table 1). We also found that coordinated attention related to greater attention to likely referents (With=0.516, Without=0.279, $p=0.005$), but that parents' touching of objects did not predict differences in toddler visual attention (With=0.480, Without=0.402). Conversely, during mealtime we found that only parent touch predicted greater toddler attention to likely referents (With=0.439, Without=0.166, $p=0.011$). Toddler touch (With=0.295, Without=0.196) and parent looks did not predict any differences (With=0.155, Without=0.321).

Our preliminary results suggest that the behavioral patterns we observe in the lab exist in the real world. Multimodal attention and coordinated attention seem to scaffold infant attention to likely

referents during play. We saw a unique pattern emerge in mealtime, with parent's hands playing a lead role, suggesting that the affordances of mealtime may elicit different behaviors from dyads (see Tamis-LeMonda et al., 2019). With continued data collection we plan to explore how the patterns of micro-level coordination vary across everyday activities in English- and Spanish-speaking families.

P1-F-90 - Validation of Teller acuity with an automatic eye tracking assessment (Klotz)

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The resolution with which we can see the world greatly alters our ability to learn from it. Over the first year of life, infants' visual acuity radically increases (Dobson & Teller, 1978), allowing them to acquire different information about the world as they detect finer detail in their visual environment. What infants learn during their fixations then contributes to development of their looking behavior. Because most studies with preverbal infants rely on some form of visual perception as a proxy for cognitive processes, it is important to have tools to assess their visual experience. Teller acuity cards have been shown to reliably assess visual acuity in infants (Preston & Freedman, 1988; Spierer, 1999) and have been widely used in clinical settings. They are less commonly used in research settings, perhaps because of the expense, training, space, and time required to use them properly. As automatic eye trackers have become common in infant labs, one solution is to develop eye tracking tools to assess visual acuity that can be easily integrated into other protocols. The goal of this project was to determine the validity of one such tool. Hansen et al. (2020) developed an automatic eye tracking assessment of infant visual acuity using an Eyelink 1000 Plus. In this procedure, infants are shown sine wave gratings passed through a gaussian filter paired with a gray field, much like the square wave gratings on a Teller Acuity Card, on a computer monitor and their eye gaze is recorded. Each trial consists of a particular grating being presented on either the left or right side of the screen; each grating was presented on two 2-s trials, once on the left and once on the right. Infants "pass" a particular grating if they attend to that grating within 2-s on both the trials it was presented. A staircase procedure was used, such that testing continued until the infant failed to pass a grating or until all gratings had been detected (maximum cycles/degree of 20.48). Using this procedure, Hansen et al. observed increases in acuity from 5 to 11 months of age, as predicted from the literature. The present project validates this eye tracking assessment by comparing visual acuity as measured with eye tracking to visual acuity as measured with Teller acuity cards. To date, 18 4- and 8-month-old infants participated in both assessments in the same session. We determined each infant's acuity (maximum cycles/degree) in each method (see Figure 1). To compare the acuity estimates for each infant, we subtracted the log-transformed acuity estimate in the Teller procedure from the log-transformed acuity estimate in the eye tracking procedure. The difference between the estimates was minimal, $M = -0.003$, $SD = 0.62$, and a t-test revealed that the differences were not significant, $t(17) = -0.02$, $p = .98$. We also correlated the two transformed scores, which yielded a correlation of $r(16) = .44$, which was non-significant with this small sample, $p = .068$. In summary, the two methods yield similar estimates of visual acuity. However, the eye tracking procedure ($M = 90.18$ s, $SD = 96.67$) takes significantly less time than the Teller cards ($M = 218.41$ s, $SD = 84.89$), $t(16) = -4.55$, $p < .001$ (see Figure 2), and can easily be incorporated into other eye tracking protocols. Thus, once complete, this validation study may demonstrate to researchers how easily they can incorporate a simple acuity assessment in any computer-based eye tracking study with infants.

P1-F-91 - Capturing the Developmental Changes in Attention Associated with High Risk for Autism Spectrum Disorder: A Multi-Method Approach (Fu)

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Sustained attention towards social information is essential for social cognition development. In typically-developing (TD) infants, sustained attention towards social information is early-emerging and increases with age (Frank et al., 2009). Infants at elevated likelihood for autism spectrum disorder (ASD), including siblings of children with ASD (ASIBs), display reduced looking behavior towards social stimuli (Chawarska et al., 2013). Eye tracking (ET) provides objective measures of looking behavior with high temporal and spatial resolution. However, ET is prone to data loss and reduced data quality (Wass et al., 2014). Behavioral coding offers a more accessible, robust, and flexible measure of looking behavior than ET (Wass et al., 2013). The concordance between ET and behavioral coding is a particular concern in infants at elevated likelihood for ASD who are more susceptible to ET data loss (Venker et al., 2019). First, we aimed to examine the within-subject association between behavioral coding and ET measures of looking preference towards social displays. Second, we used ET measures to examine whether developmental changes in looking preference towards social stimuli differed between TD children and ASIBs. The current study is a part of an on-going prospective, longitudinal research on infant attention and social development. Longitudinal data collection was conducted between 3 to 36 months with narrow age intervals. Infants watched "Simple" displays (20- to 35-second videos), followed by "Complex" displays of social and nonsocial stimuli (40-90 seconds each). The "Complex" stimuli were used to measure sustained attention. ET data were obtained in 44 TDs and 18 ASIBs. Of these participants, Behavioral coding were completed for 36 TDs and 16 ASIBs. We computed difference scores between the percentage of time looking at the computer screen during the social stimulus presentation (out of the total duration of stimulus presentation) and the percentage of time looing at the screen during the non-social displays. Greater positive scores indicate greater looking preference towards the social relative to nonsocial stimuli. Linear mixed-effects analyses revealed a significant positive within-subject association between behavioral coding and ET measures of looking preference towards the social stimuli, $F(1, 180)=116.76$, $B=0.63$, $p<.001$, controlling for the effect of Age, Group, and Task Type. Additionally, Figure 1 shows that the between-method association did not differ by Age, Group, or Task Type, all $ps>.07$. Figure 2 illustrates that the Age-by-Group interaction was significant for the "Complex" displays, $F(1, 81)=9.94$, $p=.002$, but not for the "Simple" displays, $p=.06$. Specifically, ASIBs displayed a decreasing trend of looking preference towards the "Complex" social stimuli with increased age, $B=-0.82$, $p=.06$, whereas looking preference to the "Complex" social display remained relatively stable during development in TDs, $p=.25$. The ET measures have demonstrated considerable agreement with behavioral coding of looking behavior. The ET measures revealed that infants at elevated likelihood of ASD followed a distinct developmental trajectory in looking behavior, likely to be characterized by reduced sustained attention towards social relative to non-social stimuli. Further investigations will employ area-of-interest analysis to examine group differences in age-related changes of looking behavior towards various social features.

P1-F-92 - Limitations of memory-guided planning in 2- and 3-year-olds (Blankenship)

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Memory-guided planning is the ability to use past experiences to accomplish goals (Blankenship & Kibbe, 2019). Previous work suggests that 2-year-olds can effectively plan by using past episodes when given simple one-step goals (Blankenship & Kibbe, 2021). Older preschoolers show evidence of more complex planning involving two (3-year-olds) or more (4-year-olds) steps (Blankenship & Kibbe, 2019). It is currently unknown, however, whether 2-year-olds can complete more complex, multistep goals and how this performance compares to older children. The current study examined memory-guided planning using single and multistep goals in 2- and 3-year-olds. Participants included a total of 21 children [9 2-year-olds (M=29.36, SD=4.61, 6 female), 12 3-year-olds (M=41.46, SD =3.42, 7 female)]. The online (Zoom) task required children to acquire episodic memories in the context of the experiment, and to then use those memories to engage in either a single or double step plan. We first introduced children to a cartoon "rainbow treasure box" that had two "buttons" on its top. Children were instructed that each button produced a specific color (red or blue) treasure map piece. Children were then asked to help the experimenter retrieve map pieces to finish maps for an animal character (cartoon Monkey). Critically, for the double step trials, children had to indicate when they were finished ("all done"). Children completed a total of 4 maps (2 single and 2 double steps; Figure 1). Each child's mean percent correct was computed across each trial type (single and double). For single goal trials, 3-year-olds selected the correct button significantly above chance (50%) (M=83.3%, SD=24.6%; t(11)=4.69, p=.001) but not 2-year-olds (M=66.7%, SD=35%; t(8)=1.41, p=.20). However, data collection is ongoing and previous research with 2-year-olds found a similar mean performance for single goal trials (63%; Blankenship & Kibbe, 2021). For double goal trials, 3-year-olds' performance was again above chance (M=50%, SD=11%; t(11)=2.35, p=.04), while 2-year-olds were below chance (M=6%, SD=17%; t(7)=-3.50, p=.008). Finally, 3-year-olds did not perform better than 2-year-olds on single step trials (p=.22) but did on double step trials (p=.003). These results suggest that 3-year-olds can use memories to guide planning for up to two goals, while 2-year-olds may be able to complete a single goal. These findings replicate, and extend, previous lab-based research (Blankenship & Kibbe, 2019; Blankenship & Kibbe, 2021), but within an online format.

P1-F-93 - Intersensory Processing of Faces and Voices at 6 Months Predicts Language Outcomes at at 18, 24, and 36 Months of Age (Edgar)

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Intersensory processing (IP) of faces and voices is thought to be foundational for language development. However, few studies have directly assessed this relation. This was due, in part, to a lack of sufficiently fine-grained measures of IP appropriate for infants. Two recently-developed assessments now fill this need. Using one of these new assessments, the Multisensory Attention Assessment Protocol (Bahrick et al., 2018a), we found that IP of faces and voices at 12-months predicted language outcomes at 18- and 24-months, holding traditional predictors (parent language input, SES) constant (Edgar et al., under review). A companion assessment, the Intersensory Processing Efficiency Protocol (IPEP; Bahrick et al., 2018b) is a more fine-grained assessment of just IP, indexing both speed and accuracy in the context of multiple distractors, and is capable of revealing smaller differences across infants. Here, we used the IPEP to assess whether IP of faces and voices in younger infants (6-months) would predict language outcomes at 18-, 24-, and 36-months, holding traditional predictors constant. Infants (N=103)

participating in a longitudinal study received the IPEP at 6-months. IPEP trials depicted a 2x3 grid of six women speaking, only one of whom was synchronous with the appropriate soundtrack (target event; Figure 1). Predictors: We calculated two measures of IP: accuracy (proportion of total looking to the target event) and speed (latency to fixate the target event). Also, at 6 months, we transcribed parent language input quality (number of unique words) and quantity (total number of words) from a brief, lab-based parent-child interaction. Language outcomes: At 18-, 24-, and 36-months, we transcribed child speech production quality and quantity (from parent-child interactions). At 18-months, we assessed children's expressive vocabulary size (MB-CDI). At 36-months, we assessed receptive (PPVT) and expressive vocabulary (EVT). Covariate: Maternal education level served as a proxy for SES. We conducted multiple regression analyses to assess whether 6-month accuracy and speed of IP would predict child language outcomes, holding parent language input and SES constant. Results indicated that 6-month accuracy explained significant unique variance (i.e., change in R2; variance explained by each predictor when all other predictors were held constant) in multiple child language outcomes: child speech production (quality and quantity at 18- and 24-months), receptive (36-months) and expressive vocabulary (ps<05; Table 1). Six-month speed of IP predicted significant unique variance in only 18-month child speech production (quality and quantity, ps<05). SES also predicted several child language outcomes, whereas 6-month parent language input only predicted one outcome at 36-months. Results mirrored and extended those of our previous study. Accuracy of IP of faces and voices was a strong and significant predictor of multiple child language outcomes at 18-, 24-, and 36-months, even when holding traditional predictors (parent language input, SES) constant. In contrast, speed of IP only predicted language outcomes at 18 months. Findings demonstrate that infant IP of faces and voices is an important foundation for language development. Further, fine-grained individual differences in IP can be assessed as early as 6-months and can predict language outcomes even 2.5-years later.

P1-F-94 - The effect of picture book reading on young children?s use of an emotion regulation strategy (Schoppmann)

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Joined picture book reading is a beloved everyday activity for many young children and provides benefits for several aspects of child development (Fletcher & Reese, 2005). So far, it is relatively unknown whether young children can extrapolate the emotionally relevant content of a picture book and transfer it to their own lives. We tested whether 36-month-old children can learn to apply an age-adequate adaptive emotion regulation strategy in a challenging situation, if it was depicted in a previously read picture book. Emotion regulation has profound consequences for mental health and social competences (e.g., McLaughlin et al., 2011; Blair et al., 2015). In study 1, N = 66 children (aged 36 +/- 1 month, 50% girls) participated in two waiting situations designed to elicit negative affect. In between both waiting situations, children read a picture book with its content varying between conditions. In the experimental conditions, either an adult woman or a girl distracted herself while waiting for a desired stimulus, whereas the picture book in the control condition portrayed the same protagonists preparing a meal. Descriptive statistics showed an increase in distraction in both experimental conditions and a decrease in the control condition from waiting situation 1 to waiting situation 2. A 2 (waiting situation: 1, 2) X 3 (condition: adult protagonist, child protagonist, control) mixed-model ANCOVA demonstrated no significant interaction effects but a medium effect size, F(2,48)

= 2.627, p = .083, ηp2 = .083, when controlling for the children's picture book experience. To investigate whether the experimental conditions differed from the control condition in general, we collapsed conditions. The 2 (Waiting situation: 1, 2) X 2 (group: experimental, control) mixed-model ANCOVA had a significant interaction effect, F(1,49) = 5.324, p = .025, ηp2 = .098. Post-hoc analyses revealed an increase in distraction in the experimental group compared to the control condition. Study 2 investigated the effect of interactive reading. A further condition (n = 22) was sampled during which the girl protagonist picture book from study 1 was read in an interactive manner. A 2 (waiting situation 1, 2) X 3 (condition: girl protagonist standardized reading, girl protagonist interactive reading, control condition) mixed model ANCOVA revealed a significant interaction effect, when controlling for the children's picture book experience, F(2,51) = 3.56, p = .036, ηp2 = .122, but no significant post-hoc tests. Children as young as three years learned to apply an emotion regulation strategy from joined picture book readings. Both the age of the protagonist and the reading style seemed to be irrelevant for subsequent child behavior. The adaptivity of distraction in early childhood is discussed.

P1-F-95 - Caregiver dot probe attention bias variability predicts changes in negative affect across the first two years of life (Gunther)

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The dot probe task is a metric of attention biases (AB) to emotionally valenced stimuli. Psychometric assessments of the task reveal significant intraindividual variability in task responses, which contributes to discussions of low reliability. However, AB are not a static construct and intraindividual attention bias variability (ABV) within the task may better capture the relation between AB and anxiety, versus mean (aggregate) levels of AB. High ABV to negatively valenced faces is associated with anxiety, as well as other forms of psychopathology. ABV may shed light on the stability of an individual's processing of their visual world. Among caregivers specifically, ABV may relate to regulatory abilities and how they interface with their child. Infant negative affect (NA) is considered an early precursor to childhood behavioral inhibition, which confers increased risk for social anxiety disorder in development. Understanding environmental factors that may influence changes in NA over time may better elucidate pathways to risk for psychopathology. Here, we asked how caregiver ABV related to trajectories of NA across the first two years of life. Infants were part of a multi-site longitudinal study. Data were collected when the infants were 4, 8, 12, 18, and 24 years old. We calculated caregiver ABV for dot probe trials with angry faces, based on button press reaction times. Caregivers provided up to 5 time points of ABV, which we averaged to generate an average ABV score after determining that caregiver ABV did not significantly vary over time. The NA subscale of the Infant Behavior Questionnaire (IBQ) was reported at ages 4, 8, and 12 months, and a NA composite was generated from the Toddler Behavior Assessment Questionnaire (TBAQ) for 18 and 24 month timepoints. A multilevel model examined the interaction between infant age and caregiver ABV on infant NA. The model consisted of 1123 observations nested within 276 caregiver-child dyads. Child sex was entered as a covariate and time point of measurement was added as a random effect. We found a significant interaction between infant age and caregiver ABV, b = -0.002, p < .01. There was also a main effect of age, b = 0.08, p < .001, and ABV, b = 0.01, p = .01. A Johnson-Neyman plot (Fig. 1) showing regions of significance revealed that for infants whose caregivers had a lower ABV (< 30.87), NA increased with infant age. However, for infants whose caregivers had a higher ABV (> 136.59), NA decreased with infant age. Overall, we see that there are normative increases

in NA over the first two years of infancy. However, for infants with caregivers demonstrating low ABV, these increases over time are potentiated. Conversely, for infants with caregivers demonstrating high ABV, infant NA decreases over time. These findings suggest that it is perhaps not just high ABV, but extreme patterns of ABV that may relate to deviations in trajectories. Since increases in NA over time are normative, future work should examine at what levels NA is adaptive, and at what levels it may indicate risk for psychopathology, to better interpret how these maternal traits may shape healthy socioemotional development.

P1-F-96 - Scanning efficiency as a marker of visual foraging in 7- and 11-month-old infants (Ross-Sheehy)

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Visual scanning is a critical aspect of visual foraging and scene processing, and recent work demonstrates that both the content and complexity of a naturalistic visual scene can influence the likelihood that infants will engage in efficient scanning, or the tendency for longer fixations to be followed by larger subsequent saccades (Ross-Sheehy, Reynolds & Eschman, under review). In adults, this pattern of scanning is related to improved visual search, and thus may reflect active visual foraging. The current task was modeled after this previous infant work, and incorporated scenes comprised of toys from two perceptual/conceptual categories (social and non-social objects). This allowed us to replicate our previous complexity effects, and additionally allowed us to assess scanning efficiency as a function of selective search (i.e., runs of looks to within-category objects). We hypothesized that infants who are actively engaged in visual comparison will show higher scanning efficiency. Fifty 7- and 11-month-old infants (N=25 each) were shown arrays of 1, 3, 6 or 9 images randomly selected from a pool of social (toys with faces) and non-social images (toys without faces; N=8 10-second trials). Gaze was monitored via eye tracking, and fixations and saccades to individual images were assessed. Scanning efficiency scores were then calculated for each subject and condition as the correlation between fixation duration (ms) and saccade amplitude for the immediately subsequent saccade (degrees) for each condition. If infants are actively comparing the objects in the scene, then scanning should be more selective and strategic (i.e., longer fixations followed by larger subsequent saccades). Thus, strong positive correlations should indicate active, efficient scanning, and low correlations should indicate inefficient scanning, or passive viewing. Preliminary results: Overall condition effects on scanning efficiency were assessed using linear mixed effect models. The baseline model (m0) included only age (fixed) and subject (random) effects, and alternative models included fixed effects for object category (social or non-social; m1) and set size (1, 3, 6, 9; m2). Chi-square goodness of fit tests revealed set size significantly improved model fits (m1): $\chi2(6)=31.137$, $p <.001$, but not category (m2): $\chi2(8)=6.66$, $p=.573$ (Figure 1). We next examined scanning efficiency as a function look strategy. We reasoned that engaging in successive looks to a single category might reflect active comparison, a form of visual foraging. To examine this, we compared scanning efficiency when the category of each fixation/saccade pair matched (social/social or non-social/non-social, within-category) and when they didn't (social/non-social or non-social/social, between-category). Though 7-month-olds show relatively high efficiency for both within- and between-category looks ($p=.003$, $p<.001$, respectively), 11-month-old infants only appear selective when engaged in within-category runs ($p=.034$, p=n.s., respectively; Figure 2). In addition, older infants made significantly more within-category looks that younger infants (M=57% vs. 51%). This

suggests that younger infants may be more captured by novelty whereas category-based visual foraging may still be developing between 7 and 11 months. Individual differences and alternative accounts will be explored in the full poster.

P1-F-97 - Relations among infant face-voice matching, canonical babbling, and expressive vocabulary size (Petrulla)

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Pre-linguistic vocalizations are well-established predictors of language outcomes. For example, canonical babbling (combining consonants and vowels) develops into protowords and expressive vocabulary (Fagan, 2009; Oller, 1999). Multisensory attention skills (e.g., disengaging and sustaining attention and face-voice matching) also predict language outcomes (Edgar et al., under review). A new individual difference measure, the Multisensory Attention Assessment Protocol (MAAP; Bahrick et al., 2018), assessing attention to audiovisual social and nonsocial events, is appropriate for preverbal infants and can be used to assess relations with developmental outcomes. Prior findings demonstrate that intersensory matching of audiovisual speech (face-voice matching) predicts expressive and receptive language outcomes (Bahrick et al., 2018; Edgar et al., under review). However, few studies have characterized relations between face-voice matching and canonical babbling. Thus, the joint contributions of these two variables to language outcomes remains unclear. The current study assessed relations among face-voice matching and canonical babbling and the extent to which each predicted unique variance in expressive vocabulary size. Infants (N=90) participated in a longitudinal study from 3-72 months of age. Predictors: At 12-months, infants participated in an 8-minute parent-child interaction to measure the proportion of canonical syllables relative to the total number of syllables produced. Coders segmented and categorized vocalizations from video/audio recordings using ELAN (ELAN, 2020; Oller et al., 1999). The MAAP assessed face-voice matching at 12-months. Infants viewed two women speaking side-by-side in the presence of a distractor, along with a soundtrack synchronous with one of them (see Figure 1). Face-voice matching was indexed by the proportion of total looking time to the sound-synchronous display. Language outcome: At 18-months, we used the MB-CDI to measure expressive vocabulary size. Correlations revealed that greater face-voice matching was associated with more canonical babbling at 12-months, and that greater matching and more babbling were each associated with larger expressive vocabulary at 18-months (see Figure 2). To address our main research question, multiple regressions were conducted to assess the unique variance in expressive vocabulary contributed by each 12-month predictor when holding the other predictor constant. Face-voice matching accounted for 16% unique variance in expressive vocabulary, $p=.001$. However, canonical babbling accounted for only 4% unique variance, $p=.12$ (total variance: 24%, $p<.001$). Consistent with the literature, we found significant correlations among canonical babbling, face-voice matching, and language outcomes. However, our regression models demonstrated that infants with better intersensory matching of faces and voices at 12-months have larger expressive vocabularies at 18-months, even after holding canonical babbling at 12-months constant. In contrast, canonical babbling was not a significant predictor of expressive vocabulary when face-voice matching was held constant. Thus, future research will investigate possible mediational pathways from canonical babbling to face-voice matching in predicting expressive language outcomes.

P1-F-98 - Infant Cardiac Orienting Responses during Information Processing Predict Working Memory Impairment in School-Age Children (Kable)

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Objective: Cardiac orienting responses (CORS) have been recognized as an early index of cognitive functioning and a marker of alcohol-related neurodevelopmental impairment. CORs are characterized as decelerations in heart rate (HR) after being exposed to a novel stimulus by enabling oxygen to be diverted to the brain to facilitate information processing of environmental events. Preclinical models of CORs suggest that activation of the medial prefrontal cortical area can elicit a COR in the absence of environmental input, suggesting CORs may provide an early index of areas of the brain linked to later executive functioning. Methods: Mother-infant dyads (n=44) from the Ukraine were recruited during pregnancy for a study of the impact of micronutrient supplementation in pregnant women who did or did not use prenatal alcohol exposure. Participants were then seen at 6- and/or 12-months when CORs were collected and again as school-age children where a comprehensive neurodevelopmental battery was performed. To assess CORS, stimuli (auditory tones and pictures) were presented using a fixed-trial habituation/dishabituation paradigm. Cardiac responses to the stimuli were monitored throughout the session using an EKG amplifier connected to a data acquisition computer that was triggered by the stimulus software. For the auditory condition, the standard stimulus consisted of alternating 400-Hz and 1000-Hz pure tone pair and the novel stimuli consisted of alternating 700-Hz and 1000-Hz pure tones. For the visual condition, the standard stimuli consisted of a chromatic Caucasian face of a baby, while the novel stimulus was that of a woman. HR responses were aggregated across the first 3 habituation and dishabituation trials and converted to deviation values relative to each participant's baseline HR. Z-scores were then computed at each second relative to the mean of the participants (n= 931 Ukrainian COR reference samples). Z-scores of >1 were then summed to compute a risk index for assessing deviancy from normal CORs to form a total cardiac orienting deviation index (CoDI). Participants were then categorized as having a delay if the total CoDI was greater than one standard deviation above the sample mean (>=10). The school-age battery included two indices of working memory skills: the Spatial Span Backward subtest from the Wechsler Intelligence Scales for Children IV and the Recall of Digits Backwards from the Differential Ability Scales, 2nd edition. Performance on these two tasks were combined using principal components analysis of variance with a varimax rotation. One factor (Eigenvalue =1.160) was generated, accounted for 58.0% of the variance, and was used for subsequent analyses. Results: Greater deviance in the COR response was associated with poorer working memory skills (Auditory CoDI: r= -.383, p < .010; Visual CoDI: r= -.363, p < .021; Combined CoDI: r= -.372, p < .013). Individuals identified as having a delay in any of the CORs performed in infancy had significantly lower scores on the working memory factor score than did those who had no evidence of an impaired COR in the infancy (F(1,42) =7.092, p < .011). Conclusions: CORs collected in infancy may be useful in identifying later working memory impairment.

P1-F-99 - Investigating caregivers' face experience and social attention in daily infant-caregiver interactions: A longitudinal study (Yamamoto)

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Caregivers' social attention, especially face looking, is a behavioral means used for inferring the mental states of preverbal infants and shaping the foundation of learning in infants. The majority of developmental theories have demonstrated that events, such as joint attention and eye contact contribute to learning among infants. Although assumptions about infants' sensitivity to a caregiver's gaze vary across studies, many theories assume the agent which monitors the infant's visual attention and responds to the actions of the infant. Recent advances in wearable eye-tracking have rendered possible gaze recording when participants are engaged in real-time social interaction. Previous studies that utilized eye-tracking in adults have revealed that social attention during live interaction is different during the observation of social scenes (Risko et al., 2016). However, these studies investigated social interaction between adults. As such, studies examining the social attention of caregivers during infant-caregiver interaction are scarce. Although previous infant studies conducted dual eye-tracking during infant-caregiver interaction (Yu & Smith. 2013), they focused on infants' visual attention and were based on brief recordings in the laboratory. For the purpose of understanding the foundation of learning among preverbal infants, investigating the basic statistics of caregivers' social attention in everyday environments using long-term recording is important. Thus, we longitudinally investigated the face experience and social attention of eight caregivers in the home environment during their interaction with infants aged 10 to 15.5 months. Using a wearable eye-tracker, we recorded caregivers' gaze and visual field for 90 minutes on alternative weeks. We downsampled the video at 0.5 Hz and identified the frames with infants' faces using OpenFace (Baltru?aitis, 2018). After manually removing false alarms, we defined the overlap between the face and gaze point as the caregiver's face looking. Then, we investigated the developmental change in the proportion of face-detected images and the proportion of face looking in the face-detected images. The proportion of face-detected images was stable across the development of the infant. Alternatively, the proportion of caregivers' face looking significantly decreased with the age of the infant. The effect of age was robust even when we controlled for the effects of head-center bias, interpersonal distance, infants' head orientation, infants' gaze orientation, visual saliency of face, and posture of the dyads. Moreover, surrogate data analysis demonstrated that image-independent biases were unable to explain the observed effect of age. These results suggest that caregivers were less likely to look at infants' faces as infants grew old. Finally, we investigated the object of caregivers' vision apart from the infants' faces in view. When caregivers did not look at the infants' faces in view, the proportion of looking at the infants' object-hand interaction increased with the infants' age. This result implies that caregivers' allocation for social attention changes from the infants' faces to hands across infants' development. Recent studies demonstrated that the infants' manual action and caregivers' attention to objects become a ground for language development. Thus, the observed developmental change in caregivers' social attention allocation may be associated with such learning opportunities.

P1-G-103 - Let's Collaborate: Exploring Infants? Collaborative Responses to a Novel Robotic Toy (Goldman)

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Robotic technology is becoming increasingly available in children's everyday life (e.g., Kulakci-Altintas, 2020). Although infants have more opportunities to interact with this technology, research on how they respond to and understand robots is limited. The present experiment investigates how infants spontaneously interact with a novel robotic toy when their parent is present. The robotic toy in use was marketed for young children (Figure 1). Its head displays simple facial expressions; its construction-style lifting arm and pair of treads produce a range of self-propelled movements. The robot also produces sounds and simple sentences. To peer into infants' understanding about robotic toys, the experiment was designed to explore (1) how infants would react to the robot's unfulfilled action and (2) the extent to which they would engage the parent in the event. Ten infants from 18 to 31 months (M = 23 months 17 days) sat on their parent's lap and watched the robot for the first time. In the observation phase, the robot made a series of five actions that consisted of movements, sounds (e.g., grunts, laughs, using the lift to pound on the floor), and facial expressions. For half of the infants, these actions conveyed positive affect; for the other half, they conveyed negative affect. The intensity of actions was similar across affects, as confirmed by adult observers. In the test phase, infants watched a new and unfulfilled action by the robot. The robot picked up and stacked a block on top of another. Next, it attempted to stack a third block (target) on top of the stack but could not reach the top. Finally, the robot put down the target, turned to the infant, and said "Can you help me?" Infants' reactions were coded frame by frame on their attempts to help the robot, including whether infants moved the target closer to the stack or brought the robot and target closer. Infants' verbal and non-verbal attempts to engage their parent in the event were also coded. The results revealed two response patterns regardless of the affect conveyed by the robot. First, all of the infants made frequent attempts to help the robot, ranging from 8 to 98 times during the 3-minute response period (M = 31.2, SD = 25.2). Second, all of the infants made verbal and/or non-verbal attempts to engage parents to attend to or interact with the robot, ranging from 3 to 21 times (M = 8.1, SD = 6.3). The empirical evidence suggested that infants at this age spontaneously interact with the robot in a helpful way and take an active role in initiating parental involvement. It also supported the possibility that infants this age may treat the robotic toy as intentional and goal-directed. Although children's use of technology is often viewed as a solitary activity, our results suggest potential opportunities it provides for social interaction and collaboration. Future analyses on infants' micro-action and parent-infant coordination will further clarify the interactive and collaborative aspects of their experience with robotic technology.

P1-G-104 - Still Supernovel: Children prioritize novelty over social-pragmatic cues to determine the referent of a novel word in an ongoing c (Samuelson)

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Young children are remarkably adept at determining the meaning of novel words in the course of free-flowing interactions. Much research has revealed the information sources and processes that support this ability including the use of social-pragmatic cues (e.g., Akhtar et al., 1996), word learning biases (e.g., Markman 1989), and general processes of memory and attention (e.g., Samuelson & Smith, 1998). Recently, Marno (2021) asked whether children's selection of a referent for a novel word in the context of an ongoing communicative interaction was based on social pragmatic cues or general attentional processes. Over the course of a series of interactions, 2-year-old children were familiarized with four novel objects such that one object, the target, was relatively less familiar than the other three (Figure 1).

In particular, an experimenter and the child played with the target separately from the other three objects. Marno hypothesized that in line with a pragmatic account of early word learning, when children were later asked to select one of the four objects as the referent of a novel word, they would prioritize the pragmatic cues over the relative novelty of the other objects and select the target as the referent. Twenty-two of the 40 children tested selected the target (55%), supporting the hypothesis. These results were taken to contradict prior work by Horst, Samuelson, Kucker and McMurray (2011). These researchers had examined how the relative novelty of objects influenced children's selection of a referent for a novel word. In their study, children were first familiarized with a set of novel, unnamed objects. Later, a novel name was provided in the context of three pre-familiarized objects and one, not yet seen, unnamed "supernovel" object. Horst et al. (2011) found that the 2-year-old children selected the supernovel object as the referent of the novel word. These researchers concluded that relative novelty drives referent selection. While Marno's (2021) procedure was based on that of Horst et al. (2011), the pragmatically specified target object was not pitted against a supernovel object during the naming event because all three of the novel objects in Marno's study had been seen and played with equally. Thus, we replicated her study but replaced two of the novel non-target items with familiar objects (Figure 1). This meant that at the point the name was provided there was a single novel item pitted against the pragmatically specified object. Data collection is ongoing, but out of the 27 participants to date, 23 have selected the supernovel item as the referent of the novel word (85%). We plan to test an additional 13 participants to have an equal sample size to Marno (2021). If these participants perform in a similar way to those who have already participated, the results will suggest that 2-year-old children prioritize novelty when interpreting novel nouns in the context of ongoing communicative interactions.

P1-G-105 - Associations between toddlers' number and spatial skills (Silver)

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Children's early math skills are foundational to later math performance, which in turn predicts school achievement and long-term educational outcomes (e.g., Duncan et al., 2007). Understanding the development of these early math skills is therefore crucial for ensuring that parents and educators can effectively support children's math development. Previous work finds that number skills (e.g., skills requiring the use of number words and Arabic number symbols) and spatial skills (e.g., skills requiring the use of shapes and spatial relationships) are typically positively correlated in childhood, adolescence, and adulthood (Gunderson et al., 2012; Young et al., 2018; see Atit et al., 2021; Xie et al., 2020). However, how and when these skills become linked is unknown, leaving open questions about the best ways to support early math learning. Here, we examine associations between toddlers' number knowledge and spatial knowledge (N=32, M age=2 years 7 months, range 2-3 years; 16 boys). We tested two foundational number skills: cardinality knowledge and number word comprehension. Cardinality was assessed via the Give-N task, where toddlers were asked to create sets of objects in different quantities ranging from 1 to 6 (e.g., "Can you give me three?"; Wynn, 1990). Scores on the Give-N task were the highest number at which toddlers successfully created the set twice. Number word comprehension was assessed via a Point-to-X task, a forced-choice task presenting two quantities of identical objects asking toddlers to point to a specific quantity between 1 and 10 (e.g., "Where is two?"; Silver et al., 2021). Scores on the Point-to-X task were the percentage of correct responses (out of 12

items). We also assessed two spatial skills: knowledge of shape words and understanding of spatial relations. Shape knowledge was assessed using a Point-to-Shape task, a forced-choice task presenting two shapes where toddlers were asked to point to a specific shape (e.g., "Where is the square?"), where scores were the percentage of correct responses (out of 8 items). Finally, understanding of spatial relations was assessed via a Point-to-Spatial Relations task, a forced-choice task where researchers presented toddlers with a toy tiger and two cups and asked them to point to the tiger in a specific spatial relationship to the cups (e.g., "Where is the tiger between the cups?"). Scores in the Point-to-Spatial Relations task were the percentage of correct responses (out of 7 items). As displayed in Table 1, toddlers' performance on all tasks were modestly and positively correlated (all r's > .31), and associations held when controlling for children's age. Even at the beginning of math learning, when toddlers are just beginning to learn numerical and spatial language, number and spatial skills are closely related. Future work should examine how the development of number and spatial skills may support each other over time, and the implications of these interrelations for math interventions.

P1-G-106 - Curious Environments, Curious Infants: Exploratory Factor Analysis to Examine the Role of Daily Parenting Activities on Curiosity (Lee)

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Epistemic curiosity, a desire for new information that motivates knowledge acquisition and exploratory behavior, is rooted in infancy (Kidd & Hayden, 2015). However, less is known about what predicts early epistemic curiosity. Parents as organizers of children's environments and providers of new knowledge may play an important role in the development of early curiosity. In the current study, we examined how curiosity-related parenting behaviors relate to infants' curiosity, with a focus on identifying specific types of activities in everyday parenting. Specifically, in Study 1, we developed a new comprehensive scale to measure a range of caregivers' curiosity-promoting behaviors (The Early Multidimensional Curiosity Scale; EMCS) and conducted Exploratory Factor Analysis (EFA) to analyze the structure of the scale. In Study 2, we used the results of our EFA to investigate which specific curiosity-promoting behaviors uniquely predict infants' curiosity. In Study 1, 136 parents with a child between the ages of 10 and 78 months responded to online survey that included 33 items related to their everyday behaviors and activities related to curiosity (e.g., "How interested would you be in taking your child to a museum?") on a 5-point Likert scale. EFA was conducted to explore the underlying structure of the 33-item questionnaire. A six-factor solution collectively explained 39% of the total variance. We removed 8 times that cross-loaded on multiple factors (greater than 0.35) or did not load on any factor (less than 0.35). EFA was conducted on the remaining 25 items. A six-factor solution explained 40% of the total variance: novelty-seeking (9.3%), creativity (9.1%), perspective-taking (6.8%), autonomy (5.3%), challenge-seeking (5.1%), awe-inducing (4.7%) (Figure 1). In Study 2, a subset of parents and their children from study 1 participated in an online violation of expectation (VOE) experiment designed to measure individual differences infants' looking preference for physically impossible events. Infants (N = 47, 22 females, Mage = 16.83 months, SDage = 4.31) were shown physically impossible events that violated core object representation (e.g., a car passing through a wall) and closely matched possible events (e.g., a car stopping upon hitting a wall). Based on a previous study showing that infants' visual preference for impossible events reflect an early form of curiosity (Perez & Feigenson, 2021), the "Curiosity Score" was calculated by taking the difference between infants' looking time to the impossible

versus possible event. On average, infants preferred to look at the impossible event (Mcuriosity score = 0.33s, p = 0.051), but crucially, there were large individual differences in Curiosity Scores (minimum = -2.32s, maximum = 3.2s). To examine the unique predictability of specific curiosity-promoting behaviors in individual differences in infants' Curiosity Score, we conducted a multiple regression model with each of the six factors as predictors, and infants' Curiosity Score (averaged across three VOE events) as the outcome variable. Infants' Curiosity Score was positively predicted by parental awe-inducing behaviors (B = .81, p = 0.027), but not the other five factors (Figure 2). Findings from the current study suggest that parents' everyday activities relate to their infants' curiosity, and highlight that awe-inducing activities (e.g., taking infants on nature walks) are uniquely associated with the development of early curiosity.

P1-G-107 - Shared family environment influences common variation across emerging cognitive and motor abilities in early infancy (Bussu)

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It is well known that general cognitive abilities are genetically influenced, with increasing effect of genetic factors from childhood to adulthood (Tucker-Drob et al., 2013). According to the generalist genes hypothesis, some of the same genes influence multiple domains of human cognition (Kovas & Plomin, 2006). However, genetic influences on cognition appear to vary depending on the developmental period, and it is possible that different cognitive domains that appear to be influenced by the same genetic factors later in life might be more independent early in infancy. In the present study, we investigated the etiological factors influencing individual variability in different domains of emerging cognitive and motor abilities in early infancy, and to what extent genetic and environmental influences are unique or shared across different domains. We addressed these points by looking at multivariate twin models built on raw scores from the five scales of the Mullen Scales of Early Learning (MSEL), including: gross motor skills, fine motor skills, visual reception, receptive language, and expressive language. Given the increasing recognition of the influence of early motor abilities on the development of higher-level cognitive abilities, we included the gross motor scale from the MSEL in our analyses to examine its relationship in terms of etiological contributions with emerging cognitive abilities. We analysed data from a community sample of monozygotic (MZ) and dizygotic (DZ) same-sex twins at 5 months of age (n=291 pairs, n=162 MZ pairs, n=150 male pairs) recruited for the BabyTwins Study in Sweden (Falck-Ytter et al., 2021). We selected an ACE model, estimating additive genetic (A), shared environmental (C), and nonshared environmental (E) effects, to decompose variance and covariance across the 5 MSEL scales based on the comparison of twin-twin and cross-twin-cross-trait correlations across zygosity. We tested three different types of multivariate models in order of decreasing complexity, including age and sex as covariates: the correlated factors model, the independent pathway model, and the common pathway model (Rijsdijk & Sham, 2002). The common pathway model provided the best fit to our decomposition based on Bayesian information criteria. All emerging motor and cognitive abilities appeared to load onto a common factor that captured shared variance across phenotypes (approximately 30% for each phenotype; see Figure 1). Influences from shared environment accounted for approximately 69% of that shared variance, while the rest was explained by unique environmental influences. Unique contributions to each phenotype showed mostly influence from unique environment, which includes measurement error. There were some genetic influences specific to gross motor and language scales; however, these were not significant based on confidence intervals

(Figure 2). We delineated genetic and environmental influences on different domains of emerging cognition and motor ability in early infancy. Results support previous findings on the main contribution of shared family environment to variation in infant cognition and extended previous work by showing that the contribution of family environment is shared across different domains of emerging motor and cognitive abilities at 5 months of age.

P1-G-108 - The Role of Hierarchical Temporal Structure of Playsongs and Lullabies for Infant Behavior and Physiology (Reisner)

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Infant-directed singing (IDS) has traditionally been divided into playsongs and lullabies, which are argued to arouse and soothe, respectively (Trehub & Trainor, 1998). These functions have been attributed to distinct acoustic features like tempo, pitch, loudness, and rhythmicity (Cirelli et al., 2020; Trehub & Trainor, 1998). Beyond these characteristics, looking at acoustic properties on multiple time scales and their hierarchical temporal organization could give more insight into the functionality of IDS because properties on small and large time scales make IDS unique (Falk & Kello, 2017). Thus, in the present study, we investigated the hierarchical temporal structure of playsongs and lullabies using hierarchical event clustering to account for differences between lullabies and playsongs, as well as their respective physiological and behavioral effects on infants. Our first goal is to examine if the more rhythmic playsongs contain more hierarchical event clustering than lullabies. Our second goal is to explore how differences in hierarchical event clustering relate to infant physiological and behavioral responses. Mothers sang a playsong and a lullaby to their 7-month-old infants in a naturalistic context while we recorded infant electrocardiography and behavior. We investigate hierarchical event clustering by examining the Allan Factor (AF) function and burstiness (Abney et al., 2014, 2018; Goh & Barbási, 2008) of IDS. Preliminary analyses (n = 30) show no differences in hierarchical event clustering between playsongs and lullabies, AF linear coefficient: $t(57.923) = -0.843$, $p = .403$; AF quadratic coefficient: $t(29) = 1.567$, $p = .128$ (Fig. 1); burstiness: $V = 246$, $p = .792$. We coded infant rhythmic movement as movements of the whole body or body parts occurring at least three times within one second (Thelen, 1979). Preliminary analyses (n = 22) show a trend for infants moving more rhythmically with greater hierarchical event clustering, $\chi^2(1)= 3.222$, $p = .073$ (Fig. 2). Our preliminary results suggest that while hierarchical event clustering does not seem to differ between lullabies and playsongs, it may play a role for infants' behavioral adjustment to maternal IDS. Further analyses will focus on whether interindividual differences regardless of IDS song type could play a more crucial role in hierarchical event clustering than systematic differences between playsongs and lullabies. We also plan to analyze correlations between hierarchical event clustering and infant physiological responses (i.e., respiratory sinus arrhythmia), affect, and vocalizations.

P1-G-109 - Too Much Screen Time and Not Enough Books: How SES impacted Infants? Experiences During the Pandemic (Priscilla)

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In March 2020, children's day-to-day life was dramatically disrupted in many parts of the world due to the COVID-19 pandemic. For example, as many parents struggled to manage work and childcare responsibilities, beneficial activities such as reading and one-to-one interactions were at risk of being replaced by increased screen time in children. These are concerning because an increase in screen time and a decrease in reading time have both been found to negatively impact children's social (e.g., Carson et al., 2019), cognitive (e.g., Hutton et al., 2019), and language development (e.g., Farrant & Zubrick, 2011). However, these disruptions may not have been equal for all families. For example, compared to higher SES families, lower SES parents may have experienced more stress and anxiety, resulting in less reading time and leaving their children with more passive screen time (e.g., McDaniel and Radesky, 2020; Parks et al., 2016). Here, we investigate how the pandemic has affected children's screen time and reading time, and whether these changes are moderated by SES. We interviewed 370 families in Greater Toronto Area who had a child between 14 and 34 months of age. Data was collected 6 to 16 months after the onset of pandemic-related lockdowns in Ontario. We asked caregivers whether children's average daily reading and screen times were more, less, or the same as before the pandemic. We then asked caregivers to specify what proportion of this daily average screen time was passive (e.g., TV) vs. involved live interaction (e.g., Zoom, Skype) because the latter has been shown to have potential beneficial effects that are not seen in passive screen time exposure (Myers et al., 2017; Roseberry, 2014). We also collected basic demographic information, where we used family income as a proxy of SES. After controlling for age and gender, our model shows that reported reading time was largely unaffected in higher SES children; but lower SES children were more likely to have a reduction in reading time (see Figure 1). In addition, lower SES children were more likely to have increased screen time than those from higher SES families (see Figure 2a). We also found that compared to lower SES children, higher SES children's screen time was more likely to involve live interaction (e.g., Zoom or Skype; see Figure 2b). All these findings point to a more negative impact in lower SES children's development. Our study underscores the fact that the pandemic did not equally impact all income brackets in society, and may have exacerbated the differences between high and low SES children prior to the pandemic. Moving forward, attention needs to be given to lower SES families to ensure their children's development is on track.

P1-G-110 - Exploring the Emergence of Fairness: Longitudinal Associations among Infants' Expectations for Equality and Equity (Drew)

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Previous research has shown that our sense of fairness emerges within the first months of life (Geraci & Surian, 2011; Meristo et al., 2016; Ziv & Sommerville, 2017). By 15 months old, infants' expect others to distribute resources equally (Sommerville et al., 2013) and prefer to engage with fair distributors (Lucca et al., 2018). By 18 months old, infants show an expectation for equitable resource allocation in tasks where individuals are rewarded for their work (Wang & Henderson, 2018; Sloane et al., 2012). However, it is still unclear whether infants' expectations for equality and equity are related forms of fairness that develop along the same trajectory or whether they are largely unrelated concepts that emerge independently, albeit along a similar timeline. The present study explores data from an ongoing longitudinal project that follows infants' social and moral development from birth to age three (target N= 500). Here, we present preliminary results (n = 18) from conceptual replications of two prior studies

on infants' sense of fairness (Schmidt & Sommerville, 2011; Sloane et al., 2012). We also explore whether 13-month-olds' expectation of an equal (versus unequal) distribution of goods is related to their expectation for equitable (versus inequitable) resource allocation at 21 months old. 13-month-olds (Mage = 13.12; SD = 0.16) watched four familiarization trials (2 fair, 2 unfair; counterbalanced) over Zoom or in-person in which an experimenter distributes cookies to two recipients either equally (3:3 distribution) or unequally (5:1 distribution). At 21 months old (Mage = 21.54; SD = 0.20) the same infants watched four familiarization trials (2 equitable, 2 inequitable; counterbalanced) over zoom in which two actors invest equal or unequal amounts of effort into cleaning up toys but are similarly rewarded with a sticker. Following distribution events in both studies, infants' looking time (seconds) to still images of the fair (equal, equitable) and unfair (unequal, inequitable) allocations were live coded using a one second look away criteria. Preliminary results indicate that 12 (out of 18) 13-month-olds looked longer to the unequal (versus equal) distribution of cookies (Munequal=20.06, SD= 2.34 versus Mequal=18.82, SD = 2.06), while 15 (of 18) 21-month-olds looked longer to the inequitable (versus equitable) sticker allocation (Minequitable=45.86, SD =7.0 versus Mequitable =32.45, SD = 4.14). Paired sample t tests indicate that differences in looking time to fair versus unfair outcomes are non-significant at 13 months old (p = .43) but significant at 21 months old (p=.049). A marginally significant difference between infants looking time to equal versus unequal outcomes across studies was also found (p=.06). Further, infants' average looking times to unfair (unequal, inequitable) distribution outcomes at each age were converted to proportion scores. Longitudinally, 13-month-olds' proportional looking to unequal outcomes is positively associated with their proportional looking to inequitable outcomes at 21 months old (r=.58, p=.01). Data collection is ongoing; however preliminary results suggest that infants' early expectations for equality might predict their later expectations for equitable distribution of rewards.

P1-G-111 - Impact of breastfeeding and stimulation on cognitive development of toddlers (Malhi)

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Background and Objective: The medical benefits of breastfeeding such as long-term protection against disease, reduction in morbidity, and mortality are well documented. However, the short- and long-term cognitive benefits of breastfeeding have been actively debated. The study examined the relative contribution of duration of exclusive breastfeeding and maternal stimulation on cognitive skills of toddlers. Methodology: A total of 125 toddlers (12-30 months) were recruited from the anganwadis (public health care and pre-school centers) of a North Indian city. All children with a chronological age of 30 months or less were eligible for recruitment. Exclusion criteria were history of any chronic illness or sensory impairment. Duration of breastfeeding (exclusive and total) was documented using a maternal semi-structured questionnaire. Home stimulation was measured by the StimQ (toddler version). The questionnaire has four subscales including availability of learning materials; extent to which parents read to their children; parents' involvement in developmental activities like naming and pointing objects, and responsive care giving and verbal reciprocity. Higher scores indicate greater stimulation. Results: Breastfeeding was a near universal practice and 91.2% mothers had breastfed their children. The total mean duration of breastfeeding was 13.92 months (SD=8.09) and duration of exclusive breastfeeding was 4.20 months (SD=2.61). Less than half (42.4%) of the mothers had exclusively breastfed for a period of 6 months. Mothers with relatively higher education provided more stimulation to their children (t=20.38, P= .0001) and also had children with significantly higher MDI scores (t= 5.43,

P=.005). Multiple step wise regression analysis revealed that total stimQ score, age of the child, and total duration of breastfeeding explained 29.2% of the variance in the cognitive quotient of the child (F=17.92 , P=.0001). Conclusions: Pediatric counseling needs to integrate both responsive care giving and breastfeeding promotion into public health program targeting parents and health workers. Clinicians need to play a key role in educating and counseling families about the link between early nutrition, stimulation and the cognitive development of their children.

P1-G-112 - The role of paternal autonomy support in infants' executive functioning (Laflamme)

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Background and Aims: In recent years, developmental psychology has established the importance of studying the development of higher cognitive processes involved in the voluntary control of thoughts, emotions, and actions, i.e., executive functions (EF; Diamond, 2013). EF consist of several cognitive skills that are crucial for children's socio-emotional, behavioral, and academic adjustment (Best et al., 2011; Blair, 2002). EF have both 'cool' cognitive and 'hot' emotional components (Zelazo & Carlson, 2012). Cool components are involved in cognitive regulation, while hot components support emotion regulation. A growing body of research supports the role of parenting behaviors in the development of cool and hot components of EF (Valcan et al., 2018). However, research on EF development is just beginning to address the potential contribution of fathers, and there is a lack of research that considers both maternal and paternal influences simultaneously. This longitudinal study represents the first to examine the unique contributions of both paternal and maternal autonomy support (AS) in the development of cool and hot EF during toddlerhood. AS encompasses parenting behaviors that encourage children to solve problems on their own and make their own choices (Grolnick, 2002). While some research shows that maternal AS is associated with better EF development during the preschool period (Matte-Gagné et al., 2015), the role of paternal AS in child EF development is poorly understood. Methods: 80 mother-father-infant triads took part in two home-visits, at 12 months (T1) and 18 (T2) months, allowing for the observational assessment of paternal and maternal AS (T1) and child EF (T2). The paternal and maternal AS behavior were rated at T1 with a well-validated coding scheme o(Whipple et al., 2011), applied to a 10-minute father-infant and mother-infant problem-solving sequence. At T2, child EF were measured using three tasks: the Prohibition task (Friedman et al., 2011) involving hot EF (impulse control), the Hide and Seek (Garon et al., 2014; working memory) and Reverse Categorization tasks (Carlson et al., 2004; set-shifting) both targeting cool EF (scores were standardized and averaged to compute a composite score of cool EF). Results: Correlational analyses were first performed. Paternal AS was found to be associated with hot EF ($r = .302$, $p < .008$), but not with cold EF ($r = .107$, $p = .369$). Maternal AS was associated with cold EF ($r = .243$, $p < .029$), but not with hot EF ($r = .176$, $p = .115$). Next, maternal and paternal AS were both entered as predictors of child EF in regression analyses. Results demonstrated that paternal AS was the unique significant predictor of hot EF, while maternal AS was the unique significant predictor of cold EF. Conclusion: This study highlights the unique roles of paternal and maternal AS in the development of EF during toddlerhood. It also underscores the importance of distinguishing the cool and hot dimensions of EF, and suggests differential effects of paternal and maternal AS on child EF.

P1-G-113 - Gene-parental behavior interactions and executive function in early childhood: A systematic review (Vrantsidis)

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Positive (e.g., responsiveness) and negative (e.g., intrusiveness) parental behaviors are linked to individual differences in children's executive function (EF), the cognitive abilities necessary for carrying out goal-directed behaviors in situations involving cognitive, motivational, or affective load. Children's genes are thought to confer differential sensitivity to parental behavior, with genetic variants (e.g., val allele of COMT) increasing or decreasing (e.g., met allele of COMT) sensitivity to parental behavior. The aim of this systematic review was to integrate research on gene-parental behavior interactions for children's EF in early childhood, birth to age 5, and to examine the strength of the evidence for gene-parental behavior interactions. The review was registered on PROSPERO. Psychology and psychiatry databases were searched for published peer-reviewed studies (n = 4856 articles). Reference lists and citations of included articles were screened (n = 1437). Five key informants were contacted (n = 0). Searches were re-run before final data analysis (n = 119). Articles were screened for inclusion against a priori criteria (n = 3491). Seventeen studies were identified for inclusion in the review. All 17 studies examined individual candidate genes. Genes involved in dopamine function were the most widely researched (DRD4: n = 5; COMT: n = 4; DAT1: n = 1; DRD2: n = 1), followed by serotonin (SLC6A4: n = 5; MAOA: n = 2), acetylcholine (CHRNA4: n = 1), and oxytocin (OXTR: n = 1) genes. Overall, 26 of 77 (34%) gene-parental behavior interactions were significant. Fifteen of 47 (32%) interactions involving dopamine genes and parental behavior were significant. Ten of 27 (37%) interactions involving serotonin genes were significant. Zero of two (0%) interactions involving acetylcholine were significant. One of one (100%) interaction involving oxytocin genes were significant. The results of this systematic review highlight clear limitations and future directions for research. First, the minority of gene-parental behavior interactions were significant. All studies identified for inclusion in this review were candidate gene studies. The field has moved away from candidate gene studies because of the high rate of false positives and inconsistent findings. Using newer approaches to the assessment of genotype with increased power, such as polygenic scores, will help address the issues with candidate gene research. Second, variability in the measurement of parental behavior (e.g., 19 different constructs were assessed) made it difficult to compare findings across studies. More direct replications examining the same parental behaviors will contributed to distinguishing significant findings from false positives. Third, most studies used questionnaires or individual tasks to assess EF. Using multiple EF measures allows for the creation of a latent factor or composite score, which improves construct reliability and statistical power. Heterogeneity across studies limited our ability to make cross-study comparisons and evaluate the evidence for genetic moderation. In particular, this review identified a need for more rigorous assessment of genotype and greater consistency in EF and parental behavior measurement. Addressing heterogeneity in study design has the potential to inform research on gene-environment interactions and the biopsychosocial mechanisms underlying this important aspect of cognitive development in early childhood.

P1-G-114 - Comparing different measures of language input derived from naturalistic day-long recordings (Ruan)

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Measuring bilingual language input is challenging. While the ways to measure input have expanded rapidly in recent years, there are still many unresolved issues. First, researchers used various units to measure language input (segment/block count, speech duration, adult word count (AWC)), but it is unclear how (or if) the specific unit impacts input estimation as research has not yet examined how well these measures align with each other. Second, some researchers, especially those who used day-long recordings, chose to process only part of their data. This is understandable given the intensive labour needed to manually code the enormous quantity of data, but selected samples may or may not reflect the real language exposure landscape. At ICIS2020, we presented our results regarding the relation between infants' volubility and their bilingual language input which was indexed by AWC (Ruan et al., 2020). Using the same naturalistic day-long recordings from Montréal Bilingual Infant corpus (MBI, Orena et al., 2020), the current study examines whether we could replicate our results when the language input is measured using different units (AWC v.s. Speech Duration v.s. Segment Count) and different sampling methods (periodic- v.s. top-sampling). The MBI corpus consists 1264 hours of audio recordings from 21 French-English bilingual families when their child was 10 and 18 months old. The recordings were obtained and processed by the Language ENvironment Analysis (LENA) system, which derived Child Vocalization Counts (CVC), AWC, Adult Female Speech Duration, and Adult Male Speech Duration, for 30-second segments. We computed the correlation between infant volubility (indexed by CVC) and language input and compared the results when the input was indexed by AWC, Speech Duration (i.e., the sum of Adult Female and Male Speech Duration) and Segment Count (i.e., the number of 30s segments). The results were generally consistent with few exceptions involving Segment Count. Next, we compared results when input was indexed based on a portion of the recordings selected using periodic sampling (i.e., every other segment) or top sampling (i.e., top segments with the highest AWC). The results based on these two sampling approaches often yielded noticeably different magnitudes and patterns with regard to statistical significance. These findings have important implications on how we assess bilingual language input. First, counting segments is typically done in previous studies. However, when counting segments, we lose relevant information such as how verbally active a speaker is and whether the bilingual speaker consistently uses the same language for the entire segment. More fine-grained units should be used if applicable. Second, caution should be taken with top-sampling approach where one biasedly selects samples where the caregivers are the most verbally active. As shown in previous studies, periodic or random sampling might be a more reliable choice (Cychosz et al., 2020; Orena et al., 2019).

P1-G-115 - Addressing the "task impurity" problem: Infant and maternal factors differentially predict child performance on linguistically simple/complex EF tasks (Bruce)

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Executive functions (EF) develop rapidly across early childhood and are influenced by both caregiver- and child-centric factors, such as responsive parenting or individual differences in infants' emotional reactivity/regulation (Diamond, 2013; Ferrier et al., 2014; Valcan et al., 2017). EFs are often thought to comprise of three dimensions: inhibition, updating, and shifting (Miyake et al., 2000). However, there is limited utility in categorizing/comparing EF tasks based on these dimensions in infancy and toddlerhood as research using CFA points to a more integrative framework of EF in early childhood (Wiebe et al., 2011). EF tasks are also thought to tap into non-EF domains (e.g., linguistic ability), a frequently

referenced concern known as the problem of task impurity (Best & Miller, 2010). Despite being framed as a confounding measurement issue, the amount of language required to successfully complete an EF task provides an objective means of classifying the numerous EF tasks available to developmental researchers. The purpose of the present study was therefore to examine whether infant and maternal factors differentially predict children's performance on linguistically simple and complex EF tasks. In this longitudinal study, participants included 239 children (121 females) and their mothers. At 24-months, infants completed a two-minute Frustrating Puzzle task (Perry et al., 2017) where they were instructed to independently complete a developmentally difficult puzzle. Infants with greater emotion regulation skills exhibited less frustration on this task. Maternal control (intrusiveness + directiveness) and responsiveness (positive affect + attention facilitation) was coded from a two-minute interaction task in which mothers completed a developmentally-appropriate puzzle with their child. Mothers also provided questionnaire data about their 24-month old's temperament (ECBQ) and language development (expressive vocabulary + sentence complexity; MCDI). At 36-months, toddlers completed three EF tasks: the Tongue Task (Kochanska et al., 1996), the Dimensional Change Card Sort task (DCCS; Zelazo et al., 1996), and the Day/Night task (Gerstadt et al., 1994). EF tasks were categorized based on the amount of language they require toddlers to comprehend or produce to successfully complete the task (see Table 1). For each EF task, the variable of interest was the proportion of successful trials. Hierarchical linear regression analyses were conducted with 24-month infant and maternal factors (temperament, emotion regulation, language, and parenting) entered as the independent variables, and 36-month EF performance (Tongue Task, DCCS, and Day/Night) entered as the dependent variables. Child sex and maternal education were entered as covariates. No significant interactions were detected and as such, only main effects are presented. Significant predictors of performance on the DCCS included child sex, emotion regulation, expressive language ability, and maternal education (see Table 2). In contrast, infant surgency, maternal education, and maternal responsiveness significantly predicted performance on the Day/Night task. The only significant predictor of toddlers' performance on the Tongue Task was infant surgency as model 2 did not yield a significant F change from the previous model. These findings illustrate that maternal and infant factors differentially predict toddler cognition based on the linguistic demands EF tasks place on children.

P1-G-116 - Predicting behavioral and brain markers of inhibitory control at preschool age from early measures of executive attention (Conejero)

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Inhibitory Control (IC) is to the ability to prevent prepotent responses when inappropriate. Literature on IC development has mainly focused on early childhood and adolescence, while research on IC development in the first years of life is still scarce . To have a better insight about the development of IC from infancy to early childhood , we investigated the contribution that different domains of early executive attention (EA) have on individual differences in IC in early childhood. We expected that EA skills in infancy and toddlerhood would be associated with better performance of children in IC tasks, together with a more mature inhibition-related brain functioning. We conducted a five-wave longitudinal study in which children's EA and IC (n=96) were tested at 9 months, 16-18 months, 2 years, 3 years and 5 years of age . Children performed a variety of age-appropriate EA tasks in each wave measuring endogenous attention, attention flexibility, self-regulation and conflict resolution. At age 5

years, IC was measured with a Go-NoGo/Stop task while recording event-related potentials. We found that endogenous attention at 16 months was associated with sustained attention during the Go-NoGo task and amplitude of inhibition-related N2. Attention flexibility and self-regulation at 2 years were also related to better performance of the Go-NoGo task at behavioural and neural level, whereas conflict resolution showed no relationship with children's IC. These results suggest that early emergence of IC relies on particular EA components from early on, being attention flexibility and self-regulation the more reliable predictors of IC development.

P1-G-117 - Using webcam-based online eye-tracking to investigate the impact of face masks on infants' object encoding (Thiele)

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Since the COVID-19 pandemic, infants around the world regularly encounter and interact with people wearing an oronasal face mask. Visual access to social information is reduced in these situations, as large parts of the face (i.e., nose and mouth) are covered. Potentially resulting alternations in face perception may influence infants' social development, given that facial information strongly navigates attention and learning in the first year after birth (Reid & Striano, 2007; Hoehl & Peykarjou, 2012). Adults, having extensive perceptual experience with faces, increasingly attend to the eyes when a social partner is wearing a mask (Barrick, Thornton, & Tamir, 2021). Moreover, gaze cueing effects seem to remain intact (Dalmaso, Zhang, Galfano, & Castelli, preprint). However, whether and how infants' perception and learning are influenced by face masks remains unclear. The current preregistered study addresses this gap by systematically examining the impact of facial masks on infants' object-related attention and encoding (preregistration: https://osf.io/gjczb/?view_only=09d4ae0ce0b743588803aac05ea8ce82). We focus on object-related learning since this domain is influenced by facial information that is not impaired when seeing a social partner wearing a mask: gaze cues. Infants in the second half of the first year of life can robustly follow others' gaze toward external objects and increasingly encode their visual features (e.g., Okumura, Kanakogi, Kobayashi, & Itakura, 2020), even when seeing schematic eyes outside a facial context (Michel, Wronski, Pauen, Daum, & Hoehl, 2012). Eight- to 11-month-olds participate in a webcam-based online eye-tracking task during which they repeatedly see familiarization videos showing a woman addressing them before turning her head and gaze toward one of two objects. Based on a within-subjects design, the videos vary regarding the degree to which the woman's face is covered with an oronasal mask: nose and mouth are covered, only the chin is covered (perceptual control), no part is covered (see Figure 1). To assess infants' object encoding, we measure their looking times to both objects in a subsequent paired preference phase. In line with previous studies (e.g., Wahl, Michel, Pauen, Hoehl, 2013), we assume that an enhanced preference for the previously non-cued object indicates a greater encoding of the gaze-cued object. To present the experiment and extract the dependent measures, we are using the online experiment platform Labvanced (Finger, Goeke, Diekamp, Standvoß, & König, 2017). Data collection is ongoing. The current sample comprises N = 57 infants, with N = 19 infants fulfilling our preregistered inclusion criteria. Preliminary descriptive data tentatively suggest higher encoding when either no part (M = .56, SD = .18) or only the chin part of the face is covered (M = .53, SD = .18) compared to when nose and mouth of the woman are covered with a mask (M = .47, SD = .26). At the conference we will present results including data from N = 36 infants (aimed

sample size). We will discuss the implications of our findings regarding potential influences of the pandemic on infants' social experiences and learning and evaluate the role of attentional factors.

P1-G-118 - Representation of an abstract +1 operation in infants (Cheng)

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Every natural number n has a successor of n plus 1. Understanding the relationship between each number and the number that succeeds it, known as the "successor function", is critical for understanding the relationship between counting and cardinality (Carey, 2004). Mastery of the successor function in the symbolic number domain undergoes protracted development through early childhood (Cheung et al., 2017). Infants can represent sets of small quantities non-symbolically and can update their representation of a set as objects are sequentially occluded. For example, infants who saw a doll placed behind an occluder, and then saw another doll placed behind the same occluder, expected two dolls to be revealed when the occluder was removed, and not one or three dolls (Wynn, 1992). Here, we asked whether infants can learn an abstract " 1" operation and use that operation to track quantity changes to sets of occluded objects when using the object-tracking system to keep track of successively hidden objects is not possible. Our goal was to examine a potential non-symbolic precursor to the successor function concept. In Experiment 1 (Figure 1), we tested 23 12-18-month-olds online via Zoom. First, to gauge infants' baseline interest in sets with different quantities, we showed infants two Baseline trials in which an occluder was lifted to reveal one or two objects sitting on a puppet stage, and measured infants' looking times to each event. Infants then viewed 4 Familiarization trials. On each trial, infants saw an occluder placed on an empty stage, and then watched an experimenter slide an inverted cup behind the occluder, lift the cup, and then reveal the cup to be empty inside. The experimenter then removed the occluder to reveal a single object. At Test, infants first saw a single object, which was then occluded. The experimenter then slid the cup behind the occluder and removed it. The occluder was then lifted to reveal either two objects (unfamiliar but expected outcome) or only one object (familiar but unexpected outcome) and infants' looking time was measured. We found an interaction between Baseline and Test looking ($p=.01$, $eta2p=.276$): infants looked longer to two objects at Baseline, but reversed that pattern at Test. This suggests that infants could use their representation of " 1" to update their representation of the objects behind the occluder without directly viewing the object that was added. In ongoing Experiment 2 (Figure 1), we are following up on this result to examine whether infants represented adding exactly one object, or whether they simply expected "more than before" when the occluder was removed. In Experiment 2, at Test, we will reveal either two objects (expected) or three objects (unexpected) (Figure 1). We hypothesize that if infants reasoned the cup added exactly one object, they will look longer at the 3-object outcome (controlling for infants' baseline interest in sets of 2 and 3 objects). If infants expected simply more objects than before, their looking pattern to the two outcomes would not be different. These results can provide new insights into infants' early quantificational capacities.

P1-G-119 - The Infant Curiosity Questionnaire: the first measure of General Infant Curiosity (Altmann)

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There are numerous theoretical frameworks attempting to define and explain curiosity, such as the knowledge gap theory (Loewenstein, 1994), the interest-deprivation theory (Litman & Jimerson, 2004), as well as the early, influential specifications of Berlyne (e.g. epistemic vs. perceptual curiosity and specific vs. diverse exploration, 1960). However, the concept remains elusive with open questions especially regarding its emergence and mechanisms in infancy. While there are several self-report measures for adult and some for child curiosity relating to the aforementioned theories, there has not been any measure developed yet for infants. Here, we present a newly developed caregiver-report questionnaire measuring infants' general curiosity across a target age-range of 5 to 24 months. Rather than constraining behavioral expressions of curiosity to a specific theoretical framework, we instead adopt a broad definition of infant curiosity as a keen desire or tendency to actively explore one's immediate surroundings. We developed 36 items reflecting various behaviors and developing skills with which infants can actively explore and interact with their environment from birth onwards. Caregivers are asked to evaluate how well each item reflects their child's typical behavior on a Likert-scale from 1 (strongly disagree) to 7 (strongly agree) with a 'not applicable (NA)' options for behaviors the child does not commonly display (perhaps because they are too young). An item applicable for younger infants is for instance "When my child encounters an object, they are likely to put it in their mouth for further inspection (e.g., to see what it feels or tastes like)." Other items referring to skills such as interacting socially (e.g., "When reading a picture book together, my child directs me (e.g., by pointing) towards what they want to know more about.") may only become applicable later on. The survey was piloted on N = 22 participants of a constrained age group (Mage = 11.53, 41% female). The measure showed good internal consistency (Cronbach's alpha = .85). Each item created variance but had, as expected, a positively skewed response load. Furthermore, an item directly asking caregivers about how curious they perceived their child to be, significantly correlated with the child's mean curiosity score (R = 0.44, p = 0.043) suggesting predictive construct validity. Preliminary results are promising in that the measure captures individual differences in infants' general curiosity while keeping the number of items and response time low. Small adjustments have been made and data collection from a wider population across the full age-range with a target sample size of N = 360 is currently ongoing. Reliability analyses as well as structural equation modelling has been preregistered on aspredicted.org. This new measure will help us understand infant curiosity, its development, expression, and potential stability from a very early age. It may also inform experimental studies by explaining additional variance of active engagement.

P1-G-120 - Planning alternating action patterns in toddlers (Schroer)

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Understanding, recognising and planning patterns is an essential skill in preschoolers (e.g. in mathematics: Papic et al., 2011). Perhaps one of the simplest action patterns consists of alternating between two actions, such as tapping with left, with right, with left, with right, etc. While these alternating patterns are clearly important in later school career, the development of the ability to plan these patterned or alternating action sequence, and more complex repeating sequences such as cycling through a larger set of actions, remains unknown. One study found that 5-year-olds can cycle through the use of three different coloured pencils when colouring (Freier et al., 2017). However, how well younger children and toddlers are able to plan and execute alternating actions, where just two

alternatives are involved, remains unclear. This study is the first to investigate whether toddlers are able to plan a simple repeating pattern involving alternation in their goal-directed action sequences, and whether this ability relates to executive functions and motor competence. Twenty 24-month-olds (M = 24.77 months, SD = 12.69 days, 8 females), 20 30-month-olds (M = 30.10 months, SD = 21.23 days, 12 females), and 30 36-month-olds (M = 36.50 months, SD = 19.20 days, 18 females) participated in this study. The toddlers were instructed to sort 11 small plastic coins between two small boxes in an alternating pattern following the experimenter's demonstration (e.g. left, right, left, right ... etc.). Furthermore, working memory, inhibition, switching and motor competence were assessed in small fun games to investigate whether performance on the alternating task correlated with specific executive functions or motor skills. Working memory was assessed using the spinning pots task (Hughes & Ensor, 2005), while motor competence was assessed using a cubes stacking task. We found that the ability to complete alternating goal-directed action sequences improved over age ($r(62) = .503$, $p < .001$; Figure 1). Three-year-old children showed better alternating abilities compared to 2-year-old toddlers. A stepwise linear regression with predictors of executive function scores and motor competence score showed that motor competence and working memory scores significantly predicted alternating abilities ($F(2,59) = 4.71$, $p = .013$; Figure 2). Interestingly, working memory and motor competence scores did not correlate with each other ($r(62) = .089$, $p = .484$) in this sample. Alternating abilities and working memory scores were remained marginally significantly correlated when controlling for motor competence in a partial correlation analysis ($r(62) = .247$, $p = .055$). Similarly, alternating abilities and motor competence correlated significantly when controlling for working memory ($r(62) = .272$, $p = .034$). To conclude, the results showed that the planning and execution of simple goal-directed alternating actions improves over toddlerhood. Furthermore, it was found that working memory and motor competence were both independent predictors of the ability to alternate actions. However, 3-year-olds did not show near-ceiling level performance in this task. Future research should investigate the development of planning simple alternating actions over early preschool years. Alternating between two actions might be a precursor in development to cycling abilities with more different actions.

P1-G-121 - Object permanence revisited: A pupillometric approach to object representation in infancy (Mayer)

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Infants as young as 3.5 months have shown to reliably represent occluded objects in violation-of-expectation (VoE) paradigms when assessed on looking time measures across various study designs (Baillargeon, 1987; Baillargeon, Spelke & Wasserman, 1985). Active search paradigms have yielded more inconsistent results and report object permanence at around 8-10 months of age), though higher task demands (e.g. motor skills, EF) may be affecting the outcome (Diamond, 1990; Wellman, Cross & Bartsch, 1986; Munakata, 1997). The few studies that have explored object permanence in pupillometric settings to date find that infants do not seem to represent occluded objects until much later (Sirois & Jackson, 2012; Pätzold & Liszkowski, 2020). In light of these contradicting findings, the cognitive origins of object permanence are being reconsidered. The current study aims to further investigate the pupil dilation response as a measure of cognitive effort and surprise upon unexpected object disappearance. As of yet, 28 12-month-old infants have been tested for their ability to represent objects after an occlusion event across 2x6 different trials. Data collection and processing are still ongoing until we attain

a minimum sample of N= 40 valid data sets. Pupil diameter and eye movements are recorded using a Tobii Pro Spectrum 1200 eye tracking system. During test trials infants are presented with self-recorded video stimuli depicting simple occlusion events. Stimulus materials consist of 6 different colorful toys (e.g. building blocks, rainmaker, etc) that are introduced and subsequently played with by an agent. In the following sequence, the agent places a light blue occluder in front of the object and lifts it after a 1.5s still period to reveal the object (expected outcome) or an empty set (unexpected outcome). Throughout all sequences, infants are only able to see the agent's hands and arms operating in front of a neutral background. Toys were selected based on their relevance, suitability, animacy and luminance. We opted for a simplified paradigm with reduced demands to optimize study outcomes. Preliminary regression analyses demonstrate a significant increase in baseline-corrected pupil size in unexpected relative to expected outcomes (β=.04, SE=.004, t=9.44, $p < .001$). Infants' pupils thus seem to dilate in response to the unexpected disappearance of previously occluded objects. This suggests that infants in this study have successfully formed cognitive object representations at 12 months of age. Further analysis will evaluate the statistical significance of these preliminary findings. Results will be presented with respect to theoretical as well as practical implications of the method.

P1-G-122 - Intention discrimination in grasping movement kinematics in 14-month-old infants (Rutkowska)

Joanna Rutkowska[1], Marlene Meyer[1], Andrea Cavallo[2], Cristina Becchio[2], Sabine Hunnius[1]

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Predicting others' actions is crucial when interacting in a social world (Sebanz & Knoblich, 2009). Movement kinematics are an important cue to recognise others' intentions and predict the next action (Beccio et al., 2018). For instance, the way one grasps a bottle differs based on whether one wants do drink or pour from it. Adult observers are able to predict the next action from the grasp alone (Cavallo et al., 2018). Yet, how this ability develops in infancy is still unknown. This pre-registered study investigates this ability's first prerequisite, namely the discrimination of intention-related movement kinematics in 14-month-old infants. Infants of that age already possess advanced grasping skills, such as the adjustment of their grasping movement based on their intention (Claxton et al., 2003). So far, 84 fourteen-month-old infants (39 girls, mean age: 427 days) were tested in a between-subjects habituation design. The stimuli used were videos of bottle grasping actions with two intentions: grasp-to-drink and grasp-to-pour, previously validated with adults (Cavallo et al., 2018). The videos started with the hand and the bottle on the table, and ended at the moment of the hand's contact with the bottle, and a black screen (Figure 1). Thus, the following action (drink or pour), was never presented. The infants were tested sitting in front of a display screen on their parent's lap. During the habituation phase, infants were shown unique videos of either grasp-to-drink or grasp-to-pour movements. The stimuli were shown until the child looked away continuously for 2 seconds, so the trial duration was determined by their attention to the screen. When infants' looking to the screen decreased by 50% or more, the test phase started automatically. During the test phase, infants watched two videos of grasping movement performed with either the same or different intention than before (between-subjects). We hypothesise that the habituated infants presented with a different intention grasp at test phase will show a different (increased or decreased) looking time than the habituated infants presented with grasps with the same intention. This would demonstrate that infants are sensitive to the intention information encoded in grasping movement kinematics. The study utilises a Sequential Bayes Factor

design (Mani et al., 2021), thus the size of the final sample will be determined through Bayesian sequential analysis. We set our minimal sample size at 40 habituated infants, and the maximal sample size at 120. The chosen Bayes Factor (BF) threshold for the main analysis (the Bayesian independent samples t-test) is 8 (JZS prior with r = 1). We are calculating the Bayes Factor for the hypothesised effect every 4 habituated participants, currently BF01 = 3.65 (Figure 2), which indicates moderate evidence for a lack of infants' sensitivity to the intention information encoded in grasping movement kinematics. If this result holds, it would mean that 14-month-olds cannot discriminate between actions carried out with different intentions, despite already adjusting their actions to their intentions at that age. The data collection is still in progress and we will present the final results at the conference.

P1-G-123 - Building blocks of cognition: replicating Marcus et al. (1999) and Kovács & Mehler (2009) (Spit)

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We offer close replications of two seminal infant studies, Marcus et al. (1999) and Kovács & Mehler (2009). Marcus et al. (1999) showed that after a brief auditory exposure phase, seven-month-old infants were able to learn and generalize a rule to novel syllables not previously present in the exposure phase. This study was fundamental for the idea that infants are able to form abstract representations and generalize linguistic rules. Kovács & Mehler (2009) showed that seven-month-olds who had been exposed to two languages from birth outperformed monolingual infants in a series of visual switch tasks, suggesting that babies exposed to multiple languages may experience a cognitive boost at an early age. Across four labs, we conducted exact replications of these two studies. For both experiments, we used the original methodology and stimuli. As in the original studies, we tested the hypotheses that 1) infants are able to learn abstract algebraic rules and apply them to novel input, and 2) that bilingual infants already show a cognitive advantage. In this talk we will present results from 96 children for the Marcus et al. replication. Preliminary analyses suggest that we do not replicate the original findings. Rather, a bayesian mixed-effects analysis shows that our results are moderate evidence for the null-hypothesis which states that children are not able to generalize linguistic rules from limited input. For the Kovacs & Mehler replication, we are currently in the final stages of data collection. At the time of the conference, we will be able to present data from 40 monolingual and 40 multlingual children. As such, this project aims to solidify the results of two seminal studies addressing fundamental questions concerning human cognition. Kovács, A.M., & Mehler, J. (2009). Cognitive gains in 7-month-old bilingual infants. PNAS, 106(16): 6556-6560. Marcus, G.F., Vijayan, S., Bandi Rao, S., & Vishton, P.M. (1999). Rule learning by seven-month-old infants. Science, 283(5398), 77-80.

P1-G-124 - The impact of labelling on identity-location binding in 18- and 26-month-old toddlers (Sucevic)

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Does hearing the names of objects present in the visual field support encoding information about these objects, or does it hinder it? While labelling aids memory encoding in adults (Donkin, Nosofsky &

Shiffrin, 2015), this is not the case for 8-10-month-olds (Fitch, Thaker & Kaldy, 2021). Therefore, it remains unclear at which point in development language can support working memory performance. To answer this question, the present study investigated the impact of object labelling on identity-location binding in toddlers. We postulated that language development has a key role in modulating these effects. Therefore, in order to capture the effects of labelling on working memory precision before and after notable vocabulary developments, the study was conducted with 18- (N=55) and 26-month-old toddlers (N=50). A novel gaze-contingent eye-tracking paradigm was developed for the purposes of this study. Each trial consisted of a preview, an exposure and a test phase. During the preview phase, participants were presented with a set of open windows, where each window contained a different object. In the immediately following exposure phase, participants were presented with the same set of windows, but the windows were closed. Participants had the opportunity to freely explore the windows, and upon being fixated, the window would open to reveal an object (e.g., a bear; see Figure 1a). To explore the impact of labelling on identity-location binding, fixated objects were either labelled or accompanied by a non-linguistic sound during the exploration phase. Memory for object locations was tested in an immediately-following test phase, where one of the previously explored objects was named (e.g. "Look at the bear!", see Figure 1b) while a centrally located attention getter was presented. Then, the closed windows reappeared. If the correct location was fixated, the window opened and revealed the object, accompanied by rewarding auditory feedback. To investigate whether the effects of labelling depend on working memory load, participants were presented with a set of 2, 3, and 4 locations (i.e., windows). The results revealed that the effect of labelling on identity-location binding differed depending on the working memory load, i.e. the number of locations. Both 18- and 26-month-olds showed similar performance in the 2 locations condition, regardless of the presence of labels. When the working memory load was higher (i.e. when participants were presented with 3 and 4 locations), 18-month-olds performed better when objects were accompanied by a sound, rather than a label. However, this was not the case for 26-month-olds. Taken together, these results suggest that the impact of language on working memory changes with memory load and development, providing further insights into the developmental trajectory of the interplay between these domains.

P1-G-125 - Assessing the development of cognitive skills from infancy to preschool age among children from rural Gambia (Milosavljevic)

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The prevalence of adverse environmental factors, such as undernutrition and poverty, in low- and middle-income countries (LMICs) places some children at risk of not reaching their full cognitive potential. Early childhood development has become a key priority in global health settings, yet the paucity of standardised assessments developed specifically for LMICs makes reliable measurement of cognitive outcomes challenging. Frequently researchers rely on tools developed for use in high income settings. There is a pressing need to evaluate the construct validity of child cognitive assessments in LMICs and to expand upon the age-appropriate outcomes measured. Likewise, there is a need to

examine the development of cognitive abilities during early infancy, a critical developmental period of high neural plasticity, and how this associates to later cognitive outcomes and school readiness. The Brain Imaging for Global Health project (BRIGHT; www.globalfnirs.org) is a prospective longitudinal study that has followed a group of children (N=204) from a rural area of The Gambia from the antenatal period to pre-school age. The aim of this study is to examine neural and cognitive development among children in this setting, as well as the impact of environmental adversity (e.g. undernutrition) on these domains. Families were initially seen when mothers were 34-36 weeks pregnant and then followed up when the child was 7-14 days, 1-, 5-, 8-, 12-, 18- and 24-months of age. A follow up of this cohort at preschool age (3-5 years, N=181) is currently underway. Cognitive development was measured at every visit from 5-months to preschool age using the Mullen Scales of Early Learning (MSEL). At the preschool visit, executive functioning (EF) skills - working memory (WM), inhibitory control (IC) and cognitive switching (CS) - were also assessed using tablet-based assessments. Finally, parent-report of child abilities was obtained at the preschool visit using the Early Childhood Development Index (ECDI2030) questionnaire. The objectives of the present analyses are (1) to examine cross-sectional associations between the cognitive skills measured concurrently at preschool age (in part of the sample already seen, N=81), and (2) to assess longitudinal associations between cognitive skills measured during the first 24-months of life and preschool age outcomes. At the preschool visit, there were cross-sectional significant associations between MSEL scores and WM (r=.34, p=.01), IH (r=.33, p=.01) and CS (r=.29, p=.02). ECDI2030 was also significantly correlated with CS (r=.31, p=.02) and IH (r=.42, p<.001), but not WM. MSEL and ECDI2030 scores were not significantly associated with each other. Longitudinally, MSEL scores at 24-months significantly predicted preschool aged MSEL (r=.41, p=.002) and CS (r=.34, p=.01) scores and had trend-level associations with IH (r=.23, p=.07) and WM (r=.23, p=.07). These preliminary findings suggest that measures of distinct, but theoretically related, cognitive domains map onto each other in this population. Likewise, individual differences in cognitive ability during infancy (particularly 24-months) predict both general cognitive skills and EFs (specifically cognitive switching) at preschool age. Next steps will involve examining the contribution of sociodemographic and health-related risk factors to these cognitive domains, as well as exploring their neural and attentional underpinnings.

P1-G-126 - Development of language-mediated selective attention in toddlers (Sucevic)

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Upon hearing Look at the apple!, a child will spontaneously tend to scan the visual field until she identifies the apple (e.g. Chow, Aimola Davies, & Plunkett, 2017). While language effectively orients attention towards the named objects, how the linguistic input drives attentional processes is yet to be understood. At the same time, development of mechanisms underlying spatially-driven attention orienting is better understood. Facilitation-based attention orienting is present even in newborns, while inhibitory attention effects are observed in 4-6-month-old infants (Amso & Scerif, 2015). The aim of the present study was to compare the impact of language and spatial priming on attention orienting in 18- and 26-month-old toddlers. To address this question, we developed a novel eye-tracking paradigm, whereby two objects are presented in one of four possible locations and one of the objects is labelled (prime phase, Figure 1). The impact of labelling on attention orienting was tested in a following probe phase, where either the identity, location or both were manipulated. Two objects were presented, either identical or a new identity, in the same locations as previously, neutral locations, or conflicting

locations. In the spatial version of the task, labelling was replaced by visual highlighting, which enabled us to compare the impact of language-mediated and spatial priming on selective attention. Comparison of the language- and spatially-driven cueing revealed that both language and spatial cues orient attention. The results revealed an impaired response to a target that was previously ignored, providing evidence for negative priming effect (see Figure 2). In addition, there was no inhibition of the previously attended target, suggesting no presence of inhibition of return. These results suggest that information attended during the prime phase facilitates attention orienting during the probe phase while ignored features are inhibited. Our findings suggest that language-mediated attention operates differently than spatial priming, with language overcoming inhibition more flexibly as compared to spatially-mediated attention. In addition, different looking patterns observed in 18- and 26-month-olds suggest the role of development (and vocabulary development in particular) in mediating the impact of language on attention.

P1-G-127 - Visual exploration at 6 months of age predicts executive function performance at 30 months (Johns)

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Executive function (EF), the integrated neurocognitive system underlying attention shifting, working memory, and inhibitory control processes (Miyake et al., 2000), has been widely researched from childhood to adulthood. This work has revealed that EF is predictive of long-term outcomes; however, we know much less about the relationship between infant cognitive abilities and childhood EF. The goal of the current study was to examine factors in early infancy that predict EF performance in early childhood. Prior work shows that visual cognition is predictive of later cognitive abilities, with individual differences in visual cognition tasks predicting child outcomes up to 11 years later (Rose Feldman, & Jankowski, 2012). Here, we asked whether visual cognition measured in infancy predicts EF abilities at 30 months. Our particular focus was on infant visual working memory as this cognitive system emerges early in the first year. Looking behaviour was examined at six-months in 64 infants (31 girls) in a visual working memory task (see Ross-Sheehy et al., 2003; Wijeakumar et al., 2019). Infants visually explored a display with small colourful squares blinking on and off on the left and right of the screen. On one side, the squares changed colour after each 'blink'; on the other side, the colours were always the same. Three memory loads were presented during the task: a low load (one square on each side), a medium load (two squares), and a high load (three squares). To examine EF, the same 64 infants came back to the lab at 30 months of age. During this second visit, the 30-month-olds completed the Minnesota Executive Function Scale (MEFS; Carlson & Zelazo, 2014). This task involves increasingly difficult levels in which the child is given a rule to follow, and then is asked to switch to follow a new rule. As can be seen in Figure 1, infants with lower MEFS percentile scores at 30 months looked less to the changing side in the medium and high loads in the working memory task at 6 months than infants attaining higher MEFS percentiles when they started the trial on the changing side. Interestingly, these infants with a lower MEFS percentile looked more to the changing side on low load trials than infants with a higher MEFS percentile. There was a significant interaction between load level and MEFS percentile ($X2(2, N = 64) = 6.6$, $p = .03684$), with infants attaining a lower MEFS percentile looking significantly more to the changing side in the low load than the medium load ($t(120) = 2.57$, $p = .00114$). These results indicate that infants with a lower MEFS percentile struggled to hold fixation to the changing side at the medium

and high loads during the 6-month visual working memory task, suggesting these higher loads were not within their visual working memory capacity. We are currently examining how these visual working memory measures change from 6 to 30 months in concert with additional measures of spatial and executive attention.

P1-H-128 - Within-Family Associations Between Familial Risk and Children's Home Environments Across Infancy and Toddlerhood (Prather)

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The quality of children's home environments in early childhood play an important role in children's social and cognitive skills (Vernon-Feagans et al., 2013). Specifically, both proximal (e.g., caregiver responsiveness) and distal (e.g., providing learning materials) aspects in the home environment are associated with children's school readiness (Chazan-Cohen et al., 2009). Several familial risk factors (e.g., poverty) have been associated with lower-quality home environments (Vernon-Feagans et al., 2013; Votruba-Drzal, 2003). However, recent work suggests that the quality of home environment may not be stable across early childhood (Korucu & Schmitt, 2020). It is possible that the quality of the home environment fluctuates with changes in familial risk, with quality decreasing at times when risk increases. We examined whether within-family fluctuations in both objective (i.e., income-to-needs) and subjective (i.e., perceived economic strain, perceived time for self and family) indicators of familial risk across infancy and toddlerhood predicted fluctuations in caregiver responsiveness and availability of learning materials in the home. Data from the first wave of the Family Life Project was utilized (N = 1,181, 59.3% White), when children were 6, 15, 24, and 35 months old. Mothers completed questionnaires assessing perceived economic strain and perceived time for self and family at all timepoints. Family income-to-needs was also assessed. The quality of children's home environments was assessed via the HOME measure (i.e., home observations and caregiver interviews) at all timepoints. We focused on two subscales of the HOME measure: caregiver responsiveness (e.g., parent verbalizations to child's vocalizations) and learning materials (e.g., child has three or more puzzles). Preliminary multilevel models were used to assess the amount of within- and between-family variance in all constructs of interest. Economic strain, time for self and family, and the quality of children's home environments all showed within-family fluctuation across the four waves, whereas income-to-needs showed greater stability and more variance across families (see Table 1). Results from main multilevel models showed that greater increases in economic strain at a given wave, relative to each family's mean levels of economic strain across all four waves, predicted fewer learning materials at the same wave (see Model 1 in Table 2). In contrast, increases in time for self and family at a given wave, relative to average levels across waves, predicted increases in caregiver responsiveness at the same wave (see Model 2 in Table 2). Within-family changes in income-to-needs did not predict changes in the home environment. Subjective measures of risk may be more likely to fluctuate across time than objective measures, as well as predict fluctuations in children's home environments across early childhood. Specifically, perceived economic strain may limit parents' physical resources and decrease their likelihood of investing in learning materials for their children. In contrast, experiencing more adequate time for self and family may enhance parents' psychological resources and promote parents' ability to respond consistently to children. Findings highlight the importance of examining fluctuations in different aspects of familial risk

and home environments across early childhood to fully understand the role they may play in children's development.

P1-H-129 - Parent-Infant Cooperation in Digital Contexts (Henderson)

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Cooperation requires individuals to work together in a timely and dynamic manner to attain a common goal and is essential to success in our social world. Cooperation is such an integral part of human societies that forms of cooperation can be seen in the earliest, face-to-face, interactions between infants and their caregivers (see Provenzi et al., 2018 for review). By the age of two, infants' cooperative interactions with their caregivers routinely involve coordination with objects such as playing stack-and-topple with blocks or passing a ball back and forth (see Brownell, 2011 for review). However, the ongoing shift in the nature of caregiver-infant play from objects to digital media (Guedes et al., 2019; Levine et al., 2019) raises questions surrounding how these contexts influence cooperative social game play. We examined cooperative social game play between a parent and their 18- to 26-month-old infant (N = 102 dyads) in two digital contexts: (1) parent-infant dyad sat face-to-face and played an interactive social game on a shared tablet and (2) parent-infant dyad played the same game via video-chat on separate devices. The social game, a block building task, consisted of two 45s segments and was the first of several tasks within a larger study. In segment A, parents were prompted to "Play with the blocks" and then given a more explicit prompt, to "Build a tower together", in segment B. We developed a holistic measure of cooperation (i.e., joint coordinated engagement, JCE) to capture the observed coordination of attention, communication, and action within each segment. We also measured the extent to which the parent and infant individually dominated (e.g., directing attention) each segment of the interaction. Our analyses revealed that JCE scores were significantly lower in the video chat context compared to the face-to-face context. We also found a significant effect of segment, with dyads rated as higher in JCE during the first, less structured, part of the task. Further, an age-related trend emerged such that dyads with older infants tended to score higher on JCE compared to those with younger infants. Preliminary analyses suggest that infant leading moderated the effects between context and JCE in both segments and parent leading moderated the effect between context and JCE in segment B. Specifically, interactions where parents led the interaction hindered cooperation, while interactions where infants took a more prominent role showed greater cooperation. Results will be discussed as they relate to the difficulties of communication via video chat, particularly regarding the degraded and restricted set of social cues available in comparison to face-to-face interactions and adjustments to parental scaffolding. Individual differences of our sample, including digital device novelty and prior experience with video chat interactions in relation to cooperation will be considered. This research has important implications for how infants' interactive partners might foster more effective communication and cooperative social game play with infants across diverse contexts involving screen media. Caregivers may benefit from interventions designed to teach them how to effectively scaffold their infant's cooperative and communicative abilities when using a digital device.

P1-H-130 - Cortisol and testosterone concentrations during the prenatal and postpartum period forecast later caregiving quality in mothers and fathers (Beijers)

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Background: High parental caregiving quality contributes positively to a child's cognitive and social-emotional development, whereas low parental caregiving quality increases the risk for a range of poor child outcomes, including behavior problems and psychopathology. Given that parental caregiving quality affects child development from birth onwards, it is important to detect parents who are at risk for low-quality caregiving as early as possible, preferably before or soon after birth. This study investigated whether cortisol (CORT) and testosterone (T) measured during the last trimester of pregnancy and six weeks postpartum were associated with observed caregiving quality in toddlerhood in mothers (N=63) and fathers (N=45). Methods: parental CORT and T were measured during an interaction with a simulator infant (pregnancy) and their own infant at age 6 weeks and again at age 36 months. Results: In mothers, no associations were found with CORT and T during pregnancy, but higher postpartum CORT was related to higher caregiving quality during toddlerhood. In fathers, the association between prenatal T and caregiving quality in toddlerhood was more negative for the fathers with low CORT. In contrast to mothers, higher but decreasing postpartum CORT was associated with higher paternal caregiving quality in toddlerhood. Conclusion: This study indicates that CORT, T, and their interaction measured during pregnancy and the early postpartum period are associated with parental caregiving quality when the child is 3 years of age. Also, our results provide evidence for the dual-hormone hypothesis, but only in fathers. These results indicate that multiple endocrine measures need to be included in future investigations to better understand how hormones can explain individual differences in parental caregiving quality. Eventually, this research may help to detect parents at risk for low caregiving quality soon after or even before birth, which in turn opens a window for timely interventions.

P1-H-131 - Back to work after maternity leave during the postpartum period: Consequences for maternal milk composition? (Beijers)

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For many mothers worldwide, the first months after giving birth are not only dominated by nurturing and nursing their infant, but coincide with a transition back to work. Although research indicates that women perceive work resumption primarily as stressful, the possible consequences of work resumption stress for infants are unknown. According to the Spillover-crossover model, the mechanism through which maternal work resumption stress would affect the child is through its impact on parenting quality. I argue that maternal work resumption stress can also affect the child through its impact on maternal milk composition. Next to nutrients, milk contains the stress hormone cortisol and cortisone. The intriguing hypothesis that biological constituents in milk shape offspring phenotype is known as Lactocrine Programming. In this pre-registered study, the 3B study (Baby, Breastfeeding and Back-2-work), the following hypotheses are examined: 1) Human milk cortisol concentrations are higher on a workday compared to a non-workday, 2) More work-related stress is associated with higher human milk cortisol concentrations during a workday. A sample of 141 mothers participated in the sample. Mothers filled in questionnaires on work stress in the week prior and at the end of the workday. Maternal milk samples were taken by the mothers in the morning (between 7.00-11.00 AM), afternoon (between 13.00-17.00 PM) and evening (between 19.00-23.00 PM) on a workday and a non-workday. The data collection finished December 2020. Recently, the milk samples have been analyzed in the lab for cortisol

and cortisol concentrations. It is my aim to present the first findings of this study during the meeting in July 2022.

P1-H-132 - The Development of Affective Mechanisms Underlying the Initiation of Joint Attention in Infancy (Schmidt)

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Towards the end of their first year of life, infants begin to engage social partners to communicate about objects in the environment (Carpenter et al., 1998). One early emerging behavioral indicator of intentional communication is the initiation of joint visual attention (IJA). Little is known about the motivational mechanisms underlying IJA (Kuhlmeier & Birch, 2005). While adult research shows associations with the neurophysiological activation of the reward system (Schilbach et al., 2010), the reward value of IJA in infants remains unknown. The current study aims to fill this gap. As previous research indicates an increasing emergence of positive affect in joint attention situations during the second half of the first year of life (Venezia Parlade et al., 2009), we expect 10- but not 4-month-olds to experience reward in IJA-situations. To test this hypothesis, 4- and 10-month-old infants participate in a gaze-contingent eye tracking task on joint attention (JA-task) during which they see faces of one of two actors together with two objects. Once the infant looks at one of the objects, one actor (IJA-face) follows their gaze to this object (IJA-condition), while the other actor (NOJA-face) rejects the "invitation" to share attention by looking at the opposite object (NOJA-condition; see Figure 1). As the dependent variable, we measure infants' (affective) physiological reaction using pupillometry and facial electromyography (fEMG). Before and after the JA-task, we present a pre- and post-face-task, showing the IJA- and NOJA-face next to each other and separately. If IJA is rewarding, infants should show increased pupil size and increased fEMG-activity of the muscle zygomaticus major (indicating positive affect) in the IJA- compared to the NOJA-condition. Moreover, if infants associate the IJA-face with reward-experience, infants should look relatively longer at the IJA- than the NOJA-face in the post face-task compared to the pre-face-task. At the conference, we will present data of the main study. In a preceding pilot study (preregistration: https://tinyurl.com/osfpreregistration) including 51 infants (n = 23 4-month-olds, n = 28 10-month-olds), baseline-corrected pupil size was significantly greater in the IJA- than in the NOJA-condition over the course of a 5s interval ($M_{IJA} = 0.10$, $M_{NOJA} = 0.07$, $SD_{IJA} = SD_{NOJA} = 0.26$, $p < .001$) (Figure 2). Surprisingly, we did not find a significant effect of age group, implying that already 4-month-old infants are sensitive to others following their gaze. Results align with a previous study showing enhanced neural activity during a successful IJA at both, 6.5 and 9.5 months of age (Rayson et al., 2019). In the face-task, descriptive data tentatively suggests that 10-month-old infants looked relatively longer at the IJA-face in the post- versus the pre-face-task ($M = 0.02$, $SD = 0.25$), while 4-month-olds showed a trend in the opposite direction ($M = -0.10$, $SD = 0.28$). Collecting behavioral (looking times), and physiological (fEMG and pupillometry) measures together, we will be able to provide a holistic picture of affective-motivational processes underlying the initiation of joint attention in infancy.

P1-H-133 - Do infants show language-induced social preferences when compared to artificially sounding speech and non-human agents? (Bauch)

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Infants prefer native speech patterns and sounds to those of a foreign language (Jusczyk et al., 1993), and this bias potentially affects infants' preferences for social interaction partners. Already 5-6 months old children looked reliably longer to a native speaker compared to a foreign speaker, and depicted longer gaze times to speakers with native accents compared to foreign accents (Kinzler et al., 2007). In the present on-going online study (conducted via e-Babylab, see Lo et al., 2021, PsyArXiv, doi: 10.31234/osf.io/u73sy), we tested whether these preferences purely relate to acoustic familiarity at the surface level or to more abstract familiarity at a linguistic form level. To this end, we paired natural speech and artificial speech with human speakers and robots. In EXPERIMENT 1, 26 infants (M = 16 months, SD = 4.3 months, 14 female, monolingual German environment) attended a preferential looking paradigm (comparable to Kinzler et al., 2007). For baseline, still pictures of two caucasian female human agents were presented next to each other on the screen. Following, infants saw both agents individually in a short video sequence for three times in a familiarization phase. Both agents narrated a short four-sentence-long story that was spoken with the same female voice which was either a) presented in naturally spoken German language (agent 1) or b) in artifically manipulated (robot-like) sounding German language (agent 2). During test phase, still pictures of both agents were again presented next to each other. Infants' gaze directions were recorded via webcam. We analysed the proportion index for both agents in the testphase while controlling for baseline looking times. Preliminary results indicated that infants showed no preference for the human agent paired up with native natural sounding speech compared to native artificially sounding speech, t(25) = 0.5, n.s. Infants looked equally long at both agents (48% looking time for native natural speaking human agent). In EXPERIMENT 2, a second group of 24 infants (M = 14 months, SD = 6.5 months, 11 female, monolingual German environment) was tested. The paradigm, procedure and voice stimuli were identical to the ones used in EXPERIMENT 1, however instead of humans, two human-similar looking robots were used as agents. Again, preliminary analysis suggested that children showed no preference for the robot agent that was paired with native natural speech compared to the robot paired with native artificially sounding speech, t(23) = 0.4, n.s. Children looked equally long to both robot agents (47% looking time for the native natural speaking robot agent). Overall the data for both experiments suggested that infants showed no social bias for human (EXPERIMENT 1) or human-similar looking robot agents (EXPERIMENT 2) when native speech was compaired against artifically spoken language. Thus, unlike their preference for canonic native language over native language with a foreign accent, infants did not prefer natural speech over artifical speech. This suggest that early language preferences are rather driven by abstract linguistic form cues than by pure acoustic familarity. Further planned experiments and fine-grained analysis will explore language-induced social preferences for non-human agents.

P1-H-134 - Seven-months-old infants show emotional responses to static body expressions: Evidence from pupil size changes (Geangu)

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The posture of the human body provides perceptual cues to recognise expressions of emotions such as anger, fear or happiness. We previously found that 7-months-old infants' fixation patterns discriminated fear from other body expressions (Geangu & Vuong 2020). However, it is not clear if infants at this age processed the emotional content of the body postures. To address this issue, we analysed the pupil

dilation data from the same infants as changes in pupil size can reflect emotional responses to stimuli (Geangu et al. 2011). In our eye tracking study, 48 7-months-old infants were presented with static images of adult female bodies expressing anger, fear and happiness, as well as an emotionally-neutral posture (De Gelder & Van den Stock 2011). The face of each body was blurred to remove facial emotional cues. Each image was presented for 4 sec. The images were presented as grayscale images, and they were equated for mean intensity to reduce any influence of low-level differences on pupil responses. We extracted the pupil size (in mm) from both eyes while infants viewed the images, and included a 1-sec baseline before the onset of each image. The time series for each eye were low-pass filtered and interpolated to remove artefacts such as blinks and dilation speed outliers (Kret et al. 2019). The pre-processed time series were then averaged and baseline corrected. For each infant and body expression, the pupil size change time series were averaged across trials and submitted to a functional data analysis to determine whether there were any time periods when pupil size change differed between expressions (Jackson & Sirois 2009). We found a main effect of expression between 1040 and 1640 ms after image onset ($Fs > 2.69$. $p < .05$). In line with our fixation data, pair-wise comparison showed that during this period fearful body expressions elicited significantly larger pupil dilation than neutral expressions ($ts > 2.75$, $p < .05$, corrected). There was also evidence that anger expressions elicited larger dilations than neutral expressions ($ts > 2.01$, $p < .05$, uncorrected). No differences were found between happy and neutral expressions. In combination with our previous study (Geangu & Vuong 2020), the pupil data suggest that infants as young as 7-months-old can discriminate and process emotional cues in static body postures. More specifically, our results suggest that infants have increased arousal to emotions with negative valence (fear and anger) as pupil size is linked to the sympathetic system. The current results extend and replicate the information about infant processing of emotional expressions, and further demonstrate how pupil data can help understand the development of emotion processing.

P1-H-135 - Infant Self-Regulation Is Predicted By Prenatal Exposure To Environmental Tobacco Smoke (Beebe)

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Prenatal exposure to environmental tobacco smoke (ETS) has been linked with reduced childhood self-regulation as evidenced by increased externalizing behaviors and hyperactivity, and altered structure and function of circuits supporting self-regulation. Nevertheless, effects of prenatal ETS on self-regulation during infancy remains unexplored. We examine associations of prenatal exposure to ETS with infant self-regulation during mother-infant face-to-face interaction at 4 months. Self-regulation was

operationalized with self-contingency, the likelihood of maintaining or changing behavior from second-to-second within a behavioral channel (facial or vocal affect, gaze, touch). Because lowered self-contingency has been associated with known developmental risk factors, we hypothesized that exposure would associate with lowered infant and mother self-contingency. METHOD: One hundred Latina/Black women in the Fair Start cohort at Columbia Center for Children's Environmental Health completed a 4-month visit. Split-screen videos of mothers playing with their infants "as they would at home" were coded on a 1s time-base by coders blind to ETS-status for mothers and infants separately on: positive-to-negative mother and infant facial affect, infant vocal affect, mother-touch; and mother and infant gaze-on/-off partner (Cohen's kappa ≥.70). Behavioral contingencies served as a marker of infant self-regulation. Prenatal ETS exposure was assessed via self-report questionnaire in the third trimester of pregnancy. Infants of mothers who responded yes to "Presently, does a household member or regular visitor to your home/apartment smoke cigarettes, pipes, marijuana, or cigars in your home?" were classified as "exposed." This self-report item has been associated with maternal urinary cotinine, a biomarker of exposure. Multi-level time-series models quantified predictability of second-by-second behavior within individuals (self-contingency). R software estimated random and fixed effects on the pattern of self-behavior over 150 sec, using weighted-lag time-series models (prior 3s of behavior predicting behavior at t0). We tested conditional effects of ETS-exposed (vs. non-exposed) on infant self-contingency for 7 interpersonal modality-pairings (Table 1). Individual-seconds time-series models and predicted values at t0 for ETS-exposed (vs. non-exposed) interrogated significant weighted-lag findings. RESULTS: Relative to non-exposed infants, those with ETS exposure had lower self-contingency across all 7 modality-pairings (Table 1). Predicted values explication showed that, given infants in both groups were likely to be in the most negative facial or vocal affect codes, ETS-exposed infants were more likely to make larger changes, moving to less negative-affect or more positive-affect; and more likely to change from gaze-off to on. ETS-exposed mothers were more likely to make larger changes out of negative facial affect. DISCUSSION: Prenatal ETS exposure was associated with lower, more variable infant and mother self-contingency, reflecting altered self-regulation. During mother-infant face-to-face interaction, exposed infants and mothers made larger changes in behavior in response to being in the most negative affect; such increases suggest less well-regulated behavior in the context of negative affect. Exposed infants more frequently changed from gaze-off (an arousal-regulating process) to gaze-on mother, also suggesting higher arousal in ETS-exposed infants. These findings extend prior work linking exposure to altered cognitive control-circuits and dysregulated behavior in children to infancy, a critically important period that sets the stage for future child development.

P1-H-136 - Long Term Discrepancies Between Mother and Father Ratings of Child Behavior after early mTBI (Huynh)

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Mild traumatic brain injuries (mTBI) are highly prevalent during early childhood (i.e., 0 - 5 years) and can lead to post-concussive symptoms (PCS) in cognitive (e.g., poor attention), physical (e.g., headache) and affective (e.g., irritability) domains. During early childhood, children have limited introspection and verbal capacities to express their discomfort, thus PCS are likely to manifest as behavioral disruption (Dupont et al., 2021). Behavioral disruptions are indeed one of the most common adverse consequences of TBI in children and can persist up to 30 months post injury (Gagner et al., 2018, 2020). Parental

reports are widely used to document behavioral changes occurring after mTBI but can be subject to parental bias. Discrepancies between mothers' and fathers' ratings of child behavior have been observed in other clinical and nonclinical samples and can be influenced by many factors, such as parental mental state. Given that parental mental health can be disturbed after pediatric TBI (Hawley et al., 2003), parental discrepancies may be more likely to occur. The aim of this study is to compare maternal and paternal ratings of child behavior after early mTBI 6 and 18 months after the injury. Eighty-five children with mTBI (44 boys) sustained between 18 and 60 months of age (mean age at injury = 37.03 months; SD = 10.75) were compared to 37 children with an orthopedic injury (26 boys) and 45 typically developing children (42 boys) of comparable age. Mixed ANOVAs were used to compare mothers' and fathers' ratings of child internalizing and externalizing behavior (Child Behavior Checklist; Achenbach, 1987) across the three groups, 6 and 18 months after the injury. In the mTBI group, six months post-injury, mothers reported more externalizing (mean difference = 3.20; p = .002) and internalizing (mean difference = 3.08; p = .001) symptoms than fathers (significant Group X Informant interaction, F(2, 184) = 6.14, p = .003). In the two other groups, parents had comparable ratings of child behavior. Eighteen months post-injury, there was no significant Group X Informant interaction and no differences between mothers' and fathers' ratings on internalizing behavior. As for the externalizing behavior, there was no significant Group X Informant interaction and mothers reported more symptoms than fathers across all three groups (F(1,140) = 6.19, p = .014). Six months after an early mTBI, discrepancies in parental ratings of behavior were specific to the mTBI group, suggesting that factors directly related to the brain injury (e.g., impact on family functioning, parent's affective state) may underlie parental differences in behavior ratings. It is possible that mothers are more sensitive to subtle behavior changes that occur after a mTBI, leading them to report more behavior problem than fathers. Eighteen months post-injury, PCS are likely to decrease, and child behavior is more likely to be more comparable to non injured children, which could explain why the differential effect of parental discrepancies decreases over time. Further studies should examine factors contributing to parental discrepancies after an early mTBI, especially because parents' ability to perceive PCS can be determinant for children's recovery process (Beauchamp et al., 2020).

P1-H-137 - Language practices of caregivers raising a multilingual infant or toddler in Quebec (Phillips)

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In the Canadian province of Quebec, many parents are transmitting two or more languages to their infant or toddler. While the official language of the province is French and 87.1% of the adult population claim it as one of their home languages, many of these speakers also use English. 19.2% additionally claim English as a native language (L1) and 14.5% claim one or more heritage languages (HLs; Statistics Canada, 2016; 2017). Quebec-based parents' decisions about intergenerational language transmission and their language use practices are markedly complex yet few investigations have attempted to map these patterns and the factors that influence them. The study presented here is a major contribution toward closing this gap and will provide specific new insights about the variability of experiences of young children learning two or more languages simultaneously. Study 1 (completed): In the first phase of this research project, we interviewed Quebec-based parents raising a multilingual infant or toddler.

Their responses revealed positive attitudes towards childhood multilingualism as well as a desire to prioritize the use of French in public forums, expose their children to English, and in many cases maintain one or more HLs at home (Ballinger et al. 2020). The interview data also pointed to additional factors that shape language language practices including: parents' desire to accommodate their child and to engage in natural exchanges using their dominant language(s), the unique language context of individual families, and parents' proficiency in the languages within their repertoires (Spolsky, 2004; Ballinger et al., 2020). Study 2 (in progress): In the second phase, we conducted an online questionnaire with 824 Quebec-based parents with a child under 4 years of age. Survey items allowed us to probe in more detail how these parents transmit multiple languages to their child and to quantify potential factors that shape language practices. Parents reported the language(s) they grew up with and for each of these languages, they rated their proficiency. They also reported on the languages they use with their child and the frequency with which they use those languages. We will use regression analyses to examine how variation in parents' frequency of use of their L1s with their children can be explained by 4 factors: (1) parental linguistic proficiency, (2) sociolinguistic status of each language, (3) family language dominance, and (4) parental attitudes toward childhood multilingualism. Caregivers also reported on factors that influence which language(s) they use in specific situations via a multiple choice (MC) response question as well as an open question (Figure 1). We will analyse the MC responses to assess what factors (e.g., external (environmental) vs internal (parent-infant interaction)) drive language choice. We will analyze the open question responses using a qualitative thematic analysis to uncover parents' key priorities as they make linguistic choices during interactions with their child. The findings from Study 2 will provide some of the first empirical evidence related to parental language practices in multilingual families and, further, will allow us to build a conceptual model of intergenerational language transmission within complex multilingual societies.

P1-H-138 - A longitudinal investigation of selectivity in behavioral antecedents of helping and sharing across the 2nd and 3rd years of life (Reschke)

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Early prosocial behavior contributes to healthy socioemotional development later in childhood (Laible & Karahuta, 2014; Eisenberg et al., 1999). Whereas some research has found a selectivity bias in early prosocial behaviors (e.g., Allen et al., 2018), there is limited knowledge as to whether actions antecedent to the prosocial act itself also reveal selectivity. Examining selectivity in early prosocial behaviors can contribute to ongoing theoretical discussion regarding the role of socialization in the ontogeny of helping and sharing behaviors. To address this possibility, we conducted an exploratory investigation of infants' behaviors antecedent to prosocial acts.

Data were taken from an ongoing longitudinal, multivariate study in which infants participated in two prosocial tasks (helping = out-of-reach object: pen, tape dispenser; Warneken & Tomasello, 2006; sharing = scarce resource: stickers, crackers; Dunfield & Kuhlmeier, 2013) with two targets (caregiver, unfamiliar experimenter) at two time points: when the infants were 1-to-2 years old and 1 year later when 2-to-3 years old (see Figure 1). The current investigation was limited to infants who demonstrated peak prosocial behavior (i.e., helping = returning the dropped object; sharing = giving a scarce resource; N = 172; 93 female; MageT1 = 1.52 years, SD = .25; MageT2 = 2.47 years, SD = .26).

Three antecedent behaviors were coded: (1) latency to respond prosocially, as this has been shown to reflect infants' cognitive assessment of situations that may merit prosocial intervention (Hepach et al., 2013), (2) checking behavior (i.e., back-and-forth looks between the target and the situation; see Zahn-Waxler, 1992), and (3) looking duration towards the prosocial recipient while engaging in checking behavior, as this may further elucidate infants' evaluations of prosocial situations. Each antecedent behavior was coded by two independent researchers (Cronbach's alphas ≥ .90) and analyzed using separate factorial repeated-measures generalized mixed effects models specified with either a normal distribution and an identity link (latency) or a Poisson distribution and a log link (checking behaviors, looking duration), and a compound symmetry covariance matrix with target (caregiver, experimenter), task (helping, sharing), and time point as fixed effects. Restricted maximum likelihood (REML) and Satterthwaite approximation for degrees of freedom were used in all models. Latency was included as a covariate in the models examining checking behaviors and looking duration to account for differences in task duration. We were particularly interested in effects and interactions involving target.

Several patterns of selectivity emerged. First, infants at 2-3 years of age, but not 1-2 years, took significantly longer to respond with helping and sharing towards an unfamiliar experimenter compared to a caregiver (see Figure 2a). Second, at 1-2 years, but not 2-3 years, infants engaged in significantly more checking behaviors when the target person was an unfamiliar experimenter compared to a caregiver (see Figure 2b). Lastly, infants looked at the target person significantly more when it was the experimenter compared to a caregiver when engaging in checking behaviors regardless of task type and time point (see Figure 2c).

Taken together, these results reveal different sources of selectivity in early helping and sharing behaviors. Theoretical implications for the role of socialization in the emergence of helping and sharing behaviors will be discussed.

P1-H-139 - Theory of mind following early mild traumatic brain injury in children : the role of parent-child interaction (Aubuchon)

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Introduction: A traumatic brain injury (TBI) causes the brain to move back and forth due to accelerating and decelerating forces (Mustafa & Alshboul, 2013). Sustaining a mild traumatic brain injury (mTBI) in early childhood places children at risk for long-term cognitive difficulties, including theory of mind (TOM) abilities (Bellerose & al., 2019). Identifying factors related to TOM abilities after early mTBI could help to promote socio-cognitive recovery (Beauchamp & Anderson, 2010). Studies suggest that family factors, such as number of siblings as well as quality of parent-child attachment and interactions, are positively associated with TOM development (Spzak & Bialecka-Pikul, 2020; McAlister & Peterson, 2013; Laranjo & al., 2010). The present study aims to explore the association between family factors and the development TOM abilities after an early mTBI. Method: 54 children who sustained an early mTBI (Mage at injury = 3.04 years; SD = .95 year; 52% boys) participated in the study with their parent (89% mothers) 6 and 18 months after their injury. At 6 months post-injury, parents completed a socio-demographic questionnaire including information about the number of siblings at home. Parent-child Dyads participated in two 10 minutes videotaped sessions including snack time and free play. Parent-child

attachment relationship was scored using a short version of the Attachment Q-Sort (AQS; Waters, 1995) and the quality of parent-child interactions was coded using the Mutually Responsive Orientation scale (MRO; Aksan & al., 2006; Kochanska & al., 2008). Both variables were rated by trained research assistants and inter-rater reliability was satisfactory (.70-.85). At 18 months post-injury, TOM abilities were measured with the Desires task (Pears & Mose, 2003) and a False Belief understanding task (Hughes & Ensor, 2007). Scores of both TOM tasks were combined into a single composite score. Regression analysis was conducted to determine which family indicators at 6 months predicted TOM abilities at 18 months post-injury, while controlling for child age, sex, ethnicity, and parent education. Results: Results are presented in Table 1, and suggest that only parent-child interaction quality at 6 months was a significant predictor of TOM abilities at 18 months ($B = .555$, $p < .001$). Number of siblings notably approached significance ($p = .053$). Discussion: The result suggests that after mTBI sustained in early childhood, parent-child interaction quality is associated with TOM abilities in the long-term. in early childhood (0-5 years old), parents represent the main actors in their child?s social environment, who generally did not interact with its future social environment (school, friends, educators; Beauchamp & al., 2021). This study highlights the role of parents in their child socio-cognitive recovery after an early brain injury.

P1-H-140 - Mothers' Neural Reaction to (In)Sensitive Caregiving Cues: Associations with Mothers' Attachment and Caregiving Behavior (Bhoyar)

Makayla Pollock[1], Mandar Bhoyar[1], Nanxi Xu[1], Ashley Groh[1] [1]University of Missouri A wealth of evidence indicates that mothers' attachment representations contribute to the quality of their caregiving behavior (Verhage et. al., 2016). However, less is known about the mechanisms underlying such associations. Given that how parents process infant cues are thought to inform their sensitive caregiving behavior (Rutherford et al., 2018) and attachment representations are thought to guide the processing of social information (Dykas and Cassidy, 2011), variation in mothers' cognitive processing of infant cues might serve as a potential mechanism. Event-related potentials (ERPs) are a useful tool for examining the neurocognitive processing of social information. The N400 is a negative deflection in the ERP waveform that indexes semantic processing and is larger in amplitude when a target word ending a sentence is unexpected (Federmeier & Kutas, 2002). Moreover, prior research indicates that the N400 was effectively used in detecting expectancies for attachment-relevant cues as a function of attachment security (Zayas et al., 2009). Thus, the N400 might be useful for measuring parents' attachment-relevant caregiving expectancies important for informing their caregiving behavior. We examined mothers' N400 responding to attachment-relevant (in)sensitive caregiving cues in relation to mothers' attachment representations and their caregiving behavior. Considering that sensitive caregiving as an infant predicts adult attachment representations (Schoenmaker et al., 2015), we hypothesized that mothers' N400 to insensitive (v. sensitive) responses to infant attachment cues (e.g., crying) would be larger in relation to attachment security and sensitive parenting. 129 (current n = 75) mothers completed the Attachment Script Assessment (ASA, Waters & Rodrigues-Doolabh, 2004) which assesses adult attachment security indicated by individuals' understanding that attachment relationships serve secure base and safe haven functions. Next, an EEG cap was applied to measure brain activity. Mothers completed a Lexical Decision Task in which they listened to audio-recorded primes pertaining to mother-child relationships, half of which were attachment-relevant (e.g., "when my baby cries, I will be...") and the other half were non attachment-relevant (e.g., "When my baby crawls, I will be...). Then, target text appeared on a screen that was either a word or non-word (nonsensical).

Words were sensitive (e.g., "responsive") or insensitive (e.g., "unresponsive") responses. Finally, mother-child free-play and toy-play interactions were coded for global maternal sensitivity (i.e., prompt, appropriate response across play sessions) using scales adapted from NICHD Study of Early Child Care (Frosch & Owen, 2016). Preliminary findings (n = 75) indicated a trending association between attachment security and a larger N400 to insensitive (v. sensitive) caregiving cues in response to attachment primes (r = .15). Moreover, maternal sensitivity was significantly associated with a heightened N400 to insensitive (v. sensitive) caregiving cues in response to attachment primes (r = .28, p < .05). Importantly, mothers' attachment and sensitivity were not significantly associated with N400 responding to (in)sensitive cues in response to the non-attachment-relevant primes. Findings from our study suggest that caregiving expectancies indexed via neural responding are informed by mothers' attachment representations and in turn might account for differences in caregiving behavior. Specifically, findings indicated that neural responding reflective of an expectation that attachment cues should be responded to sensitively is associated with both greater maternal security and observed sensitive caregiving behavior.

P1-H-141 - Communicative functions of singing to infants: Visual fixation and pupil dilation provide complementary results (Yamane)

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Parents sing songs to their infants during natural interactions with them (Trehub, Unyk, & Trainor, 1993), and the singing conveys a social meaning to the infants. For example, Mehr et al (2016) reported that 5-month old infants looked longer at a picture of a novel person singing a familiar melody they had heard from a parent, compared to another novel person who sang an unfamiliar melody. To date, however, it is unclear whether infants are sensitive to communicative functions of singing beyond its auditory aspects. In the present paper, we address this question by examining whether infants prefer watching dynamic movies of a singing person over a still photo of the same person presented along with the same song; and whether they respond differently when the singers' gaze is directed to them or averted. Three Japanese women were filmed while singing 3 traditional Japanese children's songs while they gazed into the camera and while they looked 45 degrees away from the camera. Still movies were created by replacing the video with still photographs of the same women. During the familiarization phase, infants were presented with one of the four movies created for each of the three singers. During the test phase, infants were presented with two side-by-side still photographs of the familiar singer's face (presented during familiarization) and a novel face silently for 15s. Infant looking times during the familiarization and test phases, and pupil diameter during the familiarization phase were recorded using Tobii T60XL eye tracker. Forty-five 5-month old infants and fifty-three 12-month old infants were tested. During the familiarization phase, both groups of infants looked significantly longer at the dynamic movies than at the still photograph presented with song (5m: $F(1, 44) = 17.87$, $p < .01$, 12m: $F(1, 52) = 24.64$, $p < .01$). Infants showed a significantly larger pupil dilation than the grand mean, but only when they viewed the dynamic movies with the singer's gaze directed at them (5m: $t(44) = 2.20$, $p < .05$, 12m: $t(52) = 3.89$, $p < .01$), as shown in Figure 1. During the test phase, the 12-month-old infants looked significantly longer at the singer's face than at the control only when they were presented with dynamic movies with direct gaze, as shown in Figure 2 ($F(1,52) = 4.29$, $p < .05$). Five-month olds did not show any preference under any conditions. The infants' gaze and pupil dilation provided complementary insight

into their processing of social singing. Infants looked longer at the dynamic movies over static photos during the habituation phase, while they showed a larger pupil dilation only when the singer's gaze was directed to them in the dynamic movie, indicating that the presence of the gaze aroused a different reaction (e.g. arousal level). By 12 months, infants were also sensitive to the singer's identity. Taken together, infants gradually become sensitive to different aspects of social singing between 5 and 12 months of age.

P1-H-142 - Recording gaze patterns during live social interaction with parent in toddlers with developmental vulnerabilities: feasibility and influence of speech (Vernetti)

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Background: Capturing attentional responses of toddlers during real life social encounters is currently possible but the apparent complexity of its implementation and its analysis seem to leave the method out of reach in developmental research and psychopathology. Furthermore, reduced attention to dynamic faces in autism has been heavily documented during screen-based studies but many important aspects of genuine social encounters are absent such as social presence and motivation to engage in reciprocal interactions. Social difficulties in children with autism may be more acute during live interaction (Drysdale et al.,2018,Cañigueral&Hamilton,2019) but may be less pronounced with familiar partners (Gillespie-Smith et al.,2014). The influence of social cues such as speech and gaze on attention to faces during interactions with parents in naturalistic contexts remains to be investigated. Objectives: To examine 1) attention to the face of a familiar person (parent) in a neurodiverse group of toddlers in a live interaction context during which the presence of speech and gaze was manipulated; and 2) the association between attention to face and autism severity. Methods: The gaze patterns of 11 toddlers with and without autism (Mage=23.1mo,55%male, ASD:n=5) were recorded by a stand-alone Tobii-Eye-Tracker as they sat facing their parent who was: 1) naturally speaking (SP+) and looking at them (EC+), or, 2) silent (SP-) and looking down (EC-). Each condition lasted 15 seconds and was repeated twice. Areas of interest comprised the overall scene and face regions. Social impairments were quantified using the ADOS. Eye-tracking calibration accuracy (M=0.08°,SD=0.05) was excellent compared to field standards. The percent valid looking time (%Valid:looking time at overall scene/duration of condition) and percent looking time to the face (%Face:looking time at face/valid looking time) between the speech and gaze conditions were compared using t-tests. Correlational analyses were computed between %Face during each condition and ADOS calibrated social affect scores. Results: T-tests revealed reduced %Valid ($p=0.039$) and %Face ($p<0.001$) during the (SP-EC-) compared to the (SP+EC+) condition such that all toddlers looked longer at the scene (M=46%,SD=18) and at the face (M=82%,SD=17) during (SP+EC+) compared to (SP-EC-) (Scene:M=35%,SD=15; Face:M=50%,SD=23)(Fig1.). %Face in the (SP+EC+) condition was negatively correlated with social affect scores ($r(9)=-0.70,p=0.033$), unlike in the (SP-EC-) condition ($r(9)=-0.12,p=0.774$) suggesting that lower attention to the parent's face during a face-to-face interaction is associated with higher autism severity scores (Fig1.). Conclusions: All toddlers attended to the scene and the parent's face but the duration of looking depended on social engagement cues. Namely, they looked more when the parent spoke and looked at them. Consistent with screen-based eye-tracking studies, (Shic et al.,2020) speech and direct gaze constitute powerful attentional cues in neurodiverse samples of toddlers. However, toddlers with higher autism symptom severity were less sensitive to the contingencies and attended less to their parents' speaking face. This preliminary study

demonstrates the feasibility of studying attention to a parent during a naturalistic setting in children with and without autism and prompts the need to further investigate real-life social attention to familiar partners to understand looking behavior closely resembling everyday experiences of toddlers with autism.

P1-H-143 - The Effects of Early Mild Traumatic Brain Injury on Joint Attention (Libenstein)

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Objective: Traumatic Brain Injury (TBI) is highly prevalent in children and can result in a range of physical, cognitive, affective and behavioral repercussions (Beauchamp & Anderson, 2013; Langlois et al., 2006). The majority are mild in nature (mTBI),but can nonetheless in some cases lead to persistent difficulties in the long-term with implications for quality of life. Among the consequences of mTBI, social problems characterized by poorer quality relationships and reduced social participation have been noted and are thought to be underpinned by social cognitive difficulties (Anaby et al., 2012). However, few studies have focused on the social consequences of mTBI when sustained early in development, and what social cognitive disruptions might antedate them. Joint attention (JA), the capacity to use nonverbal behaviors to share the experience of objects or events with others (Mundy et al., 2003), is central in the development of social communication, social interactions and social learning (e.g. Mundy & Jarrold, 2010). As such, this project aims to investigate the integrity of JA as a putative underlying skill associated with social consequences in young children who sustain a mTBI. Identifying precursor social cognitive abilities that may be disrupted after mTBI could lead to the identification of specific loci for early cognitive and behavioral intervention and accordingly improve social competence in the months and years following injury. The objectives are as follows: 1) to determine whether mTBI sustained early in development (6 months to 35 months of age) is associated with effects on JA in the acute period post-injury (within 1 month), 2) to investigate the association between JA and global social functioning concurrently at 1 month. Method: Data were collected as a sub-study of a larger prospective longitudinal cohort study exploring the outcomes of mTBI sustained in children between 6 months and 6 years of age. Participants (N = 52) between the ages of 6 to 35 months old who sustained either a mTBI, an orthopedic injury or no injury were evaluated using a measure of JA, the Early Social Communications Scales (Mundy et al., 2003), at 1-month post-injury. A parent questionnaire assessing social functioning using the Adaptive Behavior Assessment System II social domain (Harrison & Oakland, 2015) was also completed 1-month post-injury. Results: Counterintuitively, a greater frequency of higher-level initiating JA (pointing, showing, pointing with eye contact) was observed in the mTBI group. Total responding to JA (following the direction of gaze, head turn and/or pointing gestures) predicted social adaptive abilities for the mTBI group. Conclusion: This preliminary study indicates that sustaining mTBI in early childhood may be associated with heightened JA post-injury. Although surprising, this finding may represent a need in young children with mTBI to seek and secure support and help from their parents and could be in keeping with recent work showing that young children manifest greater comfort-seeking behaviors 1-month after early mTBI (Dupont et al., 2021). The findings also suggest that JA is associated with general social functioning post early mTBI. Promoting JA abilities may help improve social competence after early brain injury.

P1-H-144 - Do infants have different norm expectations for in-group and out-group members? (Gill)

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Preschool age children distinguish between moral norms and social conventions, expecting moral norms to be universal but social conventions to be culture-specific (Killen & Smetana, 2006). Although a variety of studies indicate that infants detect transgressions to moral norms, it is not clear whether they understand moral norms as distinct from social conventions. To address this question, we will compare 12- to 24-month-old infants' expectations for a. moral norm adherence, and b. social convention adherence for both in-group and out-group members. Given prior work suggesting that infants use native language as a marker of ingroup versus outgroup status (Kinzler et al., 2007), we will first manipulate whether English-speaking infants were familiarized to an English-speaking actor or a German-speaking actor. Following familiarization, infants in the moral norm condition will watch test events in which the actor either adheres to (i.e., distribute 2 cookies to each recipient), or transgressed (i.e., gave one recipient 3 cookies and the other only 1 cookie), distributive fairness norms based on equality. In contrast, infants in the social convention saw social convention adherence (i.e., using a fork to eat) versus social convention transgression (i.e., using a fork to comb her hair). Familiarization language (i.e., English versus German) and norm/convention type (i.e., moral norm versus social convention) will be fully cross yielding 4 separate conditions. We will measure infants' duration looking time to familiarization and test events using jHab, a program designed to measure infants' attention to events. We will conduct an ANOVA with test trial type as the within-subjects variable (violation vs non-violation) and condition as the between-subjects variable (norms vs conventions) on infants' looking times. Next, we will conduct confirmatory t-tests for each condition to compare looking time as a function of test trial type. We expect to find an interaction between condition and test trial type, such that infants in the English condition will look longer to the transgression events than the adherence events regardless of whether they are viewing moral norms or social conventions. In contrast, infants in the German conditions are expected to look longer to the transgression event than adherence event, only for moral norms (and not for the social conventions). Together these findings would support the notion that infants differentiate moral norms from social conventions, showing that they expect moral norms to be adhered to regardless of language status/group membership, but selectively expect other language/outgroup members to adhere to moral norms but not social conventions. The results will contribute to an understanding of the origins of uniquely moral reasoning within early childhood.

P1-H-146 - Do 6-month-old infants predict the actions of native- and foreign-language speakers? (Zacharaki)

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The use of linguistic group as a cue to divide the social world has long roots in development. Infants prefer to imitate speakers of their native language relative to foreign-language speakers (Buttelmann et al., 2013), and they prefer to select and attend to objects/food previously introduced by native- vs foreign-language speakers (Kinzler et al., 2007; Shutts et al., 2009; Marno et al., 2016). However, it is unclear what mechanisms allow infants to respond to others selectively depending on the language they speak. To date, two main theories have been proposed. In one view, infants prefer in-group members indicated by linguistic cues (Kinzler et al., 2007; Buttelman et al., 2013). In another view, infants' social

preferences are due to an evaluation of native-language speakers as more relevant sources of information relative to foreign-language speakers (Begus et al., 2016; Marno et al., 2016). Here, we will test an alternative explanation: infants prefer to interact with speakers of their native language because they hold no expectations about how foreign-language speakers will act. That is, infants' emerging ability to predict and understand others' actions is weakened when interacting with strangers who previously behaved unexpectedly (e.g., speaking a foreign language). To test this, this study investigates whether the language that others speak modulates infants' ability to predict others' actions considering others' epistemic knowledge, an ability that emerges around 6 months of age (Southgate & Vernetti, 2014). We have collected data from 30 participants, and we have not performed any analyses yet. We plan to collect EEG data of 40 6-month-old infants in total while they predict the actions of a native or a foreign language speaker. During familiarization, infants see a woman who reaches for and grasps a ball when the ball moves into a box in front of her, but who remains still when the ball moves outside of the box. Next, in a between-subjects design, the woman speaks either in the participants' native language (Catalan or Spanish) or in a foreign language (German). During test, infants are presented with two types of trials in which the woman always has a false belief about the ball's location. In the action trials, she reaches for the ball due to her belief that the ball is inside of the box. In the non-action trials, she remains still due to her belief that the ball is not in the box. We plan to analyze the event-related power of alpha oscillations in central areas of the infants' scalp during the action anticipation period relative to baseline. Central alpha oscillations, also known as mu rhythm, become desynchronized as infants (and adults) predict or observe others' actions (Debnath et al., 2019; Southgate & Begus, 2013). We hypothesize that mu rhythm will be suppressed in the action trials but not in the non-action trials when infants interact with a native-language speaker, which is an index of belief-based action prediction. However, infants interacting with a foreign-language speaker will show either less or no suppression during the action trials.

Thematic Poster - Predictors of parental feeding styles and practices: Longitudinal associations across infancy and toddlerhood (P1-H-147, P1-H-148, P1-H-149)

P1-H-147 - Maternal Feeding and Infant Food Responsiveness Across the First Year: Bidirectional Associations (Eagleton)

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Child eating behaviors and weight outcomes are negatively impacted by controlling parental feeding styles and practices. Little research, however, has considered the role of maternal feeding in the first year, a critical period for promoting child self-regulation in the context of eating. Importantly, mother-infant feeding is a dyadic process by which infant appetite cues evoke feeding strategies that may support or undermine eating in response to internal hunger and fullness cues. This longitudinal study examined bidirectional associations between controlling feeding styles (pressuring and restrictive) and practices (food to soothe) with infant food responsiveness (FR), an appetitive trait characterized by an infant's drive to eat. Specifically, we posited that pressuring (e.g., encourages infant to eat even if not hungry) and food to soothe (e.g., feeding to relieve infant distress) predict increases in infant FR and that infant FR predicts increases in maternal restriction (e.g., controlling how much an infant eats) over time.

Participants included 176 mothers (54% Non-White, 22% high school education or less) and their infants (50% female). Mothers completed a demographic questionnaire prenatally. When infants were 2-4 months (Time 1), 6-12 months (Time 2), and 14 months (Time 3) mothers self-reported controlling feeding styles (pressuring-finish, α=0.78-0.80; pressuring-cereal, α=0.78-0.80; restrictive-amount, α=0.71-0.78; restrictive-diet quality, α=0.74-0.84) using the Infant Feeding Styles Questionnaire (Thompson et al., 2009), their use of situational (e.g., in the grocery store, α=0.76-0.81) and state-based (e.g., when stressed, tired, α=0.76-0.80) food to soothe (Stifter et al., 2011), and their infant's FR (α=0.80) using the Baby Eating Behavior Questionnaire (Llewellyn et al., 2011). Data were analyzed using cross-lagged models in AMOS and full information maximum likelihood handled missing data. The use of a cross-lagged analytic model was an ideal design to examine bidirectional associations over time (see Figure 1). Maternal education, race, and ethnicity were entered as covariates. Table 1 shows all path coefficients depicted in Figure 1. Feeding styles and food to soothe showed moderate levels of stability (standardized β: 0.52 to 0.64), whereas infant FR showed less stability (β = 0.25 to 0.30). As hypothesized, pressuring to finish positively predicted infant FR from Time 1 to Time 2 and from Time 2 to Time 3. Pressuring with cereal and situational food to soothe positively predicted infant FR from Time 2 to Time 3 only. Contrary to hypotheses, infant FR did not predict restrictive feeding longitudinally, but was concurrently associated with restrictive-amount at T2 and restrictive-diet quality at T3, and restrictive-amount positively predicted infant FR from Time 2 to Time 3. The findings demonstrated that earlier controlling feeding styles and practices predicted increases in FR in later infancy. One exception was pressuring to finish, which also predicted increases in FR earlier in infancy. Although results support a unidirectional effect from controlling feeding to FR in infancy, this relationship is complex and may become bidirectional as children get older. Additional research examining maternal and infant characteristics (i.e., infant weight) that predict and moderate pathways over time is warranted.

P1-H-148 - Maternal Sensitivity and Feeding Persistence in Offering a Novel Vegetable to Infants and Toddlers (Moding)

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Responsive feeding, or identifying and appropriately responding to child feeding cues, is an extension of the broader construct of maternal sensitivity (Hodges et al., 2013). Although responsive feeding typically focuses on hunger and fullness cues, less is known about what constitutes responsive feeding in the context of offering new foods. Repeated offerings of a novel food can increase infant food acceptance, but how caregivers can accomplish this task sensitively is unclear. Our study's aim was to examine the roles of maternal sensitivity and child food acceptance in predicting maternal persistence in offering a new food across two feeding interactions. Infants (n = 57, average age = 12.3 months; range 6-24 months) and their caregivers (71% Non-Hispanic White; 95% mothers, hereafter referred to as "mothers") participated in two laboratory visits two weeks apart. During each visit, dyads played together and mothers offered their infant a new food (golden beets). Maternal sensitivity (defined as a mother's awareness, correct interpretation, and prompt and appropriate response to her baby's signals and communications) was coded using the 25-item Mini Maternal Behavior Q-Sort for video coding (Mini-MBQS-V; Moran et al., 2009). Infant acceptance was rated using a 4-point scale (0 = rejection to 3 = anticipation; Hetherington et al., 2016) for each offer (up to the first 26 per visit); ratings were

averaged to create an acceptance score for each visit. Each offer began when the mother or child approached the child's mouth with food and ended when the child tasted or refused the food. The total number of offers within each feeding was used as a measure of maternal feeding persistence. Mothers were asked to continue feeding their child the beets at home between visits (range 2-12 exposures).

To assess change over time in total offers at study visits, we estimated multilevel growth models. The unconditional model revealed that 77.6% of the variance in total offers was attributable to within-participant variability. Results from the final model (see Table 1) showed older infants received fewer offers than younger infants (γ03=-0.32, SE=0.07, p<0.0001) and infants who were more accepting received more offers than less accepting infants (γ01=4.5, SE=2.04, p<0.05). An interaction between visit and maternal sensitivity (γ12=-63.03, SE=24.73, p<0.05) suggested that at visit 2, mothers with higher levels of sensitivity offered the food fewer times (γ_{visit2}=-35.94, SE=16.78, p=.03). Maternal sensitivity was unrelated to total offers at visit 1 (γ_{visit1}=27.09, SE=16.76, p=.11). As expected, mothers persisted in offering a new food when their infants demonstrated greater acceptance. Counter to expectations, mothers offered the food fewer times when they had higher levels of maternal sensitivity, but only at visit 2, which took place after numerous experiences with the new food (i.e., at visit 1 and during multiple home exposures). It is possible that sensitive mothers more accurately identify infant acceptance and rejection cues and adjust their offering behaviors accordingly. Additional research is needed to determine how and whether maternal sensitivity relates to the longer-term goal of improving infant food acceptance over time.

P1-H-149 - Time-Varying Associations Between Family Income Level and Low-Income Mothers' Adherence to a Pressuring Feeding Style (Ventura)

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Mothers' adherence to a responsive feeding style is associated with healthier infant eating and weight outcomes, whereas adherence to a pressuring feeding style (e.g., encouraging the infant to finish the bottle) is associated with poorer outcomes (Spill et al., 2019). It has been well-documented that low-income mothers report greater adherence to a pressuring feeding style and lower adherence to a responsive feeding style compared to mothers with higher incomes, likely due, in part, to concerns about food availability and family resources (Gross et al., 2014). However, a limitation of previous research is the conceptualization of income as a static characteristic of families; in reality, fluctuations in family income are common for low-income families and were especially common during the onset of the COVID-19 pandemic and related stay-at-home mandates (Parker et al., 2020). The aim of the present study was to examine whether fluctuations in family income predicted changes in mothers' adherence to responsive vs. pressuring feeding styles across the first year postpartum and during the onset of the COVID-19 pandemic within a sample of low-income mothers. The present study was a secondary analysis of data from a matched-pair cluster randomized trial (n = 246) implemented at 3 WIC clinics in Los Angeles County, California; these clinics were compared to 3 matched control clinics (see [Ventura et al., 2021] for more details). Data collection began in May 2019 and assessments occurred when infants were newborn and 3, 6, and 11 months of age. Immediately prior to the 11-month assessments, COVID-19-related stay-at-home mandates began in California. At all assessments, mothers reported family income and other sociodemographics, and completed the responsive and pressuring feeding styles subscales of the Infant Feeding Styles Questionnaire (Thompson et al., 2009). Multilevel models were

used to examine whether between-person differences in family income (i.e., family income at the newborn assessment) vs. within-person fluctuation in family income across the first year predicted feeding styles. Time was modeled using a piecewise approach to specify change between 0-6 months (prior to stay-at-home mandates) as one slope and between 6-11 months (during the implementation of stay-at-home mandates) as a separate slope. All models were controlled for treatment group, percentage of daily feedings from a bottle, mothers' education level, parity, ethnicity, and number of people in household. Table 1 presents sample characteristics. Neither between-person differences in income ($p = .12$) nor within-person fluctuation in income ($p = .73$) predicted responsive feeding. Between-person differences in income did not predict pressuring feeding ($p = .40$), but within-person fluctuations in income were significantly and negatively associated with pressuring feeding ($p = .02$). When income was higher, adherence to a pressuring feeding style was lower, whereas when income was lower, adherence to a pressuring feeding style was higher (Figure 1). Unique effects of income changes during the implementation of stay-at-home mandates were not seen. In conclusion, fluctuations in family income across the first year postpartum, and not between-person differences in income at baseline, were inversely related to low-income mothers' adherence to a pressuring feeding style.

P1-I-150 - Examining the role of attachment, coparenting, and self-compassion in parenting sense of competency in perinatal women (Pickard)

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Maternal mental health is a known risk factor for parent-child attachment and parental sense of competency. Given the potential impact for child development, identifying variables that may support maternal wellbeing is imperative. The current study investigated the role of mental health, self-compassion, coparenting and relationship style in parental sense of competency. Method: Participants were seventy-eight women (mean age = 30.95 years, SD = 10.14) who attended a local perinatal service for psychological support and provided their consent to participate in the current study. Participants completed self-report measures prior to commencement of treatment. Results: Self-compassion and coparenting were positively correlated with secure adult relationship style and both were negatively correlated for preoccupied and fearful adult relationship style. Whereas only coparenting was negatively correlated with a dismissive style. Self-compassion was negatively related to depression, anxiety and stress, with coparenting negatively correlated with depression and stress but not anxiety. Regression analysis revealed that coparenting and self-compassion significantly explained variability in parenting sense of competency (26.8%) with self-compassion providing the largest contribution ($\beta = .409$, $p<.001$) and coparenting ($\beta = .253$, $p<.05$). A further four models that each included a separate adult relationship style were then tested. Secure and dismissive relationship styles were both found to make a small non-significant contribution to the model predicting 27.8% and 27% respectively, whilst self-compassion and coparenting remained significant. The inclusion of fearful relationship style in the model accounted for 29.6% of the variance however only self-compassion was found to represent a significant contribution, with both fearful relationships style or coparenting being non-significant. Preoccupied relationship style did not contribute to the model (26.8%) whilst self-compassion and coparenting both remained significant. Conclusion: Self-compassion was found to be consistent throughout this study acting as a protective factor for maternal well-being and sense of competency. As expected, a positive association

was found for secure relationship style and coparenting whilst negative associations were found for the insecure styles (preoccupied, dismissive and fearful). This is consistent with previous research identifying individuals with a secure style as more effective in relationships and hence potentially better able to coparent. The role of relationship style was non-significant when entered into the regression models. This suggests the effect of relationship style is overridden, with coparenting potentially acting as a proxy. Interestingly, in the model including fearful relationship style coparenting was also non-significant. This is perhaps reflective of the complexity of this relationship style and increased difficulty in coparenting. This study supports the importance for targeting maternal self-compassion and coparenting in perinatal mental health treatment to support parental sense of competency and mental well-being. The findings are limited by cross sectional design and self-report bias. Future longitudinal studies including interview and observational measures of parent-child interaction and child development would represent significant value to understanding the role of self-compassion, attachment and coparenting.

P1-I-151 - The relationship between maternal perceived stress and infant behavior at 6 months old during the COVID-19 pandemic (Smith)

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The COVID-19 pandemic presented a uniquely stressful situation to new mothers. Maternal stress can have consequences on early infant brain development; it has been found that infants are susceptible to the effects of stress experienced by their caregivers (Waters, West & Mendes, 2014). Further, maternal stress has negative consequences on infant behavioral development, with parenting stress in infancy being associated with mental health problems in pre-school children (Hattangadi, 2020). When mothers perceive themselves to be stressed, they are more likely to be distant and less engaged with their infant (Lerner, 2017) which can lead to long term social and emotional issues. In addition, excessive crying in infancy has been shown to double the risk of mood and behavioural problems at age 5 (Smarius et al., 2017) and interrupted sleep has negative effects on infant cognitive and physical growth (Tham et al., 2017). Our objective here was to test the hypothesis that, during the COVID-19 pandemic, new mothers who reported higher levels of perceived stress would be more likely to report disruptive infant behavioral habits, such as excessive crying and interrupted sleep patterns. As part of a longitudinal study of pregnancy and infant development during the COVID-19 pandemic, mothers (n=42) of 6-month-old infants completed online surveys. Mothers completed the Perceived Stress Scale (PSS), the Brief Infant Sleep Questionnaire and an Infant Crying survey. To test for a relationship between maternal perceived stress and infant sleeping and crying habits, we calculated Pearson product-moment correlations. There was a significant positive correlation between maternal stress (total PSS score, median = 21.6, range = 7 - 40) and the amount of uninterrupted sleep the infant experiences on an average night (median = 6.5 hours, range = 2 - 13 hours; r=.350, p=.023), a significant negative correlation between maternal stress and the amount of time taken to put the infant to sleep (median = 29.5 minutes, range = 2 - 90 minutes; r=-.329, p=.033), and a significant positive correlation between maternal stress and the amount of crying and fussiness in a typical day (r=.327, p=.034). These preliminary results illustrate that mothers who reported higher levels of perceived stress during the pandemic reported higher amounts of excessive fussiness and crying in a typical day. However, contrary to our hypotheses, mothers who reported higher levels of perceived stress also reported longer amounts of uninterrupted sleep for their infant on

an average night and shorter amounts of time taken to put the infant to sleep. It is possible that infants who spend more time in a fussy or crying state during the day fall asleep faster and sleep for longer periods of uninterrupted time at night. How varying levels of maternal stress and infant behaviors relate to overall developmental status in our ongoing study is currently unknown.

P1-I-152 - Infant's Self-Regulation Development: Impact of perinatal Maternal Mental Health - A prospective longitudinal Study (Schwarze)

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INTRODUCTION Self-regulation is a fundamental precondition for mental and physical health as well as overall life success. As self-regulation includes the ability to monitor and manage thinking, attention, emotions and behavior in a way to accomplish one's goals, the development of adaptive self-regulation is one of the most important developmental tasks in the first years of life. On the other hand, dysfunctional self-regulation has been shown to result in increased risk of behavioral problems, poor performance at school or working place, rejection by the social environment, physical health problems or mental disorders. Since even newborns already show first self-regulation attempts, the prenatal environment should be considered - next to postpartum environmental conditions. One factor potentially playing a critical role is pre- and postnatal maternal psychopathology. Although there is a general consensus on the multidimensionality of the construct 'self-regulation' and its etiology, evidence on the specific predictors and risk factors for self-regulation deficits remain to be determined. Furthermore, a simultaneous examination of pre- and postnatal factors in the development of infant self-regulation is needed and appropriate prospective longitudinal studies are scarce. METHODS The present study explored the effects of maternal pre- and postnatal symptoms of depression and anxiety on the infant's self-regulation development in a prospective longitudinal design based on data from N=225 mother-infant dyads. Pregnant mothers were recruited from University Gynaecological Hospital Heidelberg from the 20th week of gestation on. Exclusion criteria were fetal genetic disorders or malformations or multiple pregnancy. Maternal symptoms of depression and anxiety were tested with online questionnaires (EPDS, STAI, PRAQ) applied at 5 prenatal and 3 postnatal assessments. Infant's self-regulation (crying, feeding, sleeping) was tested at the age of 3 and 6 months postpartum, using the crying-feeding-sleeping questionnaire (SFS). RESULTS Prenatal maternal symptoms of depression and anxiety turned out to be significantly associated with infant regulatory problems. Specifically, prenatal maternal symptoms of depression were positively associated with infant feeding problems ($p<.001$) whereas prenatal maternal anxiety ($p<.001$) and pregnancy-related worries ($p<.05$) predicted all aspects of self-regulatory problems. Even when controlling for postnatal maternal psychopathological symptoms, prenatal maternal symptoms of depression and pregnancy-related anxiety remained significant predictors of infant feeding problems ($p<.05$), whereas infant crying and sleeping problems were predicted by postnatal maternal anxiety only ($p<.001$). CONCLUSION Our results suggest that the prenatal environment already plays a substantial role in the development of infant self-regulation abilities in the first months of life. Psychopathology may impact this association even on a subclinical level which underlines the importance of early prevention and intervention for young mothers/families during pregnancy and postpartum.

P1-I-154 - Ingredients for Sensitive Parenting: Infant Surgency, Parental Empathy, and Familial Social Support as Predictors of Sensitivity (Riera-Gomez)

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Background Parental sensitivity, a construct that is central to Attachment Theory (Ainsworth, Bell, & Stayton, 1974), is a parenting approach that is accepting of infant's desires and autonomous exploration during play (Ainsworth, Bell, & Stayton, 1974). Sensitive parenting fosters the development of the infant's self-regulatory skills (Dollberg, Feldman, & Keren, 2010), and resiliency against externalizing problems (Weaver & Schofield, 2015) and depression later in life (Di Manno et al., 2015). In this study, we sought to identify protective factors and risk-factors for sensitive parenting. Approach 48 parent-infant dyads (25 male, 23 female) aged 12- to 24-months (M = 17.25, SD = 3.58) were recruited from Palm Beach County, FL via social media advertisements to participate in an online freeplay interaction on Zoom. Parents responded to survey questions about infant temperament, social support from the family, and parental empathy. The CIB scale (Feldman, 1998) was used to code parental sensitivity from the recorded four-minute interactions. Analysis Infant surgency (positive emotionality), cognitive empathy, affective empathy, and social support from the family were entered into an exploratory multiple linear regression as predictors for parental sensitivity. Results The fitted regression model was: parental sensitivity score = 3.497 + 0.403*(infant surgency score) - 0.191*(support from family score) - 0.053*(cognitive empathy score) + 0.042*(affective empathy score). The results show that the overall model is significant (R2 = 0.335, F(1, 33) = 5.761, p = .022). Infant surgency (β = 0.403, p = .003), parental cognitive empathy (β = -0.053 p = .007), and parental affective empathy (β = 0.042, p = .022) are significant predictors for parental sensitivity. Social support from family (β = -0.191, p = .228) does not significantly predict parental sensitivity. Conclusion The results suggest that parents of infants with high positive emotionality may be more encouraged to respond to their children in an enthusiastic, warm, and acknowledging manner than parents with infants low on positive emotionality are. Although parents that demonstrate a high level of affective empathy, driven by intuition and emotion (Wang et al., 2020), are more likely to behave sensitively towards their infant, parents high in cognitive empathy, driven by logic (Wang et al., 2020), are less likely to behave sensitively towards their infant. This implies that the "hot", emotionally-driven components of empathy may be an essential factor that allows parents to respond to their infants in an accepting and encouraging way. Despite previous research that shows social support promotes secure-attachment between mothers and infants (Van Bakel, 2002), social support from the family may not be a protective factor over the effects of infant temperament and parental empathy when predicting sensitivity. Overall, these results provide insight into protective and risk factors for parental sensitivity that may inform future interventions that aim to promote positive parenting and emotional development for infants.

P1-I-155 - Toddler's emotion recognition in relation to parental values, labeling and visual abilities. (Gampe)

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Children's emotional understanding is learned in interactions with other people. Castro et al. (2015) proposed a socialisation model, where parental beliefs and behaviours in relation to their children's emotions as well as parents' own emotion recognition skills influence school-aged children's emotion recognition. This study investigated if this model applies to toddlers' emotional development and if

mothers and fathers play the same role. This age group is of theoretical interest because children aged 2 and 3 can already distinguish and recognise emotions very well visually, but cannot yet name them linguistically. There is a possibility that fathers and mothers play different roles in the formation of emotion recognition skills in their children because contradictory findings have been reported on the specific roles of mothers and fathers at this age (Cabrera et al., 2007; Gerhardt et al., 2020; Kujawa et al., 2014). We assessed 50 2-year-old and 3-year-old toddlers' skills with the Test of Emotion Comprehension (Pons & Harris, 2000) and a categorization task of facial expressions (Widen & Russell, 2008). Parents' beliefs about children's emotions were assessed by the PBACE questionnaire (Halberstadt et al., 2013) that is composed of 33 items in seven scales. Parental use of emotional language was assessed with the picture description task (Taumoepeau and Ruffman, 2006, 2008) where the number of emotion words and emotion causes were counted. Parents' emotion recognition abilities were assessed by presenting facial emotions for 200 ms and 300 ms and indicating which emotion was presented (Martinez & Du, 2010). Visual focus was assessed by indicating the three facial areas that were looked at the most during the presentation of a facial emotion (Schurgin et al., 2014). Results showed that children's emotion recognition abilities increased with age for the Test of Emotion Comprehension ($p = .022$) and the Categorisation Task ($p = .006$). Fathers' belief that children's positive emotions can be costly positively predicted children's emotion categorisation ($p = .032$), while fathers' belief on children's emotional control was negatively related to children's emotion comprehension ($p = .015$). Fathers' ability to correctly recognise emotions ($p = .034$) and to choose facial areas ($p = .048$) relevant to them positively predicted children's emotion comprehension. Mothers' beliefs about children's emotions and their emotion recognition abilities were not related to children's emotional abilities ($p > .164$). Parents' use of emotional language did not predict children's emotion recognition abilities ($p > .258$). This is the first study to examine the role of parents' beliefs and their own abilities in contributing to young children's ability to visually recognise emotions. It is also the first study to show that both paternal accuracy in emotion recognition and visual focus uniquely contribute to children's abilities. Moreover, the data from our sample showed the important role of paternal beliefs, but we did not find a role for quantitatively recorded labelling instances. The model by Castro et al. (2015) was partially confirmed for the young sample and our results provide new insights into the role of fathers and the role of specific partial abilities in parental emotion recognition.

P1-I-156 - Examining the continuities and discontinuities between research, advice, and parenting practice on the use of extinction for infant sleep: An updated review of the literature (Gordon)

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BACKGROUND: Extinction is considered empirically "well established" for ameliorating sleep problems in infants older than 6-months due to its reported effectiveness, ease of implementation, and lack of negative side effect. Popular advice--which presumably proceeds from such research--suggests however that extinction-based sleep training can and should be initiated well before 6-months to prevent sleep problems and their associated negative sequelae from taking root. Given the important development that occurs in this period, as well as the wide inter-individual range of regulatory capacities, it is important to examine the congruence between research and popular advice, as well as how research on extinction translates to real-world parenting practice. [This paper is an update of a review conducted in 2005 to include recent studies and current sleep advice (Gordon & Hill, 2006).] METHODS: Ten

bestselling books on pediatric sleep training on Amazon, as well as two popular internet-based sleep training programs were selected and summarized. Information on recommended start dates, reasons for intervening and recommended methods was compared to research on behavioral sleep interventions (pure extinction, graduated extinction, and prevention) derived from hierarchical evaluations of empirical support based on Sackett or Chambless criteria, as well as systematic reviews and meta-analyses. RESULTS: ? All advice sources recommended pure and/or graduated extinction. ? Some advised starting as early as 1-2 weeks (graduated) or 8 weeks (pure), with a majority endorsing 3-4 months. ? Advice routinely suggested that early sleep training would prevent sleep problems and would be easier to implement than at later ages. Congruence with advice ? Only six studies on extinction contained any infants under 6-months ? No research has examined the use of pure extinction in infants under 6-months or graduated extinction in infants under 4 months. * Studies with younger infants include them as part of a wider sample (e.g., 4-52 mos.) but fail to report the number of younger infants or outcomes by age. * No research has investigated the necessity or advantage of initiating sleep training before 6-months. * Prevention studies with younger infants were typically not specific about delays in response or employed only very brief delays in responding (<5 mins.). In these studies, improvements were rare, small, or diminished by follow-up. Transportability * Though statistically significant, sleep improvements were often small (e.g., 15-minutes longer longest bout, but no difference in wakings). * Many studies provided the intervention in the context of clinical evaluation, assessment, and ongoing support making it unclear which element was most instrumental. Further, real-world experiences of parents lack this level of assessment and instrumental support. DISCUSSION: An examination of the research underpinning current behavioral sleep advice reveals stark discontinuities and lack of adequate empirical, developmentally-based support for many of the claims found in popular sleep training methods. Given the important development that occurs in the first six months, the pursuit of consolidated sleep in this period should be empirically- and developmentally grounded. Accurate information about the necessity, timing, and practical effectiveness of behavioral strategies would assist parents in making informed decisions about how and when to work on sleep.

P1-I-157 - Interactive effects of maternal physiological arousal and regulation on maternal sensitivity: Replication and extension in an independent sample (Leerkes)

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Leerkes and colleagues (2015, 2016a, 2016b) demonstrated that maternal physiological arousal (Skin Conductance Level [SCL] augmentation) and regulation (Respiratory Sinus Arrhythmia [RSA] withdrawal) in response to infant crying predicted adaptive maternal social cognition about crying, maternal sensitivity, and infant outcomes. Specifically, maternal arousal in response to infant crying was associated with more adaptive outcomes when accompanied by high maternal regulation and with maladaptive outcomes when accompanied by low regulation. Although the pattern was robust over time and outcomes, it has not been replicated in other samples. The goals of this project are to determine: (1) if the adaptive nature of well-regulated arousal for parenting replicates in a different sample; and (2) which aspects of maternal behavior are undermined by dysregulated arousal. Participants were 176 mothers (64% non-white, 45% first-time mothers) and their 2-month-old infants. Expectant mothers completed questionnaires assessing demographics, emotional risk (depression, trait anger, emotion regulation difficulties, personality; α =.85), and emotional and cognitive responses to

videoclips of 4 crying infants. The latter yielded two factors: infant oriented cry processing (i.e., high empathy, accuracy identifying infant emotions, positive cry beliefs, adaptive causal attributions; α = .72) and mother-oriented cry processing (i.e., high anger, anxiety, negative causal attributions, and cry beliefs; α = .78). SCL and heart rate (to derive RSA) were recorded during a 2 min baseline and while watching the cry videos. Change scores were calculated to yield measures of SCL augmentation and RSA withdrawal. Mothers and 2-month-old infants participated in a free play task and the face-to-face still face. Maternal behavior (sensitivity to distress and non-distress, intrusiveness, detachment, positive regard, negative regard) and infant negative affect were rated and then averaged across tasks. Total maternal sensitivity reflected high sensitivity and positive regard and low intrusiveness, detachment, and negative regard (α = .88). Data were analyzed using multiple regression in MPLUS (see Table 1). To replicate the previous studies, race, education, maternal emotional distress, and infant-oriented and mother-oriented cry processing were entered as covariates. Maternal emotional risk, mother-oriented cry processing, and infant distress predicted lower maternal sensitivity. The main effects of SCL and RSA were not significant, but their interaction was significant. Higher SCL augmentation was positively associated with the sensitivity composite only when RSA withdrawal was high, β = .28, $p < .01$. We estimated additional regression models to determine which dimensions of maternal behavior were predicted by physiology. The interaction between RSA and SCL was statistically significant only for detachment and negative regard. Arousal was positively associated with detachment and negative regard when regulation was low, but negatively associated when regulation was high (see Figure 1). These results demonstrate the interactive effects of SCL and RSA in relation to parenting outcomes are not sample specific. Further, well-regulated arousal is adaptive in relation to sensitivity, and regulation is particularly important for inhibiting negative maternal behaviors among mothers who are highly aroused in response to crying.

P1-I-158 - Parental structuring of toddler negative emotion in relation to children's later use of language as a regulatory strategy (Kim)

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Parents are thought to guide children's language skills in ways that contribute to self-regulation of distress (Kopp, 1989). Sensitive parenting promotes young children's emotion regulation (Brophy-Herb et al., 2012), but it is unclear which sensitive practices, at the height of toddler negativity, foster children's later use of language to regulate emotions. Parental emotion labeling is associated with children's later emotion regulation through increased emotion understanding (Brinton & Fujiki, 2011). Structuring, by contrast, scaffolds children's self-regulation strategies through recruiting their cognitive ability (Hoffman et al., 2006). We investigated the extent to which parental emotion labeling and structuring at child age 18 months, when toddlers were distressed, predicted two ways children at age 36 months use language in a frustrating delayed reward task: (1) verbalizing about the situational demands of waiting, and (2) verbalizing about other topics that shift attention away from the situational demands (e.g., describing imaginative play). Further, we examined links between these forms of language use and children's nonverbal emotion expressions during the wait. To our knowledge, no study investigated how parents' spontaneous reactions to toddler distress predict, longitudinally, these aspects of 36-month-olds' verbalizations in a frustration task. At child age 18 months, we observed mothers' and fathers' responses to toddler distress during an unstructured home visit (112 families; 46%

girls; 93.3% white). Home observers recorded several types of responses to toddler negative emotion during six 10-minute periods. Sensitive emotion labeling involved explicit use of emotion terms (e.g., mad). Sensitive structuring involved attempts to engage toddlers' cognitive resources to cope, such as how to redirect attention. We controlled for total parental spoken language, given its association with children's language skills (Anderson et al., 2021). At age 36 months, we video-recorded children's behavior during an 8-minute wait task. Children received a wrapped gift and a broken toy car; mothers told children they must wait to open the gift until mothers finished questionnaires. Children's verbalizations were transcribed and coded for references to either the demands of waiting or unrelated topics (see Table 1). Another team coded children's nonverbal emotion intensity (0 = none to 3 = strong). Both teams had acceptable interrater reliability (κ's from .78 to .93). Toddler negative emotion occurred frequently during home observations (M = 10, SD = 5.39). Parental sensitive emotion labeling in response was infrequent (1.76% of total responses) whereas structuring was used more (11.94%). Regressions revealed that emotion labeling at 18 months was unrelated to the verbalizations at age 36 months during the wait task. However, structuring predicted verbalizations unrelated to waiting over and above total language input from parents, b = 2.17, t(86) = 2.74, p = .008, PRE = .08. Follow-up correlations indicated that, at age 36 months, verbalizing about the demands of waiting was linked to greater nonverbal anger intensity, r = .24, p = .01, whereas verbalizing unrelated to the demands was linked to greater happiness intensity, r = .20, p = .04. We discuss the possibility that parental structuring fosters children's use of language to distract themselves from frustration.

P1-I-159 - History of maltreatment interacts with mothers? recognition and reactions to emotions in children (Bérubé)

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Several studies have documented the phenomenon of intergenerational transmission of maltreatment (Buisman et al., 2020). Difficulties with sensitive parental behaviors could act as a mechanism to explain the transmission of maltreatment from one generation to the other (Greene et al., 2020; Savage et al., 2019). Our research examined how a history of childhood maltreatment could impair mothers' ability to accurately discriminate children's facial emotions and alter their reaction to those emotions, leading to more difficult parent-child interactions. A sample of 58 mothers and their children (M children's age = 45.33 months, SD = 12.53, 53% female) participated in the study. Mothers had to recognize the dominant emotion in a set of photographs of children's faces showing morphed images of the six basic emotional expressions. Their heart rate variability (HRV) was registered during exposition to unmorphed emotions, and their behavioral responses to those pictured were recorded on a dynamometer measuring handgrip pressure. Observations of mother-child interactions were also coded for sensitive behaviors. Mothers' history of childhood maltreatment was assessed using the Childhood Trauma Questionnaire. Results of a structural equation modeling revealed that different types of maltreatment influence the ability to recognize emotions in children. Physical abuse is related to a decreased ability to recognize fear and sadness, whereas emotional and sexual abuse are related to a decreased ability to recognize anger. Emotional neglect is associated with an increased ability to recognize anger, whereas physical neglect is associated with less accuracy for happiness (Turgeon et al., 2020). Moreover, mothers exposed to a severe form of childhood maltreatment, more accurate emotion recognition is associated with less sensitive behaviors toward the child (Bérubé et al., 2020). To have a better understanding of

those results, moderation analyses were performed to examine the physiological and behavioral response of mothers to children's facial emotions. Results show that for mothers with a history of severe maltreatment, looking at children's emotions elicits the same HRV as looking at scenery images, whereas the HRV of mothers without a history of maltreatment is lower for facial emotions than for neutral pictures. Moreover, for mothers with a history of maltreatment, a lower HRV is associated with less handgrip pressure. This is contrary to the reaction of mothers without such past for whom a low HRV is related to more handgrip pressure. These results have important implications as they suggest that mothers with a history of severe maltreatment would need tailored interventions that consider their particular reactions to children's emotions.

P1-I-160 - Child sleep as a potential moderator of the influence of childhood maltreatment on the quality of mother-child interactions (Potvin)

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Sleep has critical impacts on the health and developmental trajectory of children. In fact, poor sleep can negatively affect socio-emotional, behavioral, and neurocognitive development, and potentially lead to social interaction problems (Spruyt, 2019). Research has shown that children sleep quality is positively associated with the quality of the mother-child interactions (Bordeleau et al. 2012). Both mother-child interaction, as well as children quality of sleep are affected in mothers reporting a history of childhood maltreatment. In fact, studies have shown that these mothers experience difficulties manifesting sensitive, comforting and supportive behaviors towards their child (Bailey, 2012; Madigan et al., 2006; Savage et al., 2019). Moreover, childhood maltreatment has been associated with higher risk of developing sleep difficulties as an adult (Chapman et al., 2013). Considering that parent and child's sleep are linked, children's sleep could also be affected (Mindell et al., 2015). However, no research, to our knowledge, have examined the effect of the interaction between the maternal history of maltreatment and children's sleep on the mother-child interaction. Therefore, the aim of this study is to examine how children's sleep moderates the relationship between the mother's childhood maltreatment and the quality of mother-child interactions. Participants included 58 Caucasian mothers and their child (age M = 45.77 months, SD = 12.55). The French version of the Childhood Trauma Questionnaire including 28 items was used to measure the mother's childhood maltreatment history (Paquette et al., 2004). Videotaped interactions between mother and child were used to evaluate the quality of their interactions with the observation grid developed by Moss (Moss et al., 1998). Mothers were also asked to report the degree to which their child was experiencing sleep difficulties. A moderation analysis was conducted using the PROCESS 4.0 extension in SPSS 28. We then proceeded with simple slopes analysis to explore the effect further. Our results show child's sleep has a moderating effect on the relationship between maltreatment and the quality of interactions between the mother and child (see table 1). More precisely, for children without sleep difficulties, the mother's experience of childhood maltreatment is not related to the quality of her relationship with her child. However, for children with more important sleep difficulties, more childhood maltreatment experienced by the mother is related to lower quality of the mother-child interaction. These results point to the importance of children's sleep as a potential resiliency factor that could attenuate the parenting difficulties associated with a history of childhood maltreatment. The child's sleep could become a potential target for intervention in order to help those families to break the intergenerational cycle of maltreatment.

P1-I-161 - How to support parents of children with neurodevelopmental disabilities through family-centered telecare: The SPHERE project (Grumi)

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Introduction. Infants with neurodevelopmental disabilities (NDs) show emotional, cognitive, and socio-interactive dysregulation dramatically impacting caregiving behavior. Early video-feedback interventions (VFIs) are effective in promoting sensitive parenting, which in turn supports infants' development, even in case of NDs. Delivering VFIs in hospital-based context might be highly demanding for the healthcare systems due to high costs and disparities in access to services for families who live in remote areas. Technological advances in telemedicine may facilitate the delivery of VFI to a greater number of families of infants with ND. To the best of our knowledge, no study to date has tested the efficacy of a telemedicine VFI (TVFI) for families of infants diagnosed with ND. Methods. The ongoing Supporting Parenting at Home - Empowering Rehabilitation through Engagement (SPHERE) project is a randomized controlled trial aimed at assessing the effectiveness of an early family-centered TVFI parenting support with dyads of 0-18-month-old infants diagnosed with ND and their mothers. Enrolled dyads are assigned to one of two arms (i.e., experimental vs. control) and undergo three assessment phases: T0, baseline; T1, immediate post-intervention; T2, 6-month follow-up. Mothers assigned to the experimental arm receive six weekly TVFI sessions: four sharing the focus sessions, dedicated to joint review video segments and the discussion of specific themes; two integration sessions, during which the mother plays with the infant while the psychologist provides dyadic-tailored guidance based on topics discussed during the previous sessions. Mothers assigned to control arm receive an informative booklet addressing the same themes discussed in the experimental intervention but not tailored to their infant or their specific parenting challenges (Figure 1). For both arms, each assessment session includes (a) an online questionnaire on maternal and infants' well-being (parenting stress, maternal anxiety, maternal depression, infant's temperament) and a mother-child dyadic interaction videotaped during a videoconference. This interaction includes 10-minute face-to-face play interaction followed by the 6-minute Face-to-Face Still-Face procedure. Videotaped interactions were micro-analytically coded for maternal sensitivity, types of stimulation, teaching strategies, maternal mind-mindedness, infant's attentive orientation, and negative emotionality. Results. Preliminary results of the pilot study (n= 15) showed that participants welcomed this kind of intervention. Mothers reported high levels of satisfaction and moderated technical challenges (Figure 2). Observatory data showed an improvement in maternal sensitivity and an increase in the use of teaching strategies (e.g., modeling) in playing with their infants. Infants spent more time oriented to the mothers and engaged in playing with them. Moreover, mothers in the intervention arm exhibited less parenting stress scores at T1. Discussion. The SPHERE project holds promises to test a new model for the telemedicine care of infants with neurodevelopmental disabilities. By investing in an early and family-centered intervention we aim to provide families with timely and efficient support to the rehabilitation journey. Moreover, by promoting a telemedicine VFI we can contribute to reducing the healthcare inequalities for families who face challenges in accessing traditional rehabilitation programs.

P1-I-162 - The impact of stressful parental behaviors on infants' vagal tone: The moderating role of the time parents spend with infants (Rattaz)

Valentine Rattaz[1], Hervé Tissot[1], Nilo Puglisi[1], Nicolas Favez[1] [1]University of Geneva Background. The first aim of this study is to investigate the association between stressful interactional events (SIE) and infants' vagal tone in mother-infant, father-infant and mother-father-infant interactions. Physiological studies have shown that stressful parental behaviors during parent-infant interaction can influence infant's physiological regulation. To date, studies mostly focused on mother-infant interactions and not on father-infant or mother-father-infant interactions. The second aim of this study is to investigate the potential buffering effect of the time parents report to spend with their infant on this association between SIE and infants' vagal tone. Hypotheses. We expect SIE to be associated with infant's vagal tone, with more stressful behaviors associated with a lower vagal tone. We hypothesize that the amount of time spent by a parent with the infant might moderate the association between SIE of the other parent and the infant's vagal tone. Method. 57 families participated in laboratory visits when the infant was 3 months of age. Parents were asked to play with their infant according the following standardized scenario: 1) One parent plays alone with the infant, 2) They change roles, 3) Both parents play with the infant. Infant's ECG was recorded to assess vagal tone, indexed by Root mean square of successive differences (RMSSD), as an indicator of stress. SIEs were coded every 5 seconds during interactions. Parents were also asked to fill questionnaires indicative of the time spent with their infant during the week. Results. Results show that maternal SIE during the mother-infant interaction are associated with infant's RMSSD in every part of the scenario, the more stressful the mother's behaviors, the lower the infant's vagal tone. There was no association between father-infant or mother-father-infant SIE on RMSSD in any part of the scenario. However, the amount of time fathers reports spending with their infant moderates the relationship between maternal SIE and RMSSD during the mother-father-infant interaction. When the father reports spending more time alone with the infant, higher maternal SIE are associated with higher RMSSD during mother-father-infant interaction. Conclusion. The present study underlines the major influence of the maternal behaviors in the infant's physiological regulation. However, when the father reports spending more time with the infant, he seems to act as a buffer against infant's stress activation. Moreover, maternal stressful behaviors seem paradoxically to have a positive effect if the father spends time with the infant. This result might underline the idea that parent-infant interactions do not have to always be perfectly adjusted, unadjusted interactions can be a context for the infant to learn emotion regulation. Further studies should add an indicator of parental sensitivity to investigate if the quantity of time spent with the infant is related to the quality of the parent-infant interaction and therefore, if the sensitivity of a parent can buffer the stressful behaviors of the other parent.

P1-I-163 - The relation between language and emotion perception from 15- to 18-months (Ogren)

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From birth, young infants demonstrate an ability to perceive emotional information. Over the course of the first few years after birth, this emotion perception gradually develops into a more complex understanding of emotions throughout childhood. Yet, many questions remain regarding how infants and young children learn to make sense of the emotional information around them and ultimately begin to categorize and understand emotions. Recent theoretical work has proposed that language may be a potential mechanism for young children's developing understanding of emotion. However, much remains unknown about the relation between emotion and language in infancy, particularly at the

individual difference level. Thus, the present study aimed to examine relations between emotion perception and language in late infancy. The present study investigated the perception of emotional expressions across multiple pairs of faces among 50 15- to 18-month-old infants. Parents reported their child's productive language by completing a vocabulary checklist- the MacArthur Bates Communicative Development Inventory (MCDI; Fenson et al., 2007). Infants participated in an entirely non-linguistic emotion perception task via an eye tracker. For each trial of the emotion perception task, infants viewed a woman's stereotypical emotion face (afraid, angry, happy, or sad). This was then followed immediately by two emotional faces of a new woman- One matched the previously displayed emotion and the other mismatched. Thus, the task required infants to match emotional content across individuals, but included no language. We also assessed infants' general matching abilities using a similar paradigm with novel objects (see Figure 1). Infant total looking time to the familiar emotion category and novel emotion category were recorded. A multiple regression analysis was used to analyze the relation between infant language and nonverbal emotion perception (i.e., looking time to the novel face) while covarying for infant age, gender, and object perception. In this model, infant vocabulary did not significantly predict infant nonverbal emotion perception over and above the effect of the covariates (β=.15, p=.300). However, there was a significant effect of child gender on emotion perception (β=.28, p=.046), such that the boys spent significantly more time looking to the novel face (M=0.52, SD=0.05) than did girls (M=0.49, SD=0.04). Thus, we followed up by examining whether vocabulary related to emotion perception differently for infant boys and girls. Results revealed that infant language ability significantly predicted emotion perception over and above age and object perception for girls (β=.42, p=.024), but not for boys (β=-.03, p=.901). The present results suggest that the relation between language and emotion perception may be complex prior to 18 months of age, and modulated by multiple factors such as child gender. Boys may see an early advantage in nonverbal emotion perception, but girls with higher productive vocabularies may see an advantage over girls with lower vocabularies. Further research is necessary to address how the role of language in processing emotional information may change for boys and girls across development.

P1-I-164 - How do visually impaired infants (and their mothers) respond to the Face-to-Face Still-Face? A preliminary study (Capelli)

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Background. Socio-emotional stress regulation is a key milestone of healthy infants' development during the first year of life. Previous research has widely used the Face-to-Face Still-Face (FFSF) procedure to assess infants' socio-emotional stress in healthy and at-risk (e.g., preterm) samples. These studies have highlighted how maternal voice and touch may support infants' capacity to respond to stress elicited by the experimental manipulation of the caregiver availability (i.e., still-face). Less is known on socio-emotional stress regulation in infants with visual impairment and how maternal voice and touch may benefit them. Thus, the aims of the study are (1) comparing sighted and visually impaired infants' socio-emotional stress regulation to maternal still-face and (2) comparing mothers' voice and touch regulatory strategies across the FFSF interactive episodes (i.e., Play, Reunion). Methods. Visually impaired and sighted controls aged 9 to 12 months were recruited together with their mothers at the Developmental Neuro-ophthalmology Unit of the IRCCS Mondino Foundation (Pavia, Italy). Mother-infant dyads

participated in a videotaped FFSF session (i.e., 2-min Play interaction; 2-min Still-Face interaction; 2-min Reunion interaction). Infants' emotional state (i.e., negative emotionality) and orienting (i.e., avoiding) as well as mothers' verbal productions (i.e., explanations, playful, affective) and touching behaviours (i.e., instrumental, playful, affective) were 2-sec coded by trained students using validated coding schemes (Provenzi et al., 2020). Codes' frequencies were averaged by FFSF episode durations and multiplied by 100 to obtain %s of time. Findings. Enrolling is in progress. Preliminary data from 12 visually impaired infants and 12 sighted controls suggest that the groups did not differ for emotional state and orienting across the FFSF procedure (Fs < 1.29, ps > .05). In both groups a typical episode effect was evident with higher negative emotionality and avoiding orientation during the still-face phase (negative emotionality, $F = 11.36$, $p < .001$; avoiding, $F = 9.72$, $p < .001$) (Figure 1). Nonetheless, while mothers of sighted infants increased explanation from play to reunion, this was not observed in mothers of visually impaired infants ($F = 13.84$, $p = .002$). As for touch, mothers of sighted infants decreased the use of playful touch from play to reunion whereas mothers of visually impaired infants tended to increase it ($F = 8.78$, $p = .01$), compared to sighted controls' mothers (Figure 2). Discussion. For the first time, this study suggests that visually impaired and sighted infants similarly react to experimentally elicited socio-emotional stress. Nonetheless, mothers of visually impaired infants seem to use more playful and less mind-oriented caregiving style when regulating their infants after a socio-emotional stress episode. While preliminary, these data suggest potential targets for early mother-infant interventions in the care of infants with visual impairment.

P1-I-165 - Crawlers are more sensitive to fearful faces than non-crawlers (Gehb)

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A transition in the second half of the first year of life from a preference for looking at positive faces to a preference for negative faces has been shown by several studies (see Vaish et al., 2008 for a review). From about 7 months, infants typically look longer at negative emotional facial expressions compared to positive facial expressions. Furthermore, infants at this age are able to distinguish a happy face from a fearful face when the fearful face is a morph containing at least 60% of a purely fearful expression (Cong et al., 2019; Kotsoni et al., 2001). Thus far, it remains unclear which factors drive this shift from a positivity to a negativity bias. One suitable candidate factor is crawling, since the onset of crawling leads to several cognitive changes in infants (for an overview see, Campos et al. 2000). Crawling also brings many changes in social-emotional areas as well as in the interaction between caregivers and the infant (Campos et al., 2000). For example, researchers have recorded increases in expressions of anger by the caregivers when their infants started crawling (Biringen et al., 1995; Campos et al., 1992). Thus, the present study examined whether infants' crawling experience is related to their sensitivity to negative emotional expressions such as fear. Twenty-nine 9- to 10-month-old infants were tested in a preferential looking task. Infants were presented with different pairs of animated faces on a screen displaying a 100% happy expression paired with a morphed expression created from morphing together happy and fearful expressions (in 10% increments ranging from 10% fearful to 100% fearful). Each animation began as a neutral face, and morphed into the final expression over the span of 500ms. The infants' looking durations (recorded by eye-tracking) were analyzed in terms of the time they fixated on the fearful morph as a percentage of the total fixation time for the both the fearful morph and 100% happy face. All infants looked longer at more fearful faces (10% to 50%: M = 49.57%, Sd = 7.31% vs. 60%

to 100%:M = 55.34%, Sd = 7.36%), F(1, 27) = 7.797, p = .009, η2part = .224. Additionally, infants with at least 6 weeks of crawling experience were more sensitive to more ambiguous morphs compared to those with less crawling experience, F(1, 27) = 4.823, p = .037, η2part = .152. Specifically, crawling infants looked longer (M = 61.14%, Sd = 16.54%) at the 50% fearful morph compared to same-aged non-crawling infants (M = 49.73%, Sd = 11.08%). Thus, crawling appears to increase infants' sensitivity to fearful faces. Since infants who started crawling have showed an increase in social referencing in unfamiliar situations (Campos, 1990), it is reasonable to hypothesize that the increased sensitivity for fearful faces is an evolutionary adaptation to avoid potential dangers which infants can encounter while locomoting independently.

P1-I-166 - Associations between home chaos, maternal depression, and infant attention to emotion at 18 months of age (Jones)

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Affect biased attention refers to the degree to which a child preferentially attends to emotional stimuli. Strong patterns of attention to both negative and positive social stimuli are a risk factor for different forms of psychopathology, such as anxiety. Bronfenbrenner's Bioecological model suggests that the environmental spheres surrounding a child, from parental care to their community, are important influences on development. Thus, in understanding patterns of attention to emotion, it may be important to consider facets of the child's home environment. Home chaos is a measure of how much stability, routine, and organization there is in a home and is positively correlated with infant negative emotion and distress. Home chaos is also positively associated with caregiver depression. Additionally, caregiver depression is a risk factor for a child's maladaptive trajectories in emotional and cognitive development. In this analysis, we examined how home chaos and caregiver depression may relate to infant attention biases to emotion, which could be associated with psychopathology later in a child's life. Home chaos was measured via the Confusion, Hubbub, and Order Scale (CHAOS), and depression was measured using the Beck Depression Inventory (BDI). Both were self-report measures from the infant's primary caregiver. Infant attentional biases to emotion were measured using eye-tracking during the Overlap task, which presented an emotion face (neutral, happy, and angry) in the center of the infant's visual field. Infants were part of a multi-site longitudinal study. In this analysis, we focused on data collected when the infants (N=88) were 18 months old. First, we tested the association between home chaos and depression within this sample, finding a significant positive relation, b = 0.46, p < .001. Second, we used multilevel modeling to examine the interaction between chaos, depression, and emotion face on the dwell time to the central face during the overlap task. Emotion was entered as a random effect. The model included 262 observations nested within the 88 participants. We found a significant two-way interaction between emotion and chaos on dwell to face, b = -14.43, p = .04. There were no significant effects of depression. Probing this interaction revealed at higher levels of home chaos, dwell to happy faces is lower when compared to both angry and neutral faces. However, chaos does not relate to attention to each emotion directly (Figure 1). These findings suggest that chaos may be an important facet of environment to consider in influences on a child's socioemotional development, especially in considering how they attend to emotional stimuli compared to other emotional stimuli. These differences may reflect adaptive mechanisms to attentionally navigate an environment that is more complex or cluttered. Additionally, while environmental characteristics may

relate to caregiver depression, depression may not directly drive differences in infant attention. Future directions should examine these interrelations longitudinally.

P1-I-167 - The effect of childhood maltreatment on mother's physiological response to children's emotions and their level of sensitivity toward their child (St-Pierre)

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Several studies demonstrate that parents who have experienced childhood maltreatment exhibit different physiological responses to children's emotional signals (Compier-de-Block et al., 2015; Joosen et al., 2013). In response to these signals, mothers who have been maltreated may experience important physiological reactivity (Out et al., 2010; Dale et al., 2009). Additionally, this strong physiological response may result in a less sensitive behavior in response to the child's signals (Buisman et al., 2018; Compier-de-Block et al., 2015). This understanding, however, is specific to the response to auditory stimuli, such as crying. There is limited knowledge about parents' response to visual perception of children's emotions. Therefore, the current study examines how a history of childhood maltreatment moderates the association between mothers' physiological response to visual presentation of children's emotions and their sensitive behaviors toward their child during free play and a structured task. Participants included 47 mothers aged between 23 and 45 years ($\bar{x}$= 33,47), accompanied by their child. Mothers performed a computerized task in which they were first exposed to neutral images of landscapes, followed by images showing children's faces expressing different intensities of emotions. During this task, the heart rate variations (HRV) were recorded to obtain a measure of physiological activation induced by the stimuli. Following that task, mothers were asked to interact with their child during a free play period and then during a structured task. Mother-child interactions were then coded for sensitive behaviors. The short version of the Childhood Trauma Questionnaire (CTQ) was used to assess the presence of early maltreatment and its level of severity in mothers who participated in the study. The moderating effect of childhood maltreatment was examined by estimating multiple hierarchical regression models using SPSS 28 with PROCESS 3.5.3. Results indicate that childhood maltreatment moderates the relationship between physiological response to visual stimuli of children's emotions and sensitive behaviors during free play ($F[3.00, 43.00] = 24.52$, $p < .001$). The same results were found for the sensitive behavior during the structured task ($F[3.00, 43.00]= 7.78$, $p < .001$). Analysis of simple slope indicate that for mothers without history of maltreatment, lower HRV during facial emotions perception were associated with a more sensitive behavior during free play and the structured task. However, for mothers who were exposed to severe forms of childhood maltreatment, an increase in their HRV when looking at different images of children's emotions is associated with more sensitive behaviors. This study reveals that severely maltreated mothers exhibit a difference in the relationship between their physiological and behavioral responses to their child. These different physiological and behavioral responses thus suggest that mothers with a history of severe childhood maltreatment may benefit from adapted interventions that consider their peculiar reactions to children's emotions.

P1-I-168 - Maternal anxiety beliefs predict overprotective parenting when infants demonstrate elevated inhibition (Aaron)

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Maternal overprotective parenting is associated with child anxiety development (Nishikawa et al., 2010). However, less is known about factors that predict the use of overprotective parenting. Maternal beliefs about the harm of infant anxiety may be one such factor. Evidence for this relation stems from literature on anxiety sensitivity, in which individuals fear anxiety symptoms due to the belief that anxiety is harmful and leads to negative outcomes (Ries, 1987). When parents hold these beliefs for their infants, they may interpret inhibited temperament or anxiety as harmful to their infant. Parents may then engage in overprotective parenting to relieve their own distress when watching their infant display inhibition (McShane & Hastings, 2009). However, the relation between maternal beliefs about the harm of their infant's anxiety and maternal overprotective parenting may only be significant in the context of infant inhibited temperament, as infants with inhibited temperament pull for overprotective parenting (Lebowitz et al., 2013). It is important to examine these relations in infancy during which maternal anxiety beliefs have not yet been studied. The current study examined the moderating role of infant inhibited temperament in the relation between maternal beliefs about the harm of infant anxiety and maternal overprotective parenting behavior one year later. 164 mothers and infants participated in laboratory visits when children were 2- and 3-years-old. Maternal anxiety beliefs and infant inhibited temperament were assessed when children were 2-years-old. Maternal overprotective parenting was assessed when children were 2- and 3-years-old. Mothers completed a questionnaire assessing beliefs about child anxiety (adapted Anxiety Sensitivity Index, Taylor et al., 2007). Infants' inhibited temperament was observed during a standardized procedure (Fox et al., 2001). Mothers' overprotective parenting behavior was observed during a separate standardized procedure with their child (Nachmias et al., 1996; Kiel & Buss, 2012). Regression analyses were conducted in MPlus using FIML (Muthén & Muthén, 2015). Results indicated a significant interaction between maternal anxiety beliefs and infant inhibited temperament at child age 2-years in the prediction of maternal overprotective parenting one year later over and above the effect of overprotective parenting at child age 2-years (b= .007, SE=.002, t= 3.307, p= .001), such that maternal anxiety beliefs only predicted maternal overprotective parenting when their infants also had high levels of inhibited temperament ($\bar{X}$+1 SD, b= .006, SE= .002, t= 3.769, p< .001), and not at mean (b= .002, SE= .001, t= 1.257, p= .209) or low ($\bar{X}$-1 SD, b= -.003, SE= .002, t= -1.196, p= .232) levels. Findings suggest that the relation between mothers' beliefs and their parenting one year later is contextualized by their infants' temperament. When mothers have stronger beliefs that child anxiety is harmful, and their infant demonstrates elevated inhibition, then mothers engage in more overprotective parenting one year later. However, if infants do not display elevated inhibition, mothers' anxiety beliefs may not be relevant to how they parent that infant one year later. These findings emphasize the importance of investigating interactions between maternal and child characteristics in the trajectory of child anxiety to inform prevention and intervention.

P1-I-169 - Shared Emotional Experiences During Mother-Infant Interaction at 6-Months: Toy Pollution or Toy Solution? (Sjolseth)

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For infants, stable and nurturing relationships with caregivers may protect children from adversity and promote resilience (Garner et al., 2021). Moreover, extensive research and theory recognizes the bidirectional contributions of parent and infant to the quality of early relationships. During mother-

infant interaction, shared emotional experiences (SEEs), defined as reciprocal and synchronous emotional sharing between mother and infant, are one indicator of early relational health. While researchers have used a variety of interaction contexts (i.e., with toys; without toys) to infer qualities of the mother-infant relationship, little research has examined SEEs across toy and non-toy interactions. While these interactions may each hold value for infants' development (e.g., development of joint attention versus coregulation of emotion), it is unclear whether mothers' toy or non-toy initiations relate to higher frequency and duration of SEEs. Utilizing a sample of 57 randomly selected videos from two sites of the NICHD Study of Early Child Care and Youth Development, a rating system for SEEs was developed based on the extant literature. We examined the first five minutes of the six-month mother-infant interaction videos, when mothers interacted with their infants however they wanted (e.g., with and/or without toys). Two primary research questions guided this investigation: (1) How do mothers initiate interaction with their infants (i.e., with toys, without toys)? (2) How do these initiations relate to the frequency and duration of SEEs during mother-infant play? Mothers' efforts to initiate interaction were coded as either toy (e.g., shaking a toy) or non-toy (e.g., singing a song); total frequency scores were created for toy and non-toy initiations. At the dyadic level, frequency and duration of SEEs were coded separately for toy and non-toy play interactions. To explore possible infant correlates of SEEs, infants' bids for physical contact were also coded (present/not present). Interrater agreement ranged from 90% to 99% across all behaviors coded. Results indicated that 93% of mothers used a combination of toy and non-toy initiations with their infants; 5% initiated interaction using only toys, while 2% initiated interaction exclusively without toys (Table 1 displays means and bivariate correlations). Overall, frequency of SEEs was significantly higher during non-toy play, compared to toy play $t(1,55 = 4.96, p < .001)$. During non-toy play, frequency of SEEs predicted duration of SEEs, $F(1,54) = 29.32, p < .001$, indicating that mother-infant pairs with a higher frequency of SEEs also experienced higher duration of SEEs. Although frequency of toy initiations was not associated with frequency or duration of SEEs during toy play, frequency of toy initiations predicted frequency of SEEs during non-toy play, $F(1,54) = 46.69, p < .001$), suggesting cross-context associations. When infants sought contact with their mothers, dyads also experienced more frequent SEEs during non-toy play. Results begin to demonstrate how mothers' initiation choices with their infants relate to frequency and duration of SEEs and suggest that higher levels of shared emotional experiences are experienced when mothers and infants interact without toys. Implications for early relational health and observation of parent-infant interaction will be discussed.

P1-I-170 - Maternal and Toddler Characteristics as Predictors of Mother-Toddler Conversational Turns and Maternal Responses to Toddler Cries in the Home (Copeland)

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Parental responsiveness to young children's distress and non-distress cues play an important role in children's socioemotional functioning (Leerkes et al., 2012: McElwain & Booth-LaForce, 2006), and both parental and child affective characteristics contribute to parental responsiveness (Dix, 1991; Emery at al., 2014). However, research has predominantly examined parental responsiveness during brief, structured tasks. We have limited understanding of how maternal and child characteristics may contribute to maternal responsiveness to toddler cues in naturalistic settings, in the presence of other environmental distractions or stressors. We examined the individual and combined contributions of maternal (i.e., depression, empathy) and child (i.e., temperamental distress to limitations) affective

characteristics as predictors of (a) frequency of mother-toddler conversational turns in the home, and (b) likelihood of mothers vocalizing following toddler cries. Mothers and their infants (N = 111; 54 girls) participated when infants were 3, 6, 9, and 12 months old. At each time point, children wore the Language Environment Analysis (LENA) recording device for approximately 16 hours in the home. We used LENA data at 12 months only. LENA uses algorithms to segment audio files by "speaker" (infant, adult female, adult male) and detect infant cries and adult-child temporal vocalization sequences (i.e., conversational turns). Maternal vocalizations to toddler cries were defined as female adult vocalizations occurring within five seconds following a detected cry. Mothers reported on their dispositional empathic concern and depression at all timepoints. Ratings were highly correlated and averaged across timepoints. Mother and father ratings on children's temperamental distress to limitations at all timepoints were also averaged to obtain a robust measure of child temperament. To address our main research questions, a series of path models were tested (see Table 1). Main effects of maternal empathy, depression, and child temperamental distress were estimated as predictors of conversational turns (Model 1) and maternal vocalizations to toddler cries (Model 2). Maternal Depression x Child Temperament and Maternal Empathy x Child Temperament interactions were added one at a time to the two models. Results showed that higher maternal empathy and child temperamental distress to limitations predicted more frequent conversational turns, whereas maternal depression predicted fewer conversational turns. Interactions for conversational turns were nonsignificant. Main effects on maternal vocalizations to toddler cries were nonsignificant, but a significant Maternal Empathy x Child Temperament interaction emerged: Greater child temperamental distress predicted more maternal vocalizations following toddler cries only for mothers who reported high empathy (see Figure 1). Consistent with Dix's (1991) model on affective processes in parenting, mothers with higher empathy may be more oriented towards child vocal cues in the home, whereas mothers with higher depression may experience more relational difficulties and converse with their children less frequently. Children with higher temperamental distress elicited more conversational turns, perhaps because mothers may anticipate and try to prevent their child's distress. Moreover, mothers with higher empathic concern may be more attuned and responsive to toddler cries for children with more difficult temperaments.

P1-I-171 - Stability and Structure of Infant and Toddler Temperament in Germany Measured via IBQ-R and ECBQ (Zmyj)

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Parents and researchers agree on the statement that babies have individual differences from day 1. One of the earliest forms of these differences are reflected in their temperament - a disposition in reactivity and self-regulation (Rothbart & Bates, 2006). Young children's temperament is often measured with the Infant Behavior Questionnaire-Revised (IBQ-R, Gartstein & Rothbart, 2003) and the Early Childhood Behavior Questionnaire (ECBQ, Putnam et al., 2006) that were developed in the U.S but they are used worldwide. The IBQ-R consists of 14 scales that are grouped in three factors and the ECBQ consists of 19 scales that are grouped in three factors as well. We investigated the factor structure and longitudinal stability of infant and toddler temperament measured with the IBQ-R and the ECBQ in two German samples. In Study 1 (n = 53), the IBQ-R was applied in 9- and 12-month-old infants. In Study 2 (n = 126), testing a second sample, both questionnaires were applied in 12-, 18-, and 24-month-olds. Exploratory factor analyses of the IBQ-R in both studies revealed a two-factor solution comprising

Surgency/Extraversion and Negative Affectivity, replicating earlier findings with German infants. The Orienting/ Regulation factor was not replicated for the IBQ-R (see Table 1). The corresponding analyses of the ECBQ replicated a three-factor solution for toddlers as in the original study. Longitudinal stability was analyzed on scale level. The results showed stability of temperament ratings within infancy (Study 1) and toddlerhood (Study 2) as well as between the developmental periods within the second year of life (Study 2, see Table 2). The present findings replicate earlier findings that temperament stability exists already in infancy and can be reliably measured using the IBQ-R and ECBQ. However, the factor structure of the IBQ-R outside the U.S. requires further investigation.

P1-I-172 - Infant negative affect trajectories as a function of maternal positive engagement and household chaos (Gilmer)

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Household chaos refers to the overall level of disorder in an individual's life stemming from the home environment (Matheny et al., 1995). Household chaos has been linked longitudinally to poor self-regulatory behavior and conduct problems in children, which are, in turn, related to temperamental differences (Humphrey, 1982; Jaffee et al., 2012). Further, household chaos moderates the interaction between parenting styles and children's behavior by exacerbating the negative effect of ineffective parenting (Coldwell et al., 2006). However, previous work has relied on parenting self-reports, and it is unclear whether these relations extend to observable behaviors during parent-child interactions. Previous work has also focused on the effects of chaos beginning in childhood rather than infancy. The current study used observed parent-child interactions to examine how variation in maternal control and positive engagement may predict infant negative affect over time in the context of varying levels of household chaos. Data came from a multi-site, longitudinal study of affect and temperament. Mother-infant dyads completed a free-play interaction at 8 months which were video recorded and event coded in Datavyu. A maternal control composite was computed as the percent of time mothers spent in intrusive and controlling behaviors. A maternal positive engagement composite was computed as the percent of time mothers spent in positive vocalizations to infants and playful positive interactions. Household chaos and infant temperament were assessed via mother reports at 4, 8, and 12 months using the Confusion, Hubbub, and Order Scale (CHAOS; Matheny et al., 1995) and the Infant Behavioral Questionnaire (IBQ; Rothbart, 1981), respectively. Conditional growth models indicated that infant negative affect increased over time between 4 and 12 months ($\gamma 20 = 0.114$, SE= 0.033, $p = .001$). Negative affect trajectories did not systematically vary as a function of observed parenting or household chaos directly (all p's > .547). Instead, negative affect trajectories varied as a function of the interaction between maternal positive engagement and household chaos ($\gamma 80 = -0.070$, SE= 0.040, $p = .087$), albeit marginally. Regions of significance analysis indicated that at low (-1SD) levels of household chaos, infant negative affect trajectories significantly increased over time when mothers displayed positive engagement behaviors > 20.39% of time, and the strength of the slope of age on negative affect also increased as a function of increasing maternal positive engagement. In contrast, at mean and high (+1SD) levels of household chaos, infant negative affect trajectories were stable over time when mothers displayed positive engagement behaviors > 47.39% and 19.76% of time during the interaction, respectively. These findings are in line with previous studies of household chaos and parenting questionnaires, showing that parenting behaviors may predict distinct developmental profiles of

temperament as a function of the home environment that mothers and infants interact within. Indeed, the impact of maternal behavior may emerge most powerfully in low-risk environments, while interaction effects may be central as putative environmental risk increases. We discuss these findings in light of stable trajectories of negative affect as a potential risk factor for developmental psychopathology.

P1-I-173 - Physiological Correlates of Jealousy in Infancy (Bernardo)

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Primary emotions have been studied widely in infancy, however still little is known about the physiological mechanisms underlying blended or complex emotions during the first years of life. Jealousy in infancy is an evolutionarily adaptive mechanism characterized by a blend of emotions such as anger, fear, anxiety and/or sadness due to loss of preferential attention of a caregiver to a social competitor. To regain maternal attention, research has shown that infants display negative facial affect and materal-directed approach behaviors in response to a jealousy inducing paradigm (Hart et al., 1998). Infant jealousy behaviors have been associated with left-frontal EEG asymmetry(Platt & Jones, 2018), in addition to neural correlates, infant jealousy may be related to the body's stress reguation system. Some stress is a necessity for development, especially when it occurs within stable and supportive relationships, such as the mother infant relationship. Positive stressors in infancy are associated with surges in cortisol that increase heart rate and brain functioning, which may promote infants' learning and facilitate bonding with caregivers (Tryphonopoulos et al., 2014). In the jealousy paradigm, infants are faced with social threat which are critical in elevation of cortisol levels and activation of the HPA axis in adult research (Gunnar, Talge, & Herrera, 2009), suggesting that there may be a relationship between jealousy processing and the HPA axis during infancy. The aim of this study further examines physiological correlates of jealousy type behaviors prior to the first year of life. Consistent with past research (i.e., Hart et al., 1998), behavioral and physiological data were collected from 20 mother-infant dyads (10=Males) prior to the first year of life (M=8.27; SD=1.35)) during two conditions (counterbalanced). Mothers ignored their infant and attended to a social stressor (a life-like newborn doll) and a non-social object (a book) while ignoring their infant. Mothers were instructed to use the same positive tone and manner of speech in each condition to engage with the object. Infant responses were coded using second-by-second ratings for: gaze toward mother/object, proximity, touch, vocalizations, level of arousal and affect. Three minutes of baseline EEG activity (across the scalp from frontal to occipital regions) was obtained from the infants was recorded and asymmetry scores were calculated, utilizing alpha band (6-9 Hz, Bell, 2002), (ln(right) - ln(left)). Infant salivary cortisol levels were collected at baseline, 20- (reactivity) and 40-minutes (regulation) post social stressor condition. Paired samples t-test revealed that infants demonstrated increased mother-directed approach behaviors when faced with a social stressor, $t(19) = 2.31$, $p = .032$. Left-frontal EEG asymmetry was associated with infant's maternal-directed approach behaviors during the social condition $r(11) = 0.822$, $p = .002$. In addition, left-frontal EEG asymmetry also demonstrated an association with infants' stress regulatory abilities, measured by salivary cortisol $r(10) = -.636$, $p = .048$, indicating that higher asymmetry (more left alpha) is related to better stress regulation abilities. This study provides further evidence for the emerging links between neural and stress physiology on socio-emotional responses in infancy due to loss of exclusive maternal attention.

P1-I-174 - Infants' vagal response to mis-coordinated 3-month-old infant-father interactions: The moderator role of father involvement (Puglisi)

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BACKGROUND: Being engaged in the care of their infants provides fathers opportunities to learn how to recognize and react to infants' signals during daily interactions. However, miscoordinations may happen during daily father-infant interactions. Miscoordinations may be stressful for infants with consequences on his/her emotion regulation. Infants' regulatory responses to interactions involve the vagal influence on cardiac activity. In this study, we investigate the infant's vagal responses to Mis-coordinated Interactional Moments (MIM) during father-infant interactions and the moderator role of father involvement in daily infant care. HYPOTHESES: We hypothesize that (1) more MIM will be associated with higher stress reactions in infants during father-infant interactions; and that (2) father involvement in daily infant care moderate the effect of MIM. METHODS: Sixty 3-months-old infant-father interactions were videotaped in a standardized laboratory situation (Lausanne Trilogue Play). Infants' measure of vagus-mediated heart rate variability (RMSSD) has been obtained by measuring their ECG during the interactions. A quantitative observational coding system was used for assessing MIM during videotaped interactions; MIM were coded every 5 seconds. Fathers filled questionnaires to report their involvement in day-to-day care in terms of the number of parts of the day per week (morning, afternoon, evening, night) they spend with the infant (either alone, accompanied by the infant's mother or other persons, such as grandparents, kindergarten, nanny, others). RESULTS: The number of MIM is a tendentially significant predictor of infants' stress reaction during father-infant interactions (p=.061), meaning that when the number of MIM increases, infants' RMSSD tends to decrease. The joint effect (interaction) of the number of MIM and father involvement rates is almost significant (p=.089). This means that the effect of the numbers of MIM on infants' RMSSD tends to change depending on the level of father involvement, particularly for those fathers who report low involvement in day-to-day infant care. When father involvement rates are low and the number of MIM increases, the RMSSD tends to decrease almost attained significance (p=.078), as the infant tends to perceive more stress. DISCUSSION: The results show that (1) the increase of MIM almost relates to a decrease in infants' RMSSD (i.e. increased perception of stress) during father-infant interactions, (2) particularly when father involvement rates are low. Infants of low-involved fathers tend to experience an increase in stress when the number of MIM increase. Further analyses will provide more insight into the results of this study. A larger sample might increase the statistical power and make the interaction effect significant. Promoting fathers' involvement, alone or in the presence of others, may positively affect the infant's regulatory capacities from the earliest months of life.

P1-I-175 - The moderating effect of asymmetrical co-regulation in low- and at-risk 18-month-old infant-mother dyads (Leong)

Kelly Doiron[1], Dale Stack[1], Kalee De France[1], Samantha Bouchard[1], Lisa Serbin[1] [1]Concordia University Co-regulation between infants and parents is crucial to infant development, with their interactions characterized by varying levels of responsiveness, engagement, and contribution. While previous research into parent-infant relationships established an association between risk factors such as parenting stress and negative child emotionality (Berryhill & Durtschi, 2017), it remains unclear

how this association is impacted by co-regulation and other psycho-social risk factors. Furthermore, although asymmetrical co-regulation has been associated with less favorable outcomes (Evans & Porter, 2009), research on this pattern is limited. The objectives of the present study were to examine: 1) the effect of asymmetrical co-regulation on the association between parenting stress and child emotionality, and 2) whether this relationship changes in at-risk dyads. Participants included low-risk infant-mother dyads born full-term and healthy (n = 35) and psycho-socially at-risk dyads (n = 43). The latter group was recruited from a larger prospective longitudinal study that began when mothers were children attending schools serving disadvantaged neighborhoods. Dyads were videotaped engaging in a 15-minute free play task in their homes when infants were 18-months. Their interactions were observationally coded for co-regulation using Fogel et al.'s (2003) Revised Relational Coding System. Codes were assigned based on the level of mutual engagement and contribution to the interaction. This study focused on the asymmetrical co-regulation pattern, during which both infant and mother were engaged, but only one contributed to the interaction. Mothers also completed questionnaires measuring parenting stress (Parent Stress Index; PSI; Abidin, 1986) and infant emotionality (Emotionality, Activity, Sociability Scale Temperament Survey for Children; EAS; Buss & Plomin, 1984). Given the focus on parent-infant interactions, analyses used the parent-child dysfunction scale of the PSI and the child emotionality scale of the EAS. Moderation analyses indicated that the relationship between perceived parent-child dysfunction and child emotionality varied based on time spent in asymmetrical co-regulation. Among psycho-socially at-risk dyads, when time spent in asymmetrical co-regulation was at low (b = .62, 95% CI [0.24, 1.01], t = 3.26, p < .01) and mean levels (b = .31, 95% CI [0.04, 0.58], t = 2.30, p < .05), there was a significant positive relationship between mother-reported parent-child dysfunction and infant emotionality (Figure 1). In contrast, among low-risk full-term dyads, a positive association between parent-child dysfunction and infant emotionality was strongest at high (b = .77, 95% CI [0.37, 1.17], t = 3.93, p < .001) and mean levels (b = .46, 95% CI [0.24, 0.68], t = 4.27, p < .001) of asymmetrical co-regulation (Figure 2). These findings indicate that asymmetrical co-regulation may be a risk factor for low-risk dyads, but protective for at-risk dyads. Taken together, our findings indicate that co-regulation characterized by one active and one passive participant has a different moderating effect on the association between parent stress and infant emotionality depending on the type of risk. While passive engagement may present as a risk factor in, low-risk dyads, it may be protective in psycho-socially at-risk dyads. This study underscores the importance of considering risk when examining the development of parent-infant relationships.

P1-I-176 - Longitudinally linking maternal emotion dysregulation to infant negative affectivity: The role of maternal experiential avoidance (Baumgartner)

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Emotion dysregulation (ED), identifiable in infancy as low control over negative affect (NA), is a core feature of psychopathology in both children and adults (Keenan, 2012; Miljevich et al., 2019). Maternal ED, measured both biologically and psychologically, may transmit to infants and predict negative affectivity (Morelen et al., 2014; Ostlund et al., 2019). Maternal ED may be apparent in mothers' own perceptions of their capacities, as well as in lower respiratory sinus arrhythmia (RSA). RSA measures variance in the length of time between heartbeats, and lower levels have been demonstrated to be a valid biological correlate of adult ED (Vasileve et al., 2009). There is still much to learn about the link

between maternal and infant ED. For example, traditional assessments of ED are not parenting specific. Possibly, ED within a parenting construct, specifically experiential avoidance of infant NA, is a stronger predictor of infant NA outcomes. It is also possible that parenting experiential avoidance plays a moderating role, wherein mothers with high ED who also avoid their childrens' NA are more likely to have infants with high ED. As such, we examined how both general maternal ED and parenting experiential avoidance predicted infants' NA, and also tested parenting experiential avoidance in a moderating role. Participants were 90 mother-infant dyads (38.5% girls, 80.50% White) who participated in a larger longitudinal study when children were 1 (T1) and 2 years old (T2). At T1, mothers completed the Difficulties with Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) for maternal ED and the Parental Acceptance and Action Questionnaire (PAAQ; Cheron et al., 2009) for maternal experiential avoidance. Maternal RSA was assessed from a 5 minute resting baseline. At T2, mothers completed the Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006) to assess their infant's NA. In a multiple regression model, T1 DERS predicted T2 child NA, over and above T1 RSA ($b = 0.30$, $p = .021$, adj. $R^2 = 0.05$). However, when T1 parenting experiential avoidance was entered into the model, the T1 DERS to T2 child NA relation became non-significant, and parenting experiential avoidance predicted T2 child NA over and above other T1 factors ($b = 0.27$, $p = .024$, adj. $R^2 = 0.10$). We also conducted two moderation models with PROCESS in SPSS (Hayes, 2013) in which T1 ED (DERS or RSA) predicted T2 child NA, as moderated by T1 parenting experiential avoidance. Neither perceived ED nor RSA interacted with parenting experiential avoidance to predict later child NA. Given this set of results and the completed data collection of all measures across three time points within the infant period in the larger study, we will examine a comprehensive longitudinal mediation model (general ED to parental experiential avoidance to infant NA) for the conference presentation. Maternal experiential avoidance in response to infant NA may be more relevant to infant ED development than more general maternal ED capacity. This study has implications for both the parenting and emotion literature, and has the potential to inform infant ED theory.

P1-I-177 - Mother-Infant Touch During Perturbed Interactions: Associations with Maternal Depressive Symptomatology and Infant Crying (Mercuri)

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Touch is an important means through which mothers and infants co-regulate during periods of stress or perturbation. Infant crying represents a crucial context that provides dyads with the opportunity to engage in the mutual regulation process and is a potent communicative cue which both reflects and creates moments of disruption for the dyad (Augustine & Leerkes, 2019; Horowitz et al., 2019). Although maternal and infant touch are central to the mutual regulation process, and infant crying is a common yet powerful period of disruption, tactile synchrony (i.e., degree of coordination between mothers' and infants' respective touching behaviours) has yet to be examined during the bouts of crying that occur throughout mother-infant interactions (Field, 2010; Harder et al., 2015). Furthermore, research has demonstrated that exposure to postpartum depression is associated with less emotional repair, more prolonged periods of negative affect, and more time needed to repair mismatches in their emotional states (Feldman et al., 2009). Postpartum depression may therefore place mother-infant dyads at-risk in terms of their ability to repair disruptions throughout their interactions (Granat et al., 2017). As such, an investigation of tactile synchrony within the context of infant crying is warranted for typically developing

dyads and those at-risk via maternal depressive symptomatology. The present study examined the synchrony of maternal and infant touching behaviours among 41 mother-infant dyads, some of whom were deemed at-risk due to high levels of maternal depressive symptomatology according to the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). Mothers and their 4-month-old infants participated in the Still-Face (SF; Tronick et al., 1978), and Separation (SP; Field et al., 1986) procedures. Both procedures consisted of two normative mother-infant interactions whereby dyads interacted naturally, separated by periods of emotional (i.e., maintained neutral facial expression without vocal or tactile contact; SF) or physical (i.e., absent from infant's field of view; SP) maternal unavailability (Ntow et al., 2021). Infant crying was measured across procedures and investigated as a brief period of perturbation. Interactions were video recorded and coded second-by-second using reliable and systematic observational coding systems of maternal and infant touching behaviours, i.e., the Caregiver Infant Touch Scale (Jean et al., 2009) and the Infant Touch Scale (Moszkowski & Stack, 2007), respectively. Results revealed that mothers and infants displayed a positive pattern of tactile synchrony (i.e., coordinated changes in touch) during infant crying episodes. However, dyads in the high depression group displayed significantly less affectionate touch during instances of infant crying. Furthermore, more depressive symptoms were associated with less maternal and infant touch and lower rates of infant crying. This group of dyads may be less expressive via touch, be less affected by disruptions in their interactions, have impaired regulatory abilities, or simply require minimal amounts of touch to mutually regulate following social stressors and during brief perturbation periods. These findings enrich our limited knowledge about the dynamic interplay of maternal and infant touch within the context of typical disruptions during their interactions (i.e., infant crying) and inform preventative intervention programs for at-risk groups.

P1-I-178 - A Vote of Conscience: Investigating the Early Development of Guilt and Shame in an Online Context (Rose)

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Individuals frequently commit transgressions against those close to them. In response to these transgressions, children typically manifest one of two distinct responses: they experience guilt leading to reparative behaviours such as accepting responsibility for wrongdoing, or shame, which motivates avoidance of the victim and has been linked to maladaptive outcomes, including preschool-onset depression (Ferguson & Stegge, 1995; Luby et al., 2009). Although the exact timing and nature of the emergence of guilt and shame is under debate (Kochanska et al., 2002), some evidence suggests that, at least as measured by experimental tasks, these constructs are separable starting in the second year of life (Drummond et al., 2017). To gain traction on when and whether children's response to transgressions diverge, we investigated children's guilt and shame approaches using three virtual methods: an experimental task, a parental questionnaire, and a parental interview. 30- to 36-month-old toddlers (N = 24, M = 32.13 months) participated in a virtual version of the broken toy paradigm (Barrett et al., 1993), wherein they were led to believe they broke a teddy bear (Figure 1); children's guilt- (i.e. taking responsibility and fixing) and shame-specific (i.e. postural adjustments) behaviours in response to this transgression were coded. During the parental interview, parents were asked to speculate on their children's responses to a hypothetical "parent mishap" wherein their child broke their cell phone; these responses were coded in terms of whether they reflect guilt or shame on the child's part. Parents also

completed select items from the My Child Questionnaire that assesses parents ratings of toddlers' typical responses to transgressions, with some items assessing specific guilt behaviors and others assessing specific shame behaviors (these were similar to those which were coded from the paradigm; Kochanska et al., 1994). Within each measure, interrelations between guilt and shame scores were investigated. The relationship between guilt and shame varied according to the measure. In the broken toy paradigm, children who lowered their head in shame were marginally less likely to take responsibility for the broken toy (M = 0.63, SD = 0.52) than those who did not lower their head (M = 1.19, SD = 0.98), t(22) = 1.84, p = .080 (Figure 2). Indices of guilt and shame in the questionnaire were primarily unrelated (all p's > .131). During the parental interview, parents only reported guilt specific responses; no shame specific responses were provided. These results provide support for the claim that guilt and shame are not related, but leave open the question of whether these two constructs are predominantly separable from one another, or whether they are inversely related. In doing so, these results highlight the importance of assessing children's responses to transgressions across multiple measures.

P1-I-179 - Maternal-reported child anxious problems at age 3: The impact of child fear, child IC, and maternal intrusiveness (Zerrouk)

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Anxiety is a negative force that can limit the ability to adapt to the social world. Both child internal factors (Lee & Rebok, 2002) and maternal factors (Galbally et al., 2020; Spence et al., 2002) impact child anxiety behaviors. An internal child factor, fearful temperament, has shown to be associated with internalizing behaviors (Buss, 2011; Biederman et al., 2011; Schwartz et al., 1999). Evidence suggests that child fear is a strong predictor of the onset of pediatric anxiety disorders (Buss & Kiel, 2013). Another child factor is inhibitory control (IC), an aspect of self-regulation, that is defined as the ability to override a strong internal predisposition or external lure (Diamond, 2013). Studies typically assess IC as a moderator for internalizing behaviors (He et al., 2010). A study by Eisenberg (2009) found that higher levels of IC predicted for fewer internalizing symptoms. Maladaptive forms of parenting can induce child anxiety (Abstand et al., 2017). Intrusive parenting behaviors may play a role in maintaining children's anxiety for children experiencing negative emotions (Dadds & Barret, 2001; Vince-Cooper et al., 2014; Wood et al., 2003). Observational methods, such as parent-child interaction tasks, garner great reliability in assessing parenting constructs (Vince-Cooper et al., 2014; Wood et al., 2003). We focused on child fear and IC in typically developing 2-year-olds and maternal intrusiveness (n=182) to investigate how maternal intrusiveness impacts the relation between earlier aspects of child fear and IC with anxious behaviors at age 3. Child fear and IC were both maternally reported via the Early Childhood Behavior Questionnaire (ECBQ). Child anxious behaviors were maternally reported via the Child Behavior Checklist (CBCL). Maternal intrusiveness was measured via a mother-child interaction puzzle task at age 3. A two-step hierarchical regression model was conducted via SPSS 26 (see Table 1). Step 1 included child fear, child IC, and maternal negative behaviors predicting child anxious behaviors (R2=.166, F=11.776, p<.001). Step 2 included the same predictors with the addition of two interaction variables between child fear and child IC respectively with maternal intrusiveness (R2=.193, F=8.443, p<.001). The change in R2 from step 1 to step 2 was 0.28 and approached significance (F=3.038, p=.050). Maternal intrusiveness (beta=.174, p=0.15), child fear (beta=.310, p<.001), and child IC (beta=-.165, p=.018) were

significant as main effects. Greater child fear and maternal intrusiveness, along with lesser child IC predicted for greater anxious behaviors at age 3. The interaction between maternal intrusiveness and child fear was significant (beta=.173, p=.015). Figure 1 shows that children with respectively high levels of fear and maternal intrusiveness indicate greater anxious behaviors. There was no significant interaction between maternal intrusiveness and child IC (beta=.049, p=.503). Results support previous findings and suggest that children with high levels of temperamental fear and greater maternal intrusiveness are at a greater risk for developing anxious behaviors in early childhood. While low levels of maternal intrusiveness may be a protective factor.

P1-I-180 - Social interactions during COVID-19: Infants´responses to masked and unmasked smiling faces (Kammermeier)

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The COVID-19 pandemic has led to dramatic changes in the lives of people all around the world. Measures to reduce the risk of COVID-19 infections range from lockdowns to social distancing to wearing face masks. Although an effective hygienic measure, the covering of parts of the face with masks reduces the accessibility to facial information during face-to face interactions. As emotional facial expressions convey information regarding others' current intentions in social interaction and their orientation toward the relationship (Keltner & Haidt, 1999; Van Kleef, 2009), it is a critical question how wearing masks impacts emotion recognition and communication in young children. While recent developmental research has focused on effects of mask wearing on children's emotion recognition (Gori et al., 2021; Ruba & Pollak, 2020), very little is known about how covering parts of the face might impact infants' understanding of and reactions to others' facial emotional expressions. The current study investigated this question in a sample of 6-month-old infants who were born during the pandemic (April 2020 - April 2021). In two conditions, an experimenter smiled at children while either wearing a surgical or FFP2 mask (Mask condition) or not wearing a mask (No Mask condition). Children's emotion expression (i.e., negative, neutral, positive) was evaluated during a neutral phase (i.e., experimenter displayed a neutral facial expression) and during a subsequent test phase (i.e., experimenter was smiling). First analyses showed that in the Mask condition (n = 65) 45 percent of infants and in the No Mask condition (n = 58) 48 percent of infants showed a positive response (i.e., started to smile back at the experimenter) in the test phase. There was no significant difference in children's emotion responses between the Mask and the No Mask condition. These data suggest that young infants were able to process others' positive emotional signals in face-to-face interaction and to respond in a reciprocal manner even when parts of the faces were covered. This study provides first evidence that infant's social interactions may not be as severely impaired by current COVID-19 restrictions as when it comes to positive expressions of others.

P1-I-182 - Associations Between Temperament and ASD-Related Characteristics in The First and Second Year of Life (Wagner)

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Differences in temperamental profiles have been found in children with and without autism spectrum disorder (ASD), with higher negative affectivity and lower surgency and effortful control found in ASD (for a review, see Chetcuti et al., 2021). Prospective studies of infants with a family history of ASD have also identified infant temperamental traits that are associated with a later ASD diagnosis, including increased negative affect and lower surgency (e.g., Paterson et al., 2019). The current study extends past work to look at dimensions of temperament and levels of ASD-related characteristics during infancy and toddlerhood to better understand concurrent and predictive relations in children with no family history of ASD. Thirty-five infants participated at one or more time points between 6 and 24 months old. Caregivers completed the Autism Parent Screen for Infants (APSI; Sacrey et al., 2016) at 6, 9, 12, 18, and/or 24 months, a measure of ASD-related characteristics, the Infant Behavior Questionnaire (IBQ; Rothbart, 1981) at 6, 9 and/or 12 months, a measure of infant temperament, and the Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006) at 18 and/or 24 months, a measure of toddler temperament. By averaging available scores, APSI from 6, 9, and/or 12 months was used to calculate APSI:6-12mo, and APSI from 18 and/or 24 months was used to calculate APSI:18-24mo. For temperament, 6-, 9-, and/or 12-month IBQ was averaged for the 6 primary dimensions (Activity Level, Smiling/Laughter, Fear, Distress to Limitations, Soothability, Orienting) to create IBQ:6-12mo scores; 18- and/or 24-month ECBQ was averaged for the 3 primary factors (Negative Affectivity, Surgency/Extraversion, Effortful Control) to create ECBQ:18-24mo scores. When looking at concurrent associations between ASD-related traits and temperament, APSI:6-12mo was positively associated with IBQ:6-12mo Activity Level and Distress to Limitations and negatively associated with IBQ:6-12mo Smiling/Laughter (ps < .05; see Figure 1). APSI:18-24mo was positively associated with ECBQ:18-24mo Negative Affectivity ($r(25) = .56$, $p = .002$) and negatively associated with ECBQ:18-24mo Effortful Control ($r(25) = -.43$, $p = .026$; see Figure 2). When examining predictive associations between early temperamental traits and later ASD-related characteristics, IBQ:6-12mo Activity Level was positively associated with APSI:18-24mo ($r(19) = .51$, $p = .019$); however, this relationship was non-significant after controlling for APSI:6-12mo ($p = .15$). The current study examined temperament and ASD-related traits in infants with no family history of ASD. In both infancy and toddlerhood, concurrent associations were found between greater ASD-related traits and a) greater negative temperament dimensions (i.e., distress, negative affect) and b) lower positive temperament dimensions (i.e., smiling/laughter, effortful control), consistent with past work with children with ASD (e.g., Macari et al., 2017) and infants with a family history of ASD (e.g., Garon et al., 2009; Paterson et al., 2019). Temperament in the first year of life did not predict ASD-related characteristics in toddlerhood over and above the influence of infant ASD-related characteristics. Future work will expand the current sample to allow for examination of age-related trajectories of infant temperament as predictors of later variability in ASD-related traits.

P1-I-183 - Emotion Regulation and Caregiver Perceptions of Child Personality During Pregnancy and at Age 6 Months (Bailes)

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Caregiver representations form during pregnancy and are longitudinally associated with subsequent caregiving behaviors and the quality of the caregiver-child attachment (Benoit et al., 1997; Holden & Smith, 2019; Huth-Bocks et al., 2011). Internal working models of the child are assessed through the Working Model of the Child Interview (WMCI; Zeanah et al., 1996). Caregivers provide personality

characteristics of their child, which can be coded to assess the emotional tone of the descriptors. Guyon-Harris and colleagues (2021) found that pregnant people who used more words with a negative emotional tone when describing their unborn child were less sensitive and warm during caregiver-child interactions when infants were age 12 months. Negative personality attributions for the child may be a marker of risk for insensitive caregiving, infant mental health theory suggests that this may be a causal association (Stern, 2018), making descriptions about their child an important potential target for intervention. Thus, determining which parents are most likely to have negative descriptions of their child is critical. Theoretical and empirical work indicates emotion regulation contributes to caregivers' cognitive processes (Crandall et al., 2015; Leerkes & Augustine, 2019; Milner, 1993). Emotional suppression as a regulation strategy impedes the expression of both positive and negative emotions (Meyer et al., 2014), which may affect feelings of delight and admiration for one's child. In the current study, we examined stability of emotional tones of caregivers' personality descriptions of their child from the prenatal period to age 6 months and whether different emotion regulation strategies were associated with the emotional tone used over time. Interviewers administered the WMCI to participants during pregnancy (N=260) and at 6 months postpartum (N=129) (longitudinal data collection is ongoing). Participants provided up to five personality descriptors of their child which were coded for positive and negative tone using sentiment analysis (LIWC; Pennebaker et al., 2015). At pregnancy, participants completed the emotion regulation questionnaire (ERQ; Gross & John, 2003) which assesses emotion suppression and reappraisal. We observed moderate stability from the pre- to postnatal period for both positive and negative words (Table 1). Emotion regulation strategies were entered into regression models independently to predict proportion of positive and negative words during pregnancy and at infant age 6 months (Table 2). Emotion suppression was associated with a higher proportion of negative words in pregnancy. Emotion suppression also emerged as a predictor of lower positive emotion words at infant age 6 months. Emotion reappraisal was not associated with personality descriptors at either time. Results demonstrate emotional suppression in caregivers is relevant for understanding variation in cognitive representations of children. Most interesting, while pregnant participants' emotion suppression was associated with negative beliefs about their unborn child's personality, the link to lower attributions of positive traits was not present until the infant was born. This study adds to work suggesting, although emotion suppression is a commonly used strategy, there may be consequences for caregivers' thoughts about their baby prior to birth and may become more salient when the parent develops a relationship with their infant.

P1-I-184 - Autonomic Nervous System Maturation and Emotional Coordination in Interactions of Preterm and Full-Term Infants with their Parents (Kokkinaki)

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Objectives: There are four objectives in this study: The first objective is to investigate the relationship between emotional coordination and HRV in dyadic full-term infant-parent (Group 1) and preterm infant-parent (Group 2) interactions in the course of the first postpartum year. The second objective is to examine the relationship between emotional coordination/and HRV in Group 1 and 2 in the first postpartum year to developmental outcomes of infants at 18 months. The third objective is to investigate the role of maternal and paternal postnatal depression on the relation between emotional coordination and HRV in the two Groups and with developmental outcomes at 18 months. The fourth

objective is to examine the role of family cohesion and coping on the relation between emotional coordination and HRV in the 2 Groups and with developmental outcomes at 18 months. Methods: All mothers (with their partners) of full-term and preterm infants who will give birth between March 2021 and April 2022 at the General University Hospital of Crete (northern Crete, Greece) will be invited to participate in the study. The researcher will invite the parents of infants to participate in the study 1-2 days after birth. This is an observational, naturalistic and longitudinal study applying a mixed-method design which includes:(1) video-recordings of mother-infant and father-infant interactions at hospital, at the neonatal period, and at home at 2, 4, 6, 9, and 12 months of infants' life.; (2) self-report questionnaires of parents on depressive symptoms, family cohesion and dyadic coping of stress;(3) infants' HRV parameters at the neonatal period and at each of the above age points mentioned; and (4) the assessment of toddler's social and cognitive development at 18 months through an observational instrument. Analysis Plans: For the first objective of this study, each full-term neonate/infant-parent dyad will be video-recorded at 6 age points [neonatal period (at the hospital) and at 2, 4, 6, 9 and 12 months at the family's home]. A validated portable ECG device will be used to collect ECG recordings. For the second objective, at 18 months, the social and cognitive development of toddlers will be assessed at home by the administration of the Bayley Scales of Infant and Toddler Development, 3rd edition. For the third objective, parents will be asked to complete: a) the Edinburgh Postnatal Depression Scale (EPDS) adapted for the Greek population (at 2 months) and; b) the Beck Depression Inventory-II (BDI-II) (at 18 months).For the fourth objective, at 2 and 18 months, parents will be asked to complete: a) the Greek version of the Family Adaptability and Cohesion Evaluation Scale (FACES-IV Package), and b) the Greek Version of the Dyadic Coping Inventory - CDI. Implications: The findings of this study may extend our understanding on the early onset of adverse developmental outcomes of premature infants given that these may be related to autonomic nervous system maturation.

Poster Session 02

P2-A-185 - Baby Walks, Mama Talks: Caregivers' Verb Use Corresponds to Infants' Locomotion (Saleh)

Annissa Saleh[1], Kelsey West[2], Karen Adolph[2], Catherine Tamis-LeMonda[2]

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Caregivers tailor their moment-to-moment language to infants' ongoing actions (e.g., Custode & Tamis-LeMonda, 2020; West & Iverson, 2017). For example, caregiver says, "Go get the ball!" as infant plays with a ball (West et al., 2021). Consequently, when infants develop new motor skills, caregivers' language may also change. As infants learn to walk, caregivers may increasingly refer to locomotor actions, using words like "come," "go," "step," and "walk." We tested whether locomotor verb use differed for mothers of same-aged crawling and walking infants, and mothers of a group of older experienced walkers. We video recorded 32 infant-mother dyads (Ns = 16 13-month-old crawlers, 16 13-month-old walkers, and 16 18-month-old walkers) during two hours of naturalistic activity at home. Caregivers were instructed to go about their day as they usually would. Videos were transcribed verbatim and coded for mothers' locomotor verbs ("bring," "go," "climb"). We also coded the time infants spent locomoting (crawling or walking) by identifying the beginning and end of each bout of spontaneous locomotion. In addition, we measured infants' locomotor experience: caregivers reported on the date of infants' crawl onset: the first day that caregivers observed their infant crawl without stopping or falling for 3 meters. Mothers directed a greater number of locomotor verbs to walkers compared to crawlers. The 13- and 18-month-old walking infants received nearly double the amount of

locomotor verbs (M's = 27.27 and 26.17; SD's = 9.36 and 12.63, respectively) compared to 13-month-old crawlers (M = 15.58, SD = 8.78), F(2, 48) = 6.16, p = .004 (Figure 1A). Infants' locomotor experience (i.e., the number of days elapsed since crawl onset) was not correlated with caregivers' locomotor verb use, r = .07, p = .66. However, infants' real-time locomotion (how much infants actually moved in the moment, regardless of their status as a crawler or walk) was related to their mothers' verb use, r = .41, p = .004, even when controlling for locomotor experience. Thus, when infants spent more time moving, they heard more locomotor verbs, and when infants spent less time moving, they heard fewer locomotor verbs, regardless of infant age (Figure 1B). Findings provide compelling support that infants' developing motor skills shape their moment-to-moment behavior, and as a result, their language environment. Thus, the verbs that infants hear are related--both in the moment and over developmental time--to infants' motor actions. Each new motor skill that infants acquire--like learning to walk, climb, ride a scooter, build Lego blocks, kick a soccer ball--offers new opportunities for social interactions and consequently, for language learning.

P2-A-186 - On the move toward word learning: How infants' real-time body position shapes their views during word learning (Benacerraf)

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Infants spontaneously transition among a variety of body positions. For example, babies spend time sitting, prone (stationary or crawling), and upright (standing, cruising, or walking), and they transition among the different postures. Does infants' body position influence their opportunities for word learning? Previous work shows that infants' body position influences what babies can see (Kretch, et al, 2014; Franchak et al, 2018). In a crawling position, infants' view is dominated by the floor in front of their hands. But when infants sit or stand upright, the whole room sweeps into view and infants can see distant destinations. We propose that infants' body position shapes what they can see, and consequently different body positions offer different visual input during word learning. We video recorded 16 mother-infant dyads (all 13-month-olds, half crawlers, half walkers) during 10 minutes of free play in a laboratory playroom stocked with toys. Both infants and parents wore head-mounted eye-trackers to record their field of view and visual attention. We coded each time caregivers named an object and specified whether that object was close (within arms' reach) or far from infants. Crawlers spent most of the 10-minute session in a sitting position (M=9.31 minutes, SD=13.35) and less time in crawling (M=3.18 minutes, SD=2.79) and upright positions (M=2.56 minutes, SD=1.13). Conversely, walkers spent most of the session upright (M=8.34 minutes, SD=4.10), less time sitting (M=3.27 minutes, SD=2.75), and were rarely in prone (M=0.49 minutes, SD=0.33). Because walkers had greater access to the room and objects, they heard more nouns (M=14.50, SD=13.26) than did crawlers (M=10.00, SD=9.27). Caregivers of crawlers (M=4.57, SD=2.70) and walkers (M=4.12, SD=2.23) were equally likely to refer to distant objects. However, caregivers of walkers (M=10.37, SD=12.29) referred to close objects far more often than did caregivers of crawlers (M=5.42, SD=7.27)--presumably due to walkers' increased ability to approach more toys. For crawlers, infants' body position was unrelated to their caregivers' noun use. Crawlers heard similar rates of nouns while upright (M=0.65 nouns per minute, SD=0.56) and in prone (M=0.62 nouns per minute, SD=0.98) and sitting (M=0.54 nouns per minute, SD=0.62). Conversely, walkers heard greater rates of nouns while upright (M=1.02 nouns per minute, SD=0.91) compared to while prone (M=0.00 nouns per minute, SD=0.00) or sitting (M=0.34 nouns per minute,

SD=0.44). We are currently documenting whether and how prominently the referents of naming events appear in infants' view when objects are named, and whether and for how long infants fixate the target object. The connection between infants' body position and naming events suggests that walkers have an advantage for language learning. Because walkers have better visual access to both the room and the toys around them, they are likely to access a greater variety of objects than crawlers. In turn, caregivers are more likely to name a variety of objects. Infants' visual attention to the named objects would confer an even greater advantage.

P2-A-187 - How do infants learn adjectives? Caregivers describe the objects of infants' play (Rampersaud)

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How do infants learn language? Infants can only learn the words they hear from other speakers. Previous work shows that caregivers' words frequently correspond to infants' moment-to-moment behaviors. Specifically, caregivers' nouns and verbs correspond to infants' actions with objects (e.g., "apple" as infant eats an apple, or "stack" as infant stacks blocks). The tight temporal coordination between infants' self-generated actions and the words caregivers direct to them provides an ideal opportunity for infant word learning. However, it is unknown whether caregivers' adjective use also corresponds to infants' actions with objects. Presumably, adjectives are especially difficult to learn because the target characteristic is perceptually different depending on context. Indeed, infants learn adjectives later than nouns and verbs. As a case study for adjectives, we documented whether caregivers' color words correspond to infants' concurrent actions with objects. For example, do caregivers say "red" as infants play with a firetruck, or "orange" as infants eat a Cheeto? We collected 2-hour long recordings during natural activity at home of 53 caregiver-infant dyads split into three age groups (Ns = 20 13-month-olds, 16 18-month-olds, and 16 23-month-olds). We transcribed every color word caregivers said. Most mothers (51 of 53) said color words at least once, but they varied widely in their frequency of color words (range = 0-90). Color words were similarly frequent for 13- (M=19.60, SD=20.32), 18- (M=30.19, SD=26.68), and 23-month-olds (M=23.82, SD=21.15), $F(2,52) = 1.12$, $p = .33$ (Figure 1). During the 3 seconds surrounding each color-word utterance, we scored the color of the objects infants touched (8 chromatic and 3 achromatic colors). Caregivers' chromatic color words frequently mapped onto the objects of infants' play (Figure 2), but real-time correspondence was also marked by mismatches that may feed into ambiguity. Indeed, for 40% of chromatic color utterances, infants simultaneously touched an object of the corresponding color. However, achromatic color words were less systematically coordinated with infants' object play. We are further documenting the temporal ordering of mothers' utterances relative to infants' object play. For each instance when mothers' color word corresponded to infants' play, we are coding whether mothers used the color word to comment on an ongoing infant action, or whether the mothers' utterance prompted the infant to touch the object. Furthermore, we are investigating the context of mismatches between caregivers' color words and objects of infants' touch (e.g., when mother said "red," but infant was not touching a red object). We predict that mismatches arise from moments when moms use color words during decontextualized speech (i.e., using color words to refer to something not physically present). For example, we predict that mothers use color words when referring to past or future experiences (e.g., "remember when we saw the pink flamingos"), songs (e.g., "Baba Black Sheep"), or metaphorical

phrases (e.g., "feeling blue"). Ultimately, the correspondence between infants' actions and caregivers' language likely facilitates early word learning. Documenting the contexts in which infants hear color words contributes to researchers' current understanding of how infants learn adjectives.

P2-A-188 - Modeling objective measurements of homophilic movement patterns in a naturalistic environment (Banarjee)

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Objective: Homophily, the tendency for individuals to preferentially interact with others similar to themselves, is typically documented via self-report and, for infants, adult report. In this study, we use automated measures of position and orientation in preschool classrooms to quantify homophily through the following dyadic measures: (1) social approach, quantified as a weighted measure of movement toward each peer and (2) time in social contact with each peer. Methods: 77 infants (M=48.26 months, SD=7.47), including 47 infants with developmental disabilities (DD), and 30 typically developing (TD) infants were observed in 8 inclusion preschool classrooms. Each child was observed on 3.52 mean occasions (SD=1.32) for a duration of mean 138.2 minutes (SD=63.6) on a total of 26 days. Objective measurements of position and orientation were collected using ultra-wide radio frequency identification (Ubisense) sensors, which tracked a right and left tag worn by each child in a specially designed vest. Social contact was defined as fulfilling the criteria of distance between 0.2 and 2 meters and relative orientation within 45° and computed as a proportion of available time with each peer. Social approach was computed as the distance each child moved toward (or away from) the initial position of each peer, weighted by distance, orientation, and angle of movement. Both measures of interaction were analyzed using linear mixed effect models, with a term for the type of one child in the pair as with (DD) or without (TD) disabilities and a term for the homophily status of the pair as concordant (DD-DD, TD-TD) or discordant (DD-TD). Results: Infants in concordant dyads (DD-DD, TD-TD) exhibited greater time in social contact ($p<.001$) and higher approach velocities ($p<.001$) than discordant dyads (DD-TD), evidencing homophily in the preschool classroom. DD-DD dyads were in social contact less than TD-TD dyads ($p<.001$), but were comparable to TD-TD dyads in their social approach velocities. In addition, infants with DD were approached by other infants in the classroom at lower velocities than TD infants ($p=0.038$), but did not differ from TD infants in social contact ($p=.987$), a social preference effect evident in the movement, but not locations, of infants in the classroom. Conclusions: Movement is central to the initiation, maintenance, and termination of social interactions, and supports the physical exploration of the environment. Examining movement in the preschool classroom highlighted the role of the dyad. The tendency to seek out similar partners was evident in the approach velocities and social contact preferences of TD and DD infants. Infants with and without disabilities approached infants similar to themselves (i.e., DD-DD and TD-TD) at higher velocities and were in social contact more than dyads in which one child had a disability and the other did not (DD-TD). Infants' preference for similar peers in their movement and proximity to one another appears to be a pervasive feature of their naturalistic interactions, indicating homophilic patterns of movement and colocation at an early age in inclusion classrooms. Additionally, infants with disabilities were approached at lower velocities than TD infants, suggesting difficulties in social interactions with same-age conspecifics. The results suggest the potential

of a new generation of objective measures to quantify strengths and deficits in social interaction in naturalistic contexts.

P2-A-189 - Experimentally Manipulating Infants? Actions Affects Caregivers? Verb Input (Manikkan)

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Infants' motor skill attainments often co-occur with advances in infant communication and language learning (see Iverson, 2021 for review). However, prior work cannot determine whether infants' motor behaviors have a direct causal effect on their language learning through changes in the words infants hear, or whether the timing in development is coincidental. Here, we tested whether experimental manipulation of infants' moment-to-moment motor actions influences caregivers' language input. We observed N = 32 caregiver-infant dyads (12- to 20-month-olds) in two within-subject experimental toy play conditions in a laboratory playroom. Dyads played freely with either: (1) locomotor toys designed to get infants to move around (e.g., pushcart, broom, and balls) or (2) manual toys designed for infants to play in a stationary position using their hands (e.g., shape-sorter, stacking bricks, toy xylophone). We documented the frequency and variety of verbs that caregivers spontaneously said in each condition. Our manipulation of toys indeed affected infants' locomotion, with infants being more likely to move about or remain stationary depending on toy conditions. Most centrally, Caregivers' verbs closely aligned with infants' actions. Caregivers used more whole-body verbs like "come," "bring," and "walk" when infants played with locomotor toys (Figure 1A) (M = 11.57, SD = 8.05) compared to infants' play with manual toys (M = 3.37, SD = 3.20). Likewise, caregivers used more manual verbs like "stack," "press," and "open" when infants played with manual toys (M = 17.33, SD = 12.38) compared to infants' play with locomotor toys (M = 9.73, SD = 10.08; Figure 1B). A repeated measures ANOVA confirmed an interaction between verb type and toy condition $F(1, 29)=85.95$, $p < .001$. Our findings constitute the first experimental evidence that manipulating infants' real-time motor actions has a causal, cascading effect on the language infants hear. We are further investigating the extent to which caregivers' action verbs refer to objects; that is, whether verbs are transitive (e.g., "Get your ball"), pseudo-transitive (e.g., "Can you stack?"), or intransitive (e.g., "go, go, go") in the two toy conditions. We are documenting the specific object each verb references, and the objects' distance relative to the infant at the time caregivers use the verb. We predict that manual verbs will be transitives or pseudo-transitives and the referent objects will be within infants' arms reach. We predict that whole-body verbs will comprise a mixture of transitives, pseudo-transitives, and intransitives, and will reference objects that are both near and far from infants. Finally, we are analyzing the temporal and spatial coordination between caregivers' nouns and infants' actions on objects. We predict that caregivers will be more likely to label objects within a few seconds of infants' play with the referent and when objects are close to infants. Theories of language development should consider infants' language experiences and word-learning processes within the context of motor development. Each new motor skill opens up new opportunities for verb learning.

P2-A-190 - Does manipulation complexity from 9 to 14 months predict language ability at 36 months (Contino)

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Objective: Early experiences in one domain may result in cascading changes in other domains. Motor development during infancy provides opportunities for social interactions in a changing environment, which in turn, has been linked to the emergence of language and communication (Iverson, 2021). Hand use for one manual skill, role-differentiated bimanual manipulation (RDBM), has been shown to predict later language outcomes, but what is it about this behavior that promotes motor-language cascades? (Gonzalez et al., 2020). RDBM requires differentiation between the actions of both hands, and the level of differentiation increases across development. RDBM trajectories change rapidly during infancy and represent an important shift in infant manual skills (Babik & Michel, 2016). To better characterize the complexity of RDBM, we adapted a coding method of scaling manipulation complexity from the nonhuman primate literature (Heldstab et al., 2020). The objective of the current study was to characterize infants' interactions with objects over a 6-month period from 9 to 14 months when RDBM emerges and becomes increasingly complex. Using the theoretical framework of developmental cascades, we then examined whether infants' manipulation complexity scores could predict later language performance at 36 months. Methods: Ninety typically developing monolingual English infants (N=90; 47 male, 43 female) were assessed for manipulation complexity (MC) at 6 monthly visits from 9-14 months of age from a battery of 14 objects. MC data were coded offline using a custom template in Microsoft Excel. MC was scaled from 1-8 based on all possible combination of the following actions: (i) unimanual or bimanual manipulation; (ii) synchronous or asynchronous use of the hands; (iii) dependent or independent finger use; and (iv) in objects that contain two pieces, whether the hands manipulated one object or multiple objects (Heldstab et al., 2020). A MC score of "1" indicated the infant used one hand to manipulate one object without independent finger movement, whereas a MC score of "8" indicated that the infant used both hands to manipulate more than one object/object part with independent finger movement. Average MC scores from each month were used in analyses. Trained observers administered the Preschool Language Scales 5th edition (PLS-5; Zimmerman et al., 2011) when children were 36 months old. The PLS-5 is a standardized assessment that measures a child's receptive and expressive language abilities. Standard scores from the PLS were used in analyses. Motor-language correlations were examined with SPSS. Results: One-third of the sample has been coded for MC (N=30). Preliminary analyses revealed that 36-month PLSAC (receptive language) scores was positively correlated with 9-month MC. However, there was no correlation between 9-month MC and 36-month PLSEC (expressive language) scores, and no other infant MC timepoints predicted later language (see Table 1). Conclusions: Interim findings suggest that infants' MC scores may be a better predictor of receptive, rather than expressive language, at 36 months. Motor-language relations may vary across manual action type, object type, language type, and developmental time. Analyses in the full sample will examine whether different manipulation complexity profiles predict later language.

P2-A-191 - Facilitators between infant walking and vocabulary increases: Gestural communication and object exploration (He)

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A surprising discovery linking infant walking with receptive and productive vocabularies has been replicated cross linguistically, cross culturally, using both parental report and recording device, as well as

in infants with general language delay (Walle & Campos, 2014; He et al., 2015; Walle & Warlaumont, 2015; West et al, 2017). Research on the functional consequences following the onset of walking suggests some possible mechanism underlying this link between infant walking and language development (Clearfield, 2011). For instance, walking may afford more opportunities for the infant to interact with the physical world, especially objects in a distance, or to bid for attention with the social partner, thus creating an enriched setting for word learning (Karasik et al., 2011). In infancy, both gestural use and the ability to engage in joint attention are crucial for language learning (Salo et al., 2018). Since the onset of walking frees up both hands for gesturing (Clearfield et al., 2008) and expanded visual field (Karasik et al., 2011), could gestural use and joint attention be the mediators for word learning? The current study aims to explore whether infant walking is associated with 1) improved capacities to follow an adult's signal and to initiate joint attention with an adult, 2) increased exploratory behaviors with objects in a distance; 3) whether changes in gestural communication and exploratory behaviors mediate the link between infant walking and vocabulary increases. Sixty-five typically developing infants between 13.5 and 15 months of age from Shanghai, China participated. Thirty-two were crawlers (12 female) and 33 were walkers (14 female). Locomotor status was confirmed in the laboratory. Crawling and walking groups did not differ in age or total locomotor experience. Consistent with the previous findings, parents of walking infants reported significantly larger receptive and productive vocabularies using MacArthur CDI than those of crawling infants. Parent-infant interaction was recorded in a 10-min free play session in the laboratory. Two independent assistants blind to the hypotheses coded the number of times when the infant 1) uses pointing or showing gestures to initiate joint attention, and 2) follows an object or event in response to the parent's signal. We also corded the frequency and duration when the infant 3) retrieves an object either from a proximal distance or in distal space that requires locomotion, and 4) transports an object with assistance from the object or carries an object in their hands. Results showed that walking infants were more responsive to an adult's signal and more likely to initiate joint visual attention, both at a marginal level. More specifically, walking infants did particularly well in using pointing gesture to share their interest. Walking infants were also much more likely to carry an object in hands, $t(64)= 4.88$, $p <.01$ and for longer time, $t(64) = 4.71$, $p <.01$, while crawling infants used transporting more often, $t(64) =2.38$, $p<.05$, and for longer time, $t(64)=2.59$, $p <.05$. Both the frequency and the duration of carrying an object were significantly correlated with receptive vocabulary while retrieving a distal object was significantly correlated with productive vocabulary. In sum, this study provided encouraging data that infant walking is associated with vocabulary growth and increased engagement in gestural communication and carrying behaviors. Carrying behaviors may account for word comprehension while accessing a distal object may be beneficial to expressive language. Further studies may yield great clinical implications for infants with autism whose language development could not benefit from walking onset.

P2-A-192 - Development of chopstick use in 2-3-year-old Chinese children (Yao)

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Development of Chopstick Use in 2-3-year-old Chinese Children Learning to use utensils for eating involves coordinating spatial and motor abilities to transport food. Eating is also typically shaped by social and cultural contexts. Unlike young western children, however, Asian children must learn to

control and manipulate chopsticks for eating. Although considerable research has examined how infants in western cultures learn to use eating utensils (e.g., spoons), the development of chopstick use in Asian infants remains understudied. To address this gap, we investigated how Asian, particularly Chinese, children gain proficiency in using chopsticks to transport food during eating. We videoed 15 children (ages 21- to 36-months-old; 8 girls) and their families during mealtimes in Guiyang, China, and collected information regarding the infants' handedness. Participants' self-feeding by chopsticks (transporting food from a serving plate or personal bowl to the mouth) was coded from video clips by using Datavyu (www.datavyu.org). During feeding events, we coded spatial features (chopstick alignment), motor skill (number of feeding events, eating strategies) and caregiver involvement to understand how these factors characterize changes in chopstick use during the early childhood period. Inter-oberver reliability for each of these variables was high (ICC= .98-.99, ps < .01). Results indicated that with respect to spatial factors, children correctly aligned chopsticks in 335 out of 378 total self-feeding trials that were coded. For the motor and caregiver factors, we found that the number of both self-feeding (p<.001) and independent-feeding (self-feeding, but without caregiver involvement; p=.03) events increased with age. These findings suggest that between two to three years of age, children are gaining more control over chopsticks and achieve more autonomy as they do so. Additionally, we found that children tended to use the chopsticks more exclusively as opposed to other motor strategies to obtain food as they became older. Eating strategies that did not involve chopsticks--use of bare hands or leaning over to eat directly from a personal bowl--tended to decrease with age (p<.1). Together, our findings provide new information about how very young children (between 21 to 36 months of age) gain proficiency in the use of chopsticks, utensils which are commonly used by more than 20% of the world's population. Data analyses are ongoing with a larger sample of children (N=49) to understand how children become proficient in chopstick use in the first few years of life.

P2-A-193 - Impact of sitting on manual behaviors and biases in early infancy (Garcia Mora)

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Early manual exploration proceeds from manual skills of touching to grasping that both offer infants fundamental characteristics of objects in their environment. As infants gain experience, they move towards more conducive manual strategies to explore their environment. Higher-order manual actions may be facilitated by fewer constraints sitting competency offers during manual exploration. Previous research has investigated the impact of postural positions like supine, prone, and sitting on manual exploration, revealing more manual object explorative behaviors while in a sitting position (Soska & Adolph, 2014). Therefore, the current study investigates whether sitting may affect the frequency of manual skill strategies in early infancy. Recruited at sitting emergence, 36 infants (M=5.7 months, range: 4.4-6.8 months) were assessed for grasping, touching, and holding objects. Infants were classified as a prop (PS) or an arms-free (AF) sitter. Both hands' grasping and touch behaviors were evaluated from a 30-second video recording of infants being presented with 1.5" cubic blocks. The frequency of grasp behavior was coded with a grip configuration using at least a thumb plus finger grasp while firmly holding the object (Newell et al., 1989). A proportion of right touches (M=0.490) and grasps (M=0.491) was calculated. Infants who were +/- 2 standard errors from the mean were classified as having biased (n=20) hand use, while all others were unbiased (n=17). Manual holding behaviors of both hands were evaluated from a video recording of infants being presented with four standard toys across 4 trials.

Infants were quickly presented with 4 object types (bead, foam, shape, figure), one-at-a-time, quickly to elicit multi-object holding. An object manual hold was coded when the infant's hands acquired at least one object or more. During both tasks, infants were buckled into a supportive chair to allow for free arms to interact with the objects. Utilizing a Mann-Whitney U, AF sitters (M=6.50) grasped objects more often with both their right ($p<0.01$) and left hands ($p<.040$), than PS (M=3.56). No group effects for touches, holds, proportion of right-hand grasps, or proportion of right hand touches were observed ($ps>0.25$). However, PS are more likely to be classified as biased for grasps (13/15; $\chi2(1)=7.823$, $p<0.01$), whereas AF is more equally distributed across bias groups (7/18). These findings further support the notion that sitting allows infants to explore their environment at higher frequencies. Freeing the hands from maintaining postural control allows infants to use their hands to explore objects, particularly bimanually. Moreover, our findings provide insight into how manual asymmetries shift following sitting emergence. Prop-sitters require at least one hand for support sitting, in turn biasing their hand use by using one hand for support and the other for manipulating objects. Other research has found effects of postural control for bimanual hand use with implications for handedness (Babik, Campbell, & Michel, 2013; Thelen & Spencer, 1998). Future research should investigate whether incremental changes in postural control change how hand use fluctuates and shapes trajectories of manual asymmetries.

P2-A-247 - Embodied attention across the transition from crawling to walking (Oudgenoeg-Paz)

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In recent years multiple studies have shown that the onset of independent walking sets cascades of effects in motion resulting in advances in multiple developmental domains. Specifically, independent walking attainment was shown to precede a spurt in vocabulary. A small number of studies have attempted to directly study the mechanisms underlying this relation and suggested that changes in caregiver input and in children's exploration behaviour may explain this relation. Moreover, recent research also shows that children learn words best when caregivers provide labels at moments of embodied attention, meaning that children hold an object in such a way that it dominates their visual field. One recent study found that the frequency of labelling during embodied attention increased with age and during active exploration. However, the question remains: what mechanisms drive this increase? As walking attainment is related to changes in exploration and caregiver-child interaction, the current study tests the hypothesis that labelling during embodied attention increases as children attain independent walking. Data collection for this study is still ongoing. Up to now data from 45 children has been collected, out of which 34 completed all measurements. All children were filmed at home during 20 minutes of free play with a caregiver. Each dyad was observed three times during 6 weeks. Parents reported weekly about motor milestones attainment and completed the Dutch version of the McArthur Bates CDI at the start and end of the study. Children were aged 10.50 to 13.40 months (M = 12.10, SD = .95) during the start of the study. For the current analysis we used data from children who could crawl at the start and attained independent walking during the study (n=10) and children who crawled throughout the study (n=14). Children who did not yet crawl or already walked at the first measurement were excluded. Additional data are still being collected and we expect a final sample size of about 80 children. All observations are coded to note moments of joint engagement, and noting who is holding the object at the moment of engagement. The verbal input of the parents is also coded to indicate whether they provide a label for the object attended to. If a label is provided when the child is holding

the labelled object it is considered labelling during embodied attention. Initial analysis confirms earlier findings showing a spurt in vocabulary after the attainment of walking. Descriptive analysis and repeated measures ANOVA (controlling for age) show that labelling during embodied attention increased in the interactions of the dyads where children started walking while it remained relatively stable in the interactions of the dyads where children were crawling throughout the study. Effect size is large (partial η2=.28). Initial results thus support the hypothesis that the attainment of walking facilitates an increase in labelling during embodied attention. This increase might (partially) explain the developmental cascade linking walking attainment with a spurt in vocabulary.

P2-A-248 - Physical positioning during dyadic play in preterm and full-term infants (Kretch)

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Infants born very preterm are at risk for developmental delays and disabilities. Preterm birth can also have detrimental effects on infant-caregiver interactions. Recent work has shown that for infants born full-term, the physical context of dyadic play shifts over the first year of life. Earlier face-to-face interactions decrease in favor of broader, angular orientations, and infants increasingly initiate changes in positioning as they get older and acquire new motor skills. But how these physical dynamics unfold in preterm infants is unknown. In the current study, we compared preterm and full-term infants throughout the first year of life to examine how infants and caregivers co-construct physical spaces for play. Data for full-term, typically developing infants (n=30) were drawn from a completed observational study, and data for preterm infants (current n=17, projected final n=30) were drawn from an ongoing clinical trial. Full-term infants were tested at 3, 6, 9, and 12 months chronological age, and preterm infants at approximately 3, 7, and 12 months adjusted age. Infants were videorecorded during five minutes of free play with caregivers. Videos were divided into 5s intervals for behavioral coding. For each interval, coders identified the dyad's spatial orientation (facing, right angles, back-to-front, or different) and the infant's posture (held, supine, prone, supported sitting, independent sitting, or upright). If more than one orientation or posture occurred during an interval, it was marked as a transition. For orientation transitions, coders scored which member of the dyad initiated the transition. Data were summarized for each infant as the proportion of intervals demonstrating each behavior, and generalized linear mixed models were used to estimate effects of group, age, and their interaction. Preliminary results revealed significant group differences in most outcomes. Whereas full-term infants demonstrated dramatic changes in orientation over development--less time facing and more time at right angles--preterm infants showed little change over time in either measure (group*age interaction ps<.02; Figure 1). All postures except prone significantly changed over time: Held, supine, and supported sitting decreased while independent sitting and standing increased (ps<.01; Figure 2). There were significant group effects and interactions for held, supine, independent sitting, and upright (ps<.01). Preterm infants spent more time held than full-term infants, especially at earlier visits. In contrast, full-term infants spent more time supine at 3 months but decreased quickly. At older ages, full-term infants spent more time sitting independently but less time upright than preterm infants. Transitions in posture and orientation increased over time for both groups (ps<.001), but were slightly more common in preterm infants (ps<.04). Infant-initiated transitions appeared to increase over time in both groups

(from 0% at 3 months to >50% at 12 months), but this effect was not significant due to the reduced sample size for analysis of transitions. These findings suggest that the physical context of infant-caregiver interaction is altered in infants born preterm. Moreover, developmental changes in infant-caregiver positioning over the first year may be attenuated for preterm infants. Future work will examine the impact of developmental intervention on physical positioning during play.

P2-A-249 - Object storage skills relate to word understanding. (Marcinowski)

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Objective: Infants who store objects can explore their properties, understand relations, and learn strategies for manipulating objects more effectively. Certain object storage actions indicate more than manual proficiency. Bruner (1973) considered object storage skills to be important for the development of symbolic representation. When an object is retained for later use but placed out of immediate sensory contact, Bruner (1973) argued that the infant is holding a mental representation of that stored, but not directly sensed, object. Thus, placing an object out of sensory contact for later use was directly observable evidence of an symbolic representation of objects. Language is a system of symbols (Smith & Gasser, 2005); thus, some object storage strategies may be tied to language emergence. The purpose of this study was to investigate Bruner's (1973) proposed connection more closely. More storage actions or more advanced storage actions are proposed to correlate with greater language later in infancy, particularly holds and places. Methods: Thirty-one infants (4-6.9 months) were recruited for a longitudinal study in the first year following sitting emergence (initial visit, +3 months, +6 months, +12 months later). Infants were assessed for object storage activities at all visits and language at the final two visits. To assess object storage, infants were given 4 toy types (bead, shape, figure, foam) across 4 trials at every visit. Assessors quickly presented toys one-at-a-time to the infant to encourage multi-object storage. Infants responses were video-recorded and scored by reliable coders for object storage actions (holds, inadvertent losses, controlled drops, intermanual transfers, throws, places, and offers). To assess language, parents completed the Communication Development Inventory (CDI) at the +12 month visit. Parents endorsed whether infants could understand or also say a word from a large word inventory. The variables for object storage were the sum of actions across all 4 trials at each visit. The language variable was the sum of endorsed items on the CDI survey for word understanding, word production, and total language. Predictions were tested using Spearman rank-order correlations and Mann-Whitney U tests. Results: Overall, storage actions increased over time with more advanced strategies becoming more prevalent. Early infant holds ($\rho=0.46$, $p<0.05$) and drops ($\rho=0.37$, $p=0.02$) both positively correlated with total language. Places at the final visit positively correlated with total language scores ($\rho=0.33$, $p=0.04$). Other storage actions early in trajectories did not correlate with language ($ps>0.09$). Early 3+ object holds scored significantly higher on total language, than infants who could not hold objects ($p=0.01$). Infants who used places as a storage strategy at the final visit scored significantly higher on word understanding, than infants who did not place objects ($p=0.04$). Conclusions: This study's preliminary findings supported the motor-language connections early in life, proposed by Bruner. Object storage skills, such as holding and placing, correlated with language scores. Object play or initial word emergence likely colors the development of the other, above and beyond the information gathered through physical exploration or contextual differences in play with a partner.

P2-A-250 - Crawling and walking onset impacts infants' night wakings and posture during sleep (Rodriguez Gasca)

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Gross motor milestone onsets disrupt infant sleep. For example, crawlers awakened more at night than non-crawlers and pulling-to-stand and walking onsets disrupted sleep-wake regulation (Scher, 2005; Atun-Euny & Scher, 2016; Berger & Moore, 2021). The typical methodology for studying the relation between infants' motor milestone achievement and sleep has been actigraphy, but it is limited by the inability to document type or location of movements (Sadeh, 1991). To strengthen our understanding of the relation between motor milestone achievements and sleep disruption, this study used a novel autovideosomnography tool for a detailed look inside the infant's crib. The aim was to examine the change in number of wake episodes and movements during infants' night sleep surrounding both crawling and walking onset. Parents prospectively documented infants' milestone acquisition using a daily motor milestone diary. Crawling and walking onset were defined as the day infants took their first steps. Average age of crawling onset was 8.33 months (SD = 0.54) and the average age of walking onset was 11.30 months (SD = 1.06). Using the commercialized home video baby monitor software, Nanit, we collected video of 8 infants sleeping in their cribs the nights before, of, and after crawling and the nights before, of, and after walking onset. Approximately 460 hours of videos have been coded to date. Video coding is ongoing. Nighttime wake episodes (wake episodes; lasting > 5 minutes with movement at least once every 3 minutes) were identified and general (e.g., limb movements) and skill-relevant (e.g., hands-and-knees) movements during wake episodes categorized. Proportion of wake episodes spent in each posture within their overall sleep was computed. Generalized estimating equations (GEEs) showed infants had significantly fewer wake episodes the night after each skill was acquired compared to the nights before and of ($ps < .05$), regardless of whether the milestone was crawling or walking. The proportion of wake episodes spent moving limbs decreased the night after crawling and increased upon walking onset ($p < .01$). The proportion of time spent on hands-and-knees was higher on the night of crawling onset than on the night before walking onset ($p = .07$). Limb movements were greater over the walk transition than the crawl transition ($p = .05$). Infants may consolidate new motor skills by moving at night. We replicated past research that used actigraphy by showing that sleep is disrupted during motor skill acquisition (Scher, 2005). Increased wake episodes prior to skill acquisition may reflect infants consolidating newly-learned information. In addition, during those wake episodes, infants performed more limb movements on the night of onset for both crawling and walking; infants were also on hands-and-knees significantly more on the night of crawl onset. Such increased and skill-relevant activity may reflect the repetition of neural patterns established during learning that is later repeated during sleep as part of memory consolidation (Ji & Wilson, 2006). Data collection is ongoing, and more nights with more infants will be coded to identify whether the relationship is robust and whether other kinds of movements change with skill acquisition.

P2-A-251 - Arm posture across the first two months of life: A precursor of infant reaching (DiMercurio)

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Early spontaneous motor activity, including touches directed to the self or the surrounding environment, could be foundational in developing early body knowledge and later reaching skills in infancy. Spontaneous motor activity begins in the prenatal environment of the womb, where arm movements are performed in a restricted but aqueous space, and where movements are limited but the effects of gravity on movements is less. In contrast, the postnatal environment is more open, affording a more extensive range of movements, however, gravity clearly hampers movements from birth. This study aims to understand how infants transition into this new open gravitational space from birth. Specifically, we investigate how infants' arm postures change in the first two months of life. Previous work has examined spontaneous touch activity (prenatally: Fagard et al., 2018; Reissland et al., 2014; Zoia et al., 2007; postnatally: DiMercurio et al., 2018; Thomas et al., 2015), however, none have systematically described the arm postures infants adopt in early life while contacting their self or their close surroundings. Five infants were followed weekly from 3-weeks-old until they gained head control, between 9-to-13 weeks old. Infants were observed in the supine position for five conditions lasting 5 minutes each: baseline, toys-in-view where colorful toys were positioned on the side of the infants preferred head turn. Three other conditions were collected with varying degrees of stimuli in the surrounding environment. However, for this analysis, only the baseline and toys-in-view conditions were used to avoid any impact of auditory stimuli on basic arm movements. All touches to the body and supporting surface were coded for location and duration. Subsequently, the arm postures at touch onsets were coded following three dimensions: angle of arm at the elbow (acute or obtuse), the orientation of the arm relative to the body (towards the head, feet, left, right, or vertical), and forearm support (resting on a supporting surface or not). Data were then converted into a rate per minute. Data between conditions and hands were not significant and were therefore collapsed across those variables. Analyses on the orientation and angle of the arm postures across the weeks revealed a significant developmental trend. From three to ten weeks, infants maintained more acute elbow angles towards the head. However, between 11-to-12-weeks-old, arm postures became more obtuse towards the feet ($p = .03$). Infants also engaged in higher rates of supported than unsupported postures while contacting their body with flexed arms towards the head ($p < .001$). These findings suggest that flexed arm posture, typical of what we see in the womb, lasts for a relatively long time postnatally before arms shift to a more extended posture. Unsupported postures working against gravity are clearly more challenging for infants to produce and may take even longer to develop. Extending the arms against gravity is foundational for the development of infant reaching that emerges about 1 to 2 months later. Future analyses will examine the duration of time infants spend in different arm postures.

P2-A-252 - Which risk factor can most impact the motor behavior of infants 3-5 months of age? (Fioroni Ribeiro da Silva)

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Objective: The first aim is to verify which risk factor, environmental or biological, can most affect the motor behavior of infants at 3, 4, and 5 months of age. Secondly is to assess the affordances present in the home environment of these infants. Methods: Eighteen infants were divided into 3 groups. Biological risk group (GRB) - 6 infants at 3.3 ±0.3; 4.1 ±0.1; and 5.1 ±0.1 months of age - experienced

peri- or postpartum complications. Environmental risk group (GRA) - 6 infants at 3.1 +0.0; 4.4 ±0.2; and 5.2 ±0.1 months of age - classified with low socioeconomic status, according to the poverty income ratio. No risk group (GSR) - 6 infants at 3.3 +0.2; 4.1 ±0.1; and 5.1 ±0.1 months of age - not exposed to environmental or biological risk factors. Motor behavior was assessed through the Infant Motor Profile (IMP), and the home environment through the Brazilian version of the Affordances in the Home Environment for Motor Development - Infant Scale (AHEMD-IS) questionnaire. Descriptive analysis, normality, and homogeneity tests were performed considering p-value ≤0.05; Anova One way and Kruskal Wallis, with Bonferroni adjustment, with p-value ≤0.01. Results: There was no significant difference between groups regarding motor behavior and resources. However, compared to the GRB and the GSR, the GRA had a lower mean (79.6 ± 2.0; 89.1 ± 5.7; 89.2 ± 7.4) in the variation domain in all evaluated months. In the symmetry domain, all groups were able to become equal over the months and obtained the same mean (100 ± 0.0) at 5 months of age. In fluency, the GSR had the lowest mean at 3 (75.0 ± 0.0) and 4 (73.6 ± 3.26) months, considered typical for the age, and at 5 months of age, the lowest mean was obtained by the GRB (81 .0 ± 13.0). In performance, the GRB had the lowest mean (40.6 ± 3.0; 52.8 ± 4.1; 56.8 ± 3.2) in all the months issued. The GRA, at 3 months, had the lowest mean (74.0 ± 2.6) in the total score, and at 4 and 5 months, the GRB had the lowest mean (79.6 ± 5.27; 80.8 ± 5 .31) in this score. The GRA's home environment has fewer adequate resources for neuropsychomotor development, being evaluated as less than adequate. This group obtained the lowest mean, compared to the GRB and GSR, in stimulation variety (8.5 ± 1.9), gross motor toys (1.6 ± 0.8), fine (1.5 ± 1 .3), and the total score (15.0 ± 1.2). Conclusion: There is no significant difference in motor behavior and in the home environment of infants exposed to biological and environmental risk factors. However, the GRA had lower scores in the variation domain in all months. This result may be related to a poor home environment in dimensions variety of stimulation, gross and fine-motor toys of GRA.

P2-A-253 - Contextualizing mouth contacts in relation to early spontaneous self-touch activity (Connell)

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Mouth contacts have been described as a focal area of exploration in fetuses and neonates. For example, hand trajectories of fetuses have been observed to be slower when approaching the mouth as opposed to other areas of the body (Zoia et al., 2007). This finding has been used to suggest that fetuses have bodily awareness for where the location of their mouth is. Postnatally, infants open their mouths in anticipation of their hand-mouth movements (Reissland and Austen, 2018). Furthermore, Butterworth and Hopkins (1988) found numerous hand-to-mouth contacts in neonates, suggesting that the mouth is an area of frequent self-touch activity. In contrast, DiMercurio et al. (2018) found that mouth contacts are infrequent and below chance levels when compared to all contacts made to the body and surrounding floor. The present study aims to further identify the frequency and durations of mouth contacts and the contextual relation to other hand movements and contacts. Five infants, followed weekly from 3-weeks-old until they gained head control (between 9 and 13 weeks old), were observed while lying supine. Infant spontaneous arm movements were recorded across five 5-minute conditions (baseline, toys-in-view, musical toys, caregiver speaking, and mobile). Contacts made to the body were coded for frequency and duration across 20 locations on the body, three floor areas, and the mouth. Particular attention was paid to the contacts made to the mouth to identify the context of their

occurrence in relation to all other contacts and arm movements. Analyses have revealed that contact to the mouth is exceedingly infrequent when compared to all contacts made. Mouth touches accounted for only 1.98% of all touches to both the self and the supporting surface. Furthermore, in relation to contacts made to the lower head, only 17.86% of those touches resulted in contact with the mouth. When considering contacts made to the lower head, whole head, or body/floor, mouth contacts were below chance levels (ps<.015) but at chance levels when compared to bodily contacts. Further analyses aimed at understanding when mouth touches occur revealed that they were more likely to touch their lower head when the hand was already in a proximal as opposed to a more distal area. These findings indicate that contacts to the mouth during early life, may not represent a focal point of activity but rather a matter of convenience. When considering the activity of mouth contacts compared to all bodily area contacts, infants did not perform mouth contacts above chance levels. Infants were not contacting their mouths any more than expected and in contrast contacted the mouth less than expected if performed randomly. The relationship of lower face contacts and proximal locations, suggests that contacts to the mouth may likewise be one of locational convenience rather than focal exploration. Future analyses will examine the duration of time infants spend touching their mouths and the relation of these contacts as compared to other body areas.

P2-A-254 - The impact of object properties on infant visuo-manual coordination strategies (Connell)

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Successfully reaching for and manipulating objects is crucial in early development. To accurately reach, infants must learn to align their visual and motor systems. Classically, this alignment was described as "visually guided" in that the visual information was used to guide the hand to the desired target (Piaget, 1954). However, recent studies have called into question the degree to which vision plays a role in infant reaching. Clifton et al. (1993) found that infants successfully reached for objects to varying degrees when vision of the hand was removed. This study aims to shed new light onto how infants coordinate their vision and action during reaching. Twenty-one infants aged 9-months-old were presented with rods, drumstick- and dumbbell-shaped objects within their reaching space. Eye-tracking at 60Hz and movement kinematics at 120Hz were recorded while they reached. Objects were presented in a quasi-random order with behaviors (area of fixation and location of initial contact) were coded. The stimuli were split into three regions of interest (left, middle, and right side of the object) which were then used to determine looking and reaching alignment strategies. Three visuo-manual coordination strategies were defined as: Targeted (fixations were maintained on the area of contact during the whole reach), catch-up (area of contact was fixated after reach start), and untargeted (fixations did not stay at the place of contact). Additionally, reach duration, max velocity, movement units, and other kinematic measures of the reach were calculated. Analyses of the reaches revealed that infants used untargeted strategies more often regardless of the presented object (ps <.01). Furthermore, when an infant used a catch-up strategy, it was more often when reaching for a drumstick than a dumbbell (p <.05), though not more than the rod. Movement kinematics indicated further differences between strategies. Catch-up reaches were significantly longer in duration, attained their max velocity sooner, and had more movement units than untargeted reaches (ps < .05) but were not significantly different from targeted reaches. Alternatively, targeted reaches achieved a higher max velocity than untargeted reaches (p <.01) but not catch-up reaches. Our findings indicate that infants visuo-manual strategies depend on the

characteristics of the presented object. In contrast to the visually guided hypothesis, infants most often used an untargeted reach where they neither looked at the area they were reaching for nor visually guided their hands. When they maintained visual fixations on the contact site through the entire reach, they achieved the highest velocity of reach. Finally, when utilizing a catch-up strategy, they produced the most corrections to their reach. These reaches attained their highest velocity early in the reach before slowing down and making corrections in their hand trajectory. Catch-up strategies were also more common when presented with the drumstick. In sum, this study revealed that infants visuo-manual coordination is still in flux at 9-months-old, despite some strategy variations across objects. Future analyses will determine how movement units specifically relate to fixation shifts during movement deployment.

P2-B-194 - The Link Between Infant Amygdala Functional Connectivity and Behavioral Inhibition (Capozzoli)

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Anxiety disorders are the most prevalent of psychiatric disorders, with about a third of American adolescents affected by age 18 (Merikangas et al., 2010). One of most clearly established risk factors for anxiety is behavioral inhibition (BI), which refers to the fear of novelty (Clauss & Blackford, 2012; Degnan & Fox, 2007; Fox & Pine, 2012; Merikangas et al., 2010). Despite BI being a robust marker of the risk for developing anxiety, little is known about the neural correlates of BI in infancy. It has been hypothesized that amygdala circuitry is central to BI, due to its role in threat detection and processing fear (Graham et al., 2016; Kagan et al., 1988; MacLeod & Mathews, 1988; Wells & Matthews, 1994). While a few studies have examined associations between infant amygdala connectivity and behaviors similar to BI (i.e., fear and internalizing symptoms) during infancy, this research is limited in two ways: no studies have used observational assessments of BI and most fMRI data comes from neonates. The current research addresses these limitations by examining the association between amygdala resting state functional connectivity (rs-FC) in infants (age 4 months) and behavioral inhibition (age 14 months). Unlike previous studies, BI was assessed via both parent report survey (TBAQ) and in-lab observation, which is the gold-standard for temperament/reactivity assessment. Amygdala rs-FC was measured using a seed-based whole-brain voxel-wise approach. Based on prior work, it was hypothesized that increased amygdala-PFC connectivity would be associated with high BI, measured via both parent report (n=31) and in-lab observation (n=20). Results of the group-level analysis showed amygdala rs-FC was significantly associated with BI assessed for both temperament measures. Specifically, less amygdala-left precentral gyrus and amygdala-left superior frontal gyrus connectivity was correlated with greater BI assessed via parent report. Less amygdala-right angular gyrus, -postcentral gyrus, and -precentral gyrus connectivity was associated with greater BI measured observationally. Thus, although we did have significant findings, our specific hypothesis that increased amygdala-PFC connectivity would be linked to high BI was not supported. This study is the first to link amygdala connectivity with observational measures of BI. Although these findings are distinct from other neonatal neuroimaging studies of BI, they broadly agree with findings that default mode connectivity is associated with BI (Sylvester et al., 2018). Interestingly, we also found that motor cortex connectivity is implicated with BI. Overall, this study provides preliminary evidence that amygdala connectivity at 4 months is associated with BI one year later.

P2-B-195 - Does cross-modal reorganization depend on hearing experience? (Arrieta)

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Cross-modal reorganization (CMR) is a form of brain plasticity that occurs when a sensory modality is deprived. In the case of hearing loss, it is referred to as brain activity in temporal brain areas (those areas normally activated to auditory stimuli). CMR has been found to negatively influence oral language outcomes after cochlear implantation in adults with hearing loss (HL), but its influence on language during development in young children with HL is still not clear. Specifically, existing research has focused exclusively on measures of CMR after implantation, leaving the question of how measures of CMR pre-implantation can predict individual language outcomes unanswered. To fill this gap, we are conducting a longitudinal study of CMR, before and after cochlear implantation, and assessing the relations between individual CMR and later oral language outcomes. Here, we focus on pre-implantation measures of CMR in children with HL. We expect that greater CMR in this population compared to typically-hearing (TH) controls would be an index of pre-implantation brain plasticity, showing the brain's capacity to adapt to HL and later integrate the degraded signal given by the CI. CMR was assessed in six children with profound HL before CI implantation (average age: 25.47 months) and six age-matched TH controls using functional Near-Red Spectroscopy (fNIRS), a neural imaging technique that measures hemodynamic changes in the cortex. Children were presented with visual stimuli consisting of 40-second silent videos of moving colourful shapes (preceded and followed by 20-second intervals without stimuli, i.e., black background). An optode design of 16 sources and 16 detectors was placed around temporal and pre-frontal areas and CMR was indexed by the responses in auditory brain areas in response to visual stimulation. Data pre-processing was performed using Homer2 package in MATLAB, following the work by Blanco et al. (2018). Preliminary channel by channel analyses using two-sample t-tests showed evidence of CMR in 5 channels, and all but one showed that children with HL showed higher activations to visual stimuli than TH controls. Specifically, the only channel that showed significant group effects for both oxy- and deoxy-haemoglobin was located on the temporal area in the left hemisphere, around the left primary auditory cortex. These results show the expected pattern of brain reorganization induced by HL. Longitudinal data acquisition is currently in progress and will be used for predicting post-implantation language outcomes.

P2-B-196 - The time-course of visual rule learning in preverbal infants: evidence from neural entrainment (Bettoni)

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It is well-known that infants are able to discover and generalize repetition-based, abstract patterns in continuous streams of information, a learning mechanism known as Rule Learning (RL, Marcus et al., 1999). The classic approach to investigate infants' RL skills relies on habituation procedures, in which infants are exposed to sequences of items instantiating a rule-like pattern, and looking times are measured during post-habituation test trials to assess infants' ability to discriminate the familiar from novel rules and to generalize familiar pattern to novel items (e.g., Rabagliati et al., 2019). This approach, focusing on the outcome of learning, does not inform us of the temporal dynamics of the learning

process. One way this can be investigated is by exploiting neural entrainment, the phenomenon by which brain activity naturally synchronizes to the rhythm of periodic external stimuli (Norcia et al., 2015). Electrophysiological studies in adults have shown that, when applied to RL, neural entrainment will align neural excitability to the unfolding structure embedded in the item stream, thus supporting the learning of the rule (e.g., Ding et al., 2017). Here, for the first time, we recorded electroencephalographic (EEG) measures of neural entrainment to investigate the time-course of RL from sequences of visual shapes in 9-month-olds infants (N=17, 6 females, preliminary sample). Participants were exposed to a 2-minutes continuous stream of visual shapes organized into ABA triplets. Shapes were presented at a fixed rate of 6 Hz so that the triplet structure corresponded to a frequency of 2 Hz (Figure 1A). After the learning phase, participants were presented with six looking-time test trials alternating between the familiar (ABA) and novel (ABB) triplets instantiated by new shapes (Figure 1B). To explore the dynamics of learning, we extracted the first and last 20 seconds from the stimulation and analyzed the EEG signal recorded at occipital electrodes (E70, E75, E83) in the frequency domain. To assess the generalization of the familiar rule to novel items, we compared infants' total looking times to the novel versus the familiar rule test trials. Data collection is still in progress. Preliminary results from the Z-scores of the signal to noise ratio at the stimulation frequencies (6 Hz and 2 Hz) revealed that the signal was significantly higher than noise already in the first 20 seconds of stimulation (Z-scores > 2.33, Bonferroni corrected), revealing a clear EEG response time-locked to the item frequency (6 Hz) and the frequency of the embedded triplet (2 Hz). At the test, infants showed a non-significant trend towards longer looking times to the novel triplet (M = 11.54 ms, ES = 2.40) compared to the familiar one (M = 9.78 ms, ES = 1.30), $t(14) = 1.021$, $p > .325$), indicating that the entrainment of neural response to the ABA structure during learning did not translate into a robust novelty preference at the behavioral level. Although exploratory, these preliminary results suggest that neural entrainment is a promising tool to explore how the infant's brain tracks regularities and structures in the input.

P2-B-197 - Investigating socioemotional development across the first year of life: Early infant fNIRS response to voices and BITSEA (Booker)

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Background: The highly socially oriented context of the first year of life lays the foundations for how infants process and communicate socioemotional information throughout their lives as their brain rapidly develops, attuning to emotionally expressive cues from their caregivers (Grossmann, 2015). Previous functional neuroimaging research on infant auditory vocal discrimination has found that infants demonstrate preferential activation to their mother's voice (Imafuku et al., 2014) and emotional prosody (Cheng et al., 2012). Furthermore, though it is understood that the ability to process and discriminate between emotional cues and expressions is a necessary skill needed to predict others' actions and guide an individual's behavior within a social interaction (Frith, 2009), little is known about how neural prosodic emotion discrimination in early life (Doi et al., 2013; Grossmann et al., 2010) can predict later socioemotional behavioral outcomes. To this end, the current study examined the predictive value of fNIRS-measured neural response to mother's and stranger's voices at happy and angry emotional prosodies in early infancy on socioemotional assessment outcomes at one year. Methods: 17 infants (11 F, 6 M) ranging in age from 0.30-2.01 months at time of fNIRS (Mage = .88

months) listened to recordings of their mothers' and a control, 'stranger' females' voice speaking nonsense sentences in happy and angry tones whilst undergoing fNIRS during natural sleep in their mother's lap. All fNIRS data was collected with the NIRSx NIRSCOUT system on a prefrontal 8x8 montage and was preprocessed using Homer3 (Huppert et al., 2009) following a pipeline previously demonstrated to be robust to noise while retaining the most trials in infant data (Germani & Gervain, 2021). Block averages were computed and extracted for each channel. At a one year follow-up (Mage = 12.72 months), participants' primary caregiver completed the Brief Infant-Toddler Social Emotional Assessment (BITSEA; Briggs-Gowan et al., 2004). BITSEA scores were then split into composites of competence and problem scores; in addition, an autism spectrum disorder (ASD) risk subscale of the BITSEA competence and problem items was calculated (Kiss et al., 2017). Results: After conducting a repeated measures GLM for each channel with emotion (happy, angry) and actor (mother, stranger) as within subject variables, a significant interaction between emotion and actor was observed in mPFC channel 4-5 ($F(1,16) = 4.88$, $p = .04$) such that infants showed greater activation to mother's versus stranger's happy voice and greater activation to stranger's versus mother's angry voice (Figure 1). Bivariate correlations were then run across all stimulus conditions in channel 4-5 with all problem and competence BITSEA scores. A significant positive association between ASD problem scores and HbO in response to stranger angry voice was observed ($r(15) = .58$, $p = .01$) (Figure 2). Conclusions: These results suggest that neural mother-stranger and emotional prosodic discrimination in the first months of life may be predictive of parent-rated socioemotional outcomes. More specifically, this neural sensitivity in early infancy to negative emotional cues may be an early marker of risk for later socioemotional problems within the first year of life.

P2-B-198 - Language exposure is negatively associated with white matter microstructure in the arcuate fasciculus during infancy (Govindaraj)

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Background: Significant associations between the early home language environment and later language skills have been well established in research on infants (e.g., Hart & Risley, 1995); however, the role of the brain in these associations remains unknown. A recent investigation of pre-school aged children has shown that more conversational turn taking between the caregiver and child is associated with more coherent white matter microstructure (Romeo et al., 2018). This study aims to examine the interplay of the home language environment and neurodevelopment in infancy. Objective: We aimed to determine if the home language environment is associated with white matter microstructure in typically developing infants. Methods: The sample (n=55) included infants at a low probability for developing autism spectrum disorder (ASD) and infants at a high probability for developing ASD who were shown to be typically developing at 24 months based on diagnostic assessments. All infants contributed at least one diffusion-weighted MRI scan (i.e., 3, 6, 12, 24 months) and at least one full day of home language recordings at 9 months (LENA Recorder). Fractional anisotropy (FA) values were generated from scans

across each tract of interest: segments of the arcuate (AF-direct, AF-indirect), inferior frontal-occipital (IFOF), inferior longitudinal (ILF), and uncinate (Uncinate) fasciculi, splenium of the corpus callosum (Splenium), and corticospinal tract (CST) (Fig 1a). FA is measured on a scale of 0 to 1 with greater values reflecting more coherent white matter organization. Home language environment variables were extracted by LENA software: Adult Word Count (AWC), Child Vocalization Count (CVC), and Conversational Turn Count (CTC) [Xu et al., 2009]. AWC measures the number of adult words spoken near the target infant, CVC estimates the number of speech-like vocalizations produced by the target infant, and CTC measures exchanges between an adult and the target infant that occur within 5 seconds of one another. Age at MRI scan was selected a priori to be included as a covariate. Based on principal component analysis, data collection site was added to all models. False discovery rate (FDR) corrections were used to correct for multiple comparisons; corrected p-values are reported as q-values. Results: General linear regression (Table 1) showed a significant negative association between CVC at 9 months and FA in the posterior indirect segment of the left arcuate at 6 months ($q = 0.012$, Fig 1b). Significant negative associations were found between AWC and CTC at 9 months and FA in the posterior indirect segment of the left arcuate at 24 months ($q = 0.012$, Fig 1c; $q = 0.01$, Fig 1d, respectively). The remaining models yielded non-significant results after FDR corrections. Conclusion: This study provides the first evidence that infants who hear more caregiver speech have less mature white matter in the arcuate. Negative associations between the language environment variables and the posterior indirect segment of the left arcuate substantiate findings that prolonged white matter growth early in development is positively associated with later cognitive skill (Deoni et al., 2016). While the design of the current study prohibits inferences about the directionality of the results, these results do suggest that white matter may play an important mechanistic role in how caregiver speech supports later language skills.

P2-B-199 - The effect of sleep on the developing infant brain (Yancey)

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Infant sleep patterns are intricately connected to physiology, environment, and parental influences (Sadeh et al., 2010). Moreover, disrupted sleep patterns are often a co-occurring symptom in many psychological disorders (Sivertson et al., 2015). However, the exact mechanism by which sleep is associated with mental health outcomes remains largely unknown. Frontal alpha asymmetry assessed using electroencephalography (EEG) is a well-studied neural marker of motivation (Davidson, 1995), whereby greater relative right FA reflects a withdrawal response and increased risk for the development of later psychological disorders (Davidson, 1995; Harmon-Jones & Allen, 1998). The current study examined the association between infant sleep patterns and frontal brain asymmetry. We hypothesized that poorer sleep patterns would be associated with greater right frontal brain responses, whereas better sleep patterns would be associated with greater left frontal brain responses. The present study assessed a group of infants at 5 months ($N = 62$) in order to examine the association between infant sleep measures and frontal asymmetry. Infant sleep was measured using the Brief Infant Sleep Questionnaire and metrics of sleep patterns were computed: total sleep duration variable, sleep quality variable (e.g., average number of night wakings, time awake during the night, sleep latency), and clinical markers of sleep (e.g., > 3 night wakings, > 1 hour in wakefulness, < 9 hours of sleep) [BISQ; Sadeh, 2004]. Functional near-infrared spectroscopy data were recorded while infants were presented with a non-social stimulus and frontal asymmetry scores were computed by subtracting the left dlPFC measure

from the right dlPFC (i.e., higher scores represent more relative right [withdrawal] lateralized responses). A linear regression with total amount of sleep, sleep quality, and clinical markers of sleep predicting frontal asymmetry was conducted and found to be significant F(3, 58) = 2.96, p = .039, R 2 = .13. Follow-up analyses showed that reduced sleep was associated with greater right lateralized frontal brain responses, b = -.06, t(58) = -2.05, p = .044. No other significant associations were found. Overall, the current findings suggest that sleeping more hours during infancy may have a protective effect for brain development which may have long term, cascading consequences.

P2-B-255 - Maternal resting heart rate predicts mother-infant physiological synchrony at rest (Zhang)

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Research suggests that physiological synchrony is a critical component of the parent-child relationship as it offers the opportunity for the mother and infant to co-regulate each other (Feldman, 2007). Mother-infant physiological co-regulation is evident even before birth and remains important throughout infancy. In theory, maternal regulation of their infants' physiology can, in turn, help infants learn how to regulate on their own (Atzil & Gendron, 2017). However, more research is needed to understand the complex nature of mother-infant co-regulation and physiological synchrony. Some prior work has shown that physiological synchrony is influenced by mother and childs' own physiological activity (Creaven et al., 2014; Wass et al., 2019). This suggests that physiological self-regulatory processes within the individual are related to co-regulatory processes within the dyad. Yet, less is known on how resting levels of physiological activity may influence mother-infant physiological synchrony in the first few months of life. Thus in this present analyses, we investigated the extent to which resting levels of mother's and infant's heart rate was associated with mother-infant physiological synchrony. We examined these questions using data from 104 three month old infants (n = 40 female, M age = 3.47, SD = 0.39) enrolled in the longitudinal Stress, Home Environment, Language and Learning (SHELL) study. Electrocardiography (ECG) was recorded continuously for five minutes while the infant sat on their mothers' lap passively viewing non-arousing stimuli on a computer screen. Trained coders edited ECG data for movement artifacts. Interbeat intervals (IBI) were then calculated from ECG. Time-lagged mother-infant physiological synchrony coefficients were calculated from the IBI time series using multilevel modeling and then entered into a regression to test predictors of synchrony. Results from regression revealed that maternal (β = .779, $p < 0.001$) but not infant (β = -.003, p = .97) average resting IBI positively predicted lagged infant-to-mother physiological synchrony but not mother-to-infant synchrony. As shown in Figure 1, higher levels of maternal resting IBI (i.e., lower heart rate) were related to higher levels of infant-to-mother physiological synchrony. These results were observed while controlling for range of covariates, including infant sex, caregiver ethnicity, and birth order. These results suggest that when mothers have lower heart rate, they are more likely to be influenced by their infant's physiology. One interpretation of these findings is that mothers with lower resting heart rate are better able to down-regulate their arousal levels and thus, are more likely to be attuned to their infants' physiology and can more easily adapt to it. These results further support the idea that maternal physiological self-regulation may influence co-regulation with her infant. Future research is needed to understand contexts of stress or adversity may moderate this association. Additionally, further studies are needed to understand how the relation between self-regulation and co-regulation may impact infant development.

P2-B-256 - That's mom! - The integration of maternal face, voice, and odor in the infant brain (Jessen)

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Recognizing their mother is a crucial prerequisite for the development of secure bonding, and one of the first social skills an infant develops. While numerous studies have investigated infants' responses to their mother face or voice, other modalities have largely been neglected. In particular maternal odor, which is known to play an important role for mother-infant-interaction in other species, has long been neglected in our own species as a source of social information. However, recent work could show that maternal influence sociocognitive processing also in human infants (e.g., Jessen, 2020; Durand et al., 2020; Leleu et al., 2019; Rekow et al., 2020). In the present study, we therefore investigated how maternal signals in different sensory modalities are combined in the infant brain, and to what degree maternal odor influences the processing of face and voice information. To that end, n=91 7-month-old infants were randomly assigned to one of two groups: a maternal odor group, in which infants were exposed to their mother's odor during the experiment, and a stranger odor group, in which infants were exposed to a different mother's odor. We recorded the EEG signal while infants watched photos of their mother or a different mother and heard a recording of their own mother's or a different mother's voice, with the visual onset preceding the sound onset by 800 ms (Fig 1A). In response to their mother's face (compared to a stranger's face), infants showed an enhanced Nc response when they smelled a stranger, but not when they could smell their mother (Odor x Face: $F(1,145) = 4.9$, $p=.028$, Fig 1B). In contrast, we did not find any influence on the processing of maternal vs. stranger voice in combination with the face (all $p>.05$). Hence, maternal odor does seem to have an impact on facial processing, but we could not find evidence for an influence on the perception of voice identity. In sum, our data further characterize the influence of maternal odor in early social perception and suggest potential differences in influence on different sensory modalities.

P2-B-257 - Synchronizing with the rhythm: infant neural entrainment to musical and speech stimuli before and after early rhythmic training (Cantiani)

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Neural entrainment is defined as the process whereby brain activity, and more specifically neuronal oscillations measured by electroencephalography (EEG), can synchronize with external (exogenous) stimulus rhythms. Low-frequency (< 6 Hz) neural entrainment has been observed for abstract stimulus properties such as the rhythms of musical beats and linguistic constituents (Nozaradan et al., 2011). Recent theories suggest that individual differences in this phenomenon could be one factor leading to atypical development trajectory of language acquisition found in Developmental Language Disorder and Dyslexia (Goswami, 2011). However, despite the importance that neural oscillations have assumed in the last years in the field of auditory neuroscience and speech perception, in human infants the oscillatory brain rhythms and their synchronization with complex auditory exogenous rhythms have been relatively unexplored. Cirelli and colleagues (2016) have shown a successful approach to measure infants' neural entrainment to easy rhythmic patterns, providing preliminary evidence that such neural responses can be influenced by infant individual differences and their early musical experiences. The

present study has a twofold aim. First, we aimed to further investigate infant neural entrainment to rhythmic patterns, and specifically to complex non-speech (musical) and speech rhythmic stimuli. Second, we investigated the impact of ecological early rhythmic training (Dondena et al., 2021) on the same measures of neural entrainment. 25 8-month-old infants have been so far included in the study. Their EEG signals were recorded while they passively listened to non-speech and speech rhythmic stimuli modulated at different rates. The Figure shows a graphical representation of the three different stimuli that were used. The temporal envelope of the three rhythm patterns was extracted using a Hilbert function implemented in MATLAB and the Fast Fourier Transform (FFT) was applied to compute the spectrum of acoustic energy. As represented in the Figure, the frequency spectrum of acoustic energy varied across stimuli, peaking respectively at 3.3 Hz for the Tabla musical stimulus, at 0.87 Hz and 1.7 Hz for both the African musical stimulus and the Speech stimulus. After the assessment, 12 infants participated in the early auditory training whereas 13 did not. The training provides exposure to and active synchronization with complex musical rhythms (through specific "tapping" and "bouncing" tasks). It took place in small groups of infant-caregiver pairs for 1 hour/week for 6 weeks and indications were given to caregivers in order to continue the interventions at home. All infants were tested again with the same neural entrainment task after six weeks. FFT was applied to the averaged EEG using Letswave7 (Mouraux & Iannetti, 2008). Neural entrainment to the incoming rhythms was measured in the form of peaks emerging from the EEG spectrum at frequencies corresponding to the rhythm envelope. These measures were coupled with more traditional ERP analyses. The visual inspection of the averaged EEG spectrum revealed clear responses above the noise floor at frequencies corresponding to the rhythm envelope, suggesting that infants' brain at 8 months of age was capable to entrain to the incoming complex auditory rhythms, for both music and speech. Further analyses are still ongoing and the final results will be presented at the conference.

P2-B-258 - The effectiveness of a daily skin-to-skin contact intervention in mothers and their full-term infants: primary and secondary outcomes of a randomized controlled trial (Beijers)

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Background: In preterm and low birthweight infants, many studies have documented the beneficial effects of mother-infant skin-to-skin contact (SSC). SSC is also encouraged post-delivery in mothers with healthy full-term infants. However, only a few studies examined the effectiveness of a SSC intervention in mothers and full-term infants beyond the first postnatal days. Moreover, these studies did not use randomized controlled designs. The present randomized controlled trial (RCT) investigated the effectiveness of a daily SSC intervention in healthy mothers and their full-term infants. This presentation will focus on maternal mental health as the primary outcome, and the following secondary outcomes: (exclusive) breastfeeding duration, infant crying and sleeping behaviors, infant stress regulation, quality of mother-infant interaction, and toddler cognitive and behavioral outcomes. Method: Participants were 116 healthy mother-infant dyads who were randomly allocated to either the SSC or care-as-usual condition (1:1). Mothers in the SSC group were requested to provide at least one daily continuous hour of SSC to their infant for the first five postnatal weeks. Mothers noted the amount of SSC in a daily logbook, and completed depression, anxiety, and stress questionnaires on 2, 5, 12 and 52 weeks after birth. A weekly logbook for the first twelve postnatal weeks was used to examine breastfeeding frequency. At infant 2, 5 and 12 weeks of age, a Baby Day Diary was completed for 3 days. Mothers

bathed their infants during a home visit at infant age 6 weeks. At 12 months of age, mothers indicated the number of months that their infants received (exclusive) breastfeeding. At 36 months of age, mothers filled in questionnaires on children's externalizing and internalizing behavior, and executive functioning. Results: Depending on the type of analyses (intention-to-treat versus per protocol, including only mothers in the SSC condition who strictly adhered to the daily hour of SSC during the intervention period), the results for the primary outcome indicated that daily SSC in healthy mother-infant dyads may reduce anxiety and fatigue symptoms, but not depressive, stress, and pain symptoms. Moreover, SSC was associated with longer exclusive and continued breastfeeding duration, reduced infant crying duration, longer infant sleep duration, and decreased internalizing and externalizing behavior problems in toddlerhood. We did not find evidence that SSC was associated with infant stress regulation, the quality of mother-infant interaction, and toddler cognitive development. Discussion: This RCT indicates that daily SSC during the first five postnatal weeks is a promising, cheap, and accessible intervention that may improve important outcomes for the infant and the mother, including (exclusive) breastfeeding duration and child socio-emotional development. However, before considering whether these findings justify recommending daily SSC to new parents, replication studies are crucial to confirm the results.

P2-B-259 - Predictor for closed-loop Brain Computer Interface to facilitate perceptual learning in infants: A preliminary investigation (Aggarwal)

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Background: With age, full-term infants develop efficient perceptual systems. However, due to insufficient neuronal development it is compromised in preterm newborns, putting them at risk for perceptual deficiencies. This study used high-density EEG for longitudinally investigating EEG power associated with the visual evoked potential as a function of visual looming motion in full-term and preterm infants. Methods: A total of 16 healthy infants, 8 full term and 8 preterm infants were recruited for this study and were tested twice, session 1 at 4-5 months, followed by session 2 at 11-12 months.The preterm infants were born at ≤ 33 weeks of gestation and tested corrected for prematurity. Encephalogram was recorded at 500 Hz with a 128-channel array while infants watched a looming ball approach them on a collision course under three different accelerations. Looming-related VEP responses registered during the final 1.5 s before the virtual collision at occipital electrodes (60-100) were considered for the three loom speeds, and average EEG power for theta, alpha and beta frequencies were computed (Figure 1). Results: Figure 2 shows that neural oscillations in the theta band were prominent in both full-term and preterm infants for both sessions. However mean EEG power in theta was more prominent for full-term than for preterm infants for both sessions. Longitudinal investigation showed that the mean energy for preterms in session 1 and 2 remained the same which might indicate slow development in premature infants. A significant two-way interaction of Frequency band × Group was found, $F(2,28)=6.892$, $p=0.04$, showing that full-term infants displayed higher EEG power compared to premature infants at both sessions, but only in the theta-band and not in the alpha and beta bands. Conclusion: Preliminary findings show that the average EEG power in the theta band can be used as one of several potential demarcators to distinguish between mature and immature brain responses to visual looming. Further research is needed to establish an acceptable theta power range during the first year of life, as an indicator of mature brain responses to looming stimuli. This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie

Sklodowska-Curie grant agreement No. 897102 Author's would like to acknowledge the contribution of Arnav Balyan for assistance in coding and participating in discussions.

P2-B-260 - Creation and validation of an App for mobile devices to screen for child developmental and behavioral problems in Brazil (Alves)

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INTRODUCTION: Development assessment is a necessary action to promote children's global health, and health professionals must have access to reliable and culturally adapted tools for this. We created the app TEDI (Screening & Stimulation of Child Development) to improve child developmental assessment in Brazil. TEDI is based on the Brazilian version of the Survey of Well-being of Young Children (SWYC-BR) (Figure 1) and in "Child Booklet", the official Brazilian tool for development surveillance. The app screens developmental and behavioral problems in children under 65 months and contextual risk factors. TEDI calculates child age, finds the appropriate forms for that age, generates results, and offers management suggestions. We created 54 vignettes to improve the comprehensiveness of the developmental milestones items (DM-SWYC-BR). OBJECTIVE: To describe the creation and validation process of the app TEDI. METHODS: Firstly, we developed algorithms integrating SWYC-BR and "Child Booklet" information to offer safe and feasible management suggestions. TEDI's initial structure and goals were assessed by specialists in child development. Following, we performed a usability test to assess the app's functionalities, evolving health professionals who worked in primary health care and specialized clinics. Finally, we performed a test-retest to examine the reliability of the SWYC-BR combined with the vignettes. We interviewed twice 100 mothers of children under 65 months. In the first interview, mothers answered DM-SWYC-BR in a phone call. After 4 to 8 days, they were interviewed again, but, at this time, mothers watched the vignettes during a video call before answering the DM-SWYC-BR. Mothers evaluated the contribution of the vignettes to the comprehension of the items. We calculated the proportion of agreement of the answers before and after watching the vignettes. The proportion of agreement above 60% was considered good. The children's results in the DM-SWYC-BR were analyzed to assess differences between the interviews. RESULTS: The initial algorithms were revised based on the specialists' contributions, leading to a new version of the app. During the usability test, 23 professionals evaluated the app's main functionalities (login, navigation, visualization, and information clarity), design, and vignettes' aesthetics. More than 80% of the professionals approved the functionalities, 78% the design, and 91%, the vignettes. Nevertheless, only 61% felt secure in using the management suggestions. After revisions, we tested 24 versions of the app for the IOS and 26 for Android. We analyzed 19 answers per item, on average, during the test-retest (Graphic 1). The proportion of agreement was considered good or very good in 87% of the items. We qualitatively assessed the vignettes with a moderate agreement (13%) and redone some. The first and second DM-SWYC-BR results differed in 12% of the children, but there was no significant difference in the proportion of children suspected of developmental delay considering both assessments (33% vs. 29%). Almost 84% of the mothers considered vignettes improved the comprehensiveness of the items. CONCLUSIONS: The validation process brought scientific consistency to TEDI. Afterward, field testing will be carried out to improve the app and enhance actions to monitor child development in Brazil.

P2-B-261 - Predictors of hot and cold inhibitory control in toddlers born very preterm (Stefani)

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Background: Inhibitory control-the ability to delay or inhibit unwanted responses, modulates our everyday behaviour (Diamond, 2013). It is distinct from, yet related to, general cognitive ability, and it predicts academic achievement and behavioural issues in childhood (Kim et al., 2013). In toddlerhood, inhibition is contained within a single executive function factor (Wiebe et al., 2011). School-aged children born very preterm present with difficulties in inhibition, but these have not been well characterised in the first years of life, and their predictors remain poorly understood. Examining performance from a "hot" (affective context) and "cool" (neutral context) perspective can further inform inhibition development in this population. Method: Participants were 30 toddlers (30-months-old-corrected for prematurity) born preterm (23-32 weeks) and 36 30-month-old full-term toddlers, from the UCH Preterm Development Project (London, UK). The two groups did not differ on gender distribution, age, SES, maternal education, or cognitive composite from the Bayley-III. We used the Snack and Gift Delay tasks as measures of hot EF (all participants completed), and a newly developed computerized measure of EF (BabyScreen v1.5) as a measure of cold EF. The BabyScreen is a multitasking task where children are required to press or swipe targets while avoiding distractors (19 preterm and 26 terms completed). Predictors of performance within the preterm group were examined using simple (sample size-permitted) or multiple linear regressions; best-fitting models were determined by AIC where applicable. Results: Preterms performed significantly poorer than full-terms on the BabyScreen interference score (x2 (1)=6.04, p=.04) and on items that required task-switching (W=334, p=.04), but not on items that required rule-switching (W=317, p=.09). In the Snack and Gift Delay tests, preterms waited significantly less time (W=669, p=.005; W=369, p =.02) and had lower inhibition scores (W=672, p=.01; p =.03) compared to full terms. Inhibition scores and waiting times from the delay tasks (hot EF) were positively correlated (r range=.40-.91, all p<.01), but they did not correlate with any of the BabyScreen (cold EF) measures (all p>.05). Interference and task-switching scores were positively correlated (r=.39, p=.01). Within the preterm group, better task-switching (cold EF) was predicted by two exploratory simple linear models that included absence of intraventricular haemorrhage at birth and a complete dose of antenatal steroids as predictors, explaining 25% and 22% of the variance (R2 adj model-1 = .25, F(1,17)=6.91, p=.02; R2 adj model-2= .22, F(1,17)=6.06, p=.02), respectively. Better waiting times from the Snack Delay (hot EF) were best predicted by a model that included: maternal education (over GCSEs); no diagnosis or lower grade of intraventricular haemorrhage; and being male, explaining 42% of the variance (R2 adj = .42, F(5,25)=7.82, p<.001; AICcWt =70%). Conclusion: This low-risk preterm-born sample demonstrates deficits in hot EF and in a subset of cold EF detected at 30-months-old. Predictors of inhibition performance suggest potentially distinct neurobiological mechanisms of impairment and demonstrate the heterogeneous structure of inhibition ability. Given that a likely balance of both hot and cool processes is predictive of real-life outcomes, preterm children might be at a developmental disadvantage that puts them at greater risk for poor self-regulation.

P2-C-200 - Exploring the role of spatial frequency information in newborns' discrimination of emotional faces (Silvestri)

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It is known that preverbal infants are able to perceptually discriminate emotional facial expressions from early on in development, and until the age of 7 months, they prefer to look at happy faces over neutral or negatively valenced faces. This preference is apparent also in newborns, but the studies conducted so far are just a few, and the results are not straightforward: happy faces are preferred over fearful faces under static presentation conditions (Farroni et al., 2007), while they are not preferred over disgusted faces when dynamically presented (Addabbo et al., 2018). Moreover, only recently have researchers begun to explore what visual information infants rely on when making these discriminations. In adults, expertise in emotion discrimination relies on the processing of low spatial frequencies information, which involves the activation of the fast-responding magnocellular visual pathway (Vuilleumier et al., 2003). The only two studies conducted in infants showed that, unlike adults, 7-month-old infants' neural discrimination of emotional faces rely on the high SF content of the stimuli (Jessen & Grossmann, 2017; van den Boomen et al., 2019), which has also been linked to the involvement of the slow-responding parvocellular visual pathway (Vuilleumier et al., 2003). These findings appear intriguing in light of the early limitations of the visual system, which biases infants' perception towards the low-SF bands of visual images (Acerra et al., 2002). Accordingly, newborns rely on low-SF when discriminating neutral faces based on identity (de Heering et al., 2008). Here we used a spatial filtering approach, in which high- or low-Spatial Frequency (SF) bands are selectively removed from the images (Goffaux et al., 2005), to investigate what information newborns use when discriminating emotional faces. Eighty-five newborns participated in three different studies aimed at (1) replicating earlier evidence of newborns' preference for happy over fearful faces dynamic unfiltered (Broad-SF) faces, (2) testing whether newborns' preferential response generalizes to High-SF or Low-SF frequency images or both. In Study 1, twenty-two newborns were tested in a preferential looking task in which dynamic unfiltered displays of happy and fearful expressions were simultaneously presented. Results replicated earlier demonstrations of newborns' preference for happy faces ($p = .002$). In Study 2, forty-one newborns were presented with Low-SF (< 0.5 c/g) or High-SF (> 0.6 c/g) versions of the same unfolding emotions. A preference for happiness was found for the High-SF faces ($p = .02$) but not for Low-SF faces ($p = .43$), suggesting that, like older infants, newborns relied on the high-SF content of the images when discriminating emotional expressions. In Study 3 (N=22), we used a habituation task to investigate whether the low-SF content of the images was at least sufficient to allow newborns to discriminate between the two emotions. Results showed successful discrimination for Low-SF faces ($p < .001$). This study is the first to apply a spatial filtering approach to newborns' discrimination of emotional expressions. Results suggest that SF bands modulate the perceived salience of facial cues for emotions at birth, with low-SF contributing critically to the salience of threat-related cues.

P2-C-201 - Measuring interest in early childhood: a validation of various measures of interest in young children (Satarai Madhavan)

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Children learn language in leaps and bounds; as evidenced by the differences in vocabulary sizes of children between 16 to 30 months of age (Frank et al., 2016). However, while their lexicon development remains a constant between languages and among children, variation is apparent in the type of words children know; for example, 48% of German 16-month-olds may know the word bear but not digger, while 52% knows digger but not bear (Szagun et al., 2009). Therefore, what factors determine what kind

of words children learn in early childhood? Studies have shown that children's interests influence their learning trajectory: they actively point and vocalise to extract information from conversation partners, and retain such information better (Mani & Ackermann, 2018). The extent to which interest affects language development during infancy is a recent focus of developmental research, and valid, direct measures of interest would open up new possibilities to investigate its impact. Thus far, interest measures concerning infants have been in the form of parental reports and questionnaires or behavioural observation; however, recent evidence suggests that parents may not be to reliably indicate children's interests (Ackermann et al., 2020). Physiological responses such as pupil dilation have also been previously associated with arousal and cognitive effort, with task-evoked pupillary responses (TEPRs) varying as a function of curiosity ratings (Kang et al., 2009). This study aims to validate various measures of interest in young children - pupillary dilation, behavioural responses and parental reports. Therefore, our research questions are: 1. Do children's pupillary response to being presented with images of differing interest vary as a function of parental ratings of interest, their overt choices in behavioural tasks, and the speed of their choices in behavioural tasks? 2. Are parental ratings of interest related to children's overt choices in behavioural tasks? We recruit 81 2-3-year-old monolingual German children. Children complete two tasks: (1) a Pupillometry task, where they are presented with images from a range of defined categories; (2) A sticker-choice task, where they are asked to choose between two sticker-images from two different categories belonging to the range of categories assessed in the pupillometry task. In addition, prior to the study taking place, parents are asked to complete a questionnaire aimed to estimate their child's interests in the categories presented. From these tasks, we extract four main measures of interest: pupil diameter, choice in the sticker task, speed of choice in sticker task, and parental ratings of interest. We predict that (1) children's pupillary responses will be associated with the overt measures of interest obtained from children (choice and speed of choice in sticker task) and parental ratings of interest; and (2) parental ratings of interest will be related to children's choices in the sticker task. With this study, we validate a wide number of measures of interest in early childhood, thereby establishing physiological, behavioural, and parental responses as indicators of interest in young children. In doing so, we verify dependable methods to investigate how interest affects language learning during childhood.

P2-C-262 - Cross-decoding of eye movement dynamics reveals the incremental development of face-race representations in infancy (Xiao)

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Our ability to categorize faces develops rapidly within infancy. Recent behavioral findings suggest a qualitative developmental change: young infants categorize face races based on perceptual similarities (e.g., White vs. Black faces), but older infants' categorization is driven by conceptual knowledge (e.g., own- vs. other-race faces). The current study examined this developmental change through infants' eye movement patterns.

Eye movement dynamics have been regarded as a reliable measure to index preverbal infants' perceptual capacities. The current study used a data-driven approach to model the temporal and spatial pattern of infants' face-scanning data with the Hidden Markov Model (HMM).

Infants aged 3 (n = 23), 6 (n = 32), and 9 months (n = 26) watched videos of own-race and other-race female actors (30s/video). With eye movement data, we built one HMM for each participants' own-race face trial, and one HMM for each participants' other-race face trial. Then, we used leave-one-subject-out cross-validation to examine the accuracy of face-race classification. If infants formed categories of face-race, the face-race classification should be significantly above chance (50%). The results showed successful classification in 6- (65.5%, p = .002) and 9-month-old infants (72.9%, p = .001), but not in 3-month-olds (47.8%, p = .719).

To probe the development of face-race categorization, we performed cross-age classification. The HMMs of 6-month-olds failed to classify face-race from the eye movement of 3- (50.0%, p = .998) or 9-month-olds (50.0%, p = .998). The HMMs of 9-month-olds could classify the eye movement of 6-month-olds (61.9%, p = .023) but not 3-month-olds (58.7%, p = .230). Together, these results show the development of face-race categorization as an incremental process: infants' face-race categories become increasingly distinct with age. This suggests that young infants' face race representations serve as building blocks for later refined categories of face-races.

P2-C-263 - Diminished left gaze bias to faces in infants with elevated autism-related traits (Brittenham)

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Bias to looking at the left side of the face, thought to reflect configural processing mediated by the right hemisphere, emerges as early as the second half of the first year of life (e.g., Guo et al., 2009), aligning with neural evidence of configural face processing in early infancy (e.g., Scott & Nelson, 2006). Research with individuals with autism spectrum disorder (ASD) and infants with a family history of ASD has found a lack of left gaze bias to faces (Dundas et al., 2012a, 2012b). The broader autism phenotype (BAP) refers to a set of subclinical autism traits present in nonautistic individuals, and elevated ASD-related traits have been correlated with differences in visual processing in the broader population (e.g., DiCriscio et al., 2019). The current study extends this approach to examine how levels of ASD-related traits might relate to left gaze bias in infants with no family history of ASD. Eighteen infants (Mage)= 9.82 months, SD = 3.29; Range: 6-19 months) viewed 18 emotional faces, each for 5-s, taken from the NimStim database (Tottenham et al., 2009). Each face was preceded by a 1-s scrambled image of the face, and gaze was monitored by an SMI RED 120 Hz eye-tracker. Areas of interest (AOIs) were drawn on the left and right sides of stimuli. Net dwell time was calculated for AOIs, and a measure of left bias was calculated for faces and scrambled faces (left dwell time divided by left plus right dwell time). The Autism Observation Scale for Infants (AOSI; Bryson et al., 2008) measured ASD-related behaviors in infants, and categorical analyses examined infants high and low on the measure based on the AOSI scoring cutoff of 9 for Total Score. Across participants, a one-sample t-test examining left bias to faces against chance (0.5) showed a significant bias for faces, t(17) = 2.56, p = .02, but not scrambled faces, p = .11. A correlational analysis showed no relationships between left bias and AOSI scores (ps < .11). When examining infants high (n = 6) and low (n = 12) on the AOSI separately, the left bias to faces held only for the low ASD traits group, t(11) = 3.67, p = .004, who also showed a left bias for scrambled faces, t(11) = 2.73, p = .02. The high ASD traits group showed no left bias (faces: p = .73; scrambled faces: p = .87; see Figure 1). Past research found that infants with a family history of ASD showed a reduced left bias to faces (Dundas et al., 2012a), consistent with older autistic individuals (e.g., Dundas et al., 2012b). The

current study found this reduced left gaze bias in a group of infants with no family history who displayed elevated levels of ASD-related traits. This work extends our understanding of how early differences in visual processing associated with ASD or shared family history of ASD might also relate more generally to subclinical autism-related characteristics in the broader population (e.g., DiCrisicio et al., 2019).

P2-C-264 - Feeling Stressed: Physiological and Subjective Stress Responses to Infant Crying (Cregan)

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Crying is a powerful signal used to communicate from child to caregiver (Green et al., 2000). However, it is also an aversive stimuli that can lead to significant parent stress, particularly in cases where the infant is unsoothable (Humphry & Hock, 1989). Although considerable research has examined subjective parental stress responses to infant crying, few studies have explored physiological measures of stress such as electrodermal activity (EDA). When EDA has been assessed, there has not been a baseline measure to account for natural variation in EDA among individuals (Boukydis & Burgess, 1982). Additionally, more research is needed to evaluate how subjective and physiological stress are related. The study included 93 undergraduate participants (71 females, 22 males; MAge = 19.44 yrs, SDAge = 1.26 yrs). Each participant was presented with a 15-second, black baseline video clip, then they were shown either four, 30-second video clips of infant (i.e., less than 6 weeks old) crying or four, 30-second video clips of toddler (i.e., 3-5 years old) tantrums. This was followed by the block of videos the participants had not viewed yet. After each video, participants had 10 seconds to subjectively rate their stress from 1 (not stressed) to 7 (extremely stressed). Empatica?s E4 bracelets recorded EDA while participants viewed all video clips. Subjective stress scores were created by averaging all subjective stress ratings for infant crying clips. EDA scores were created by averaging samples taken during the crying videos. The results presented below are part of a larger study on perceptions of negative affect in infants and toddlers. The infant crying findings have been highlighted for this conference. A 2 (Time) x 2 (Gender) Mixed ANOVA was used to explore differences in subjective stress ratings for infant cries (Table 1). Participants rated their subjective stress significantly higher when watching the cry videos (M = 2.85; SE = 0.14) than at baseline (M = 1.14; SE = 0.06). There was no significant main effect of sex and no interaction. A 2 (Time) x 2 (Gender) Mixed ANOVA was used to explore differences in EDA ratings for infant cries (Table 1). Participants? EDA was significantly higher when watching the cry videos (M = 1.18; SE = 0.29) than at baseline (M = 0.83; SE = 0.18). Males (M = 1.51; SE = 0.41) had significantly higher EDA scores compared to females (M = 0.50; SE = 0.23). Males? EDA increased significantly more over time compared to females (Figure 1). A Pearson?s Correlation showed no significant relationship between subjective stress ratings and measures of EDA for watching the infant cries, r(92) = -.151, p = .152. The results showed that infant crying has an effect on both subjective and physiological stress (even after accounting for baseline levels of stress). However, the two measures of stress were unrelated when examining the impact of infant crying. Furthermore, there were gender differences in stress responses to infant crying. Although there was no difference in subjective stress ratings between males and females, the males in the study showed a larger physiological stress response compared to the females. More research is needed to determine why the two measures of stress are unrelated in this context and to examine gender differences in stress responses to infant crying.

P2-C-265 - Supporting Early Semantic Network Analyses: Extending the McRae Feature Database to Include a Comprehensive Set of Early Nouns (Johnson)

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One focus in word learning is the shift from learning single words to acquiring a lexicon. Of interest are the features of word-word relations that characterize semantic organization over time. Adults respond more rapidly to words with high, relative to low, relatedness (Locker et al., 2003; Yates et al., 2003). Unger et al. (2020) argue that semantic organization depends on the statistical co-occurrence of concepts in the language starting in early childhood. Studies of early semantic organization focused on predicting word acquisition in production find that children are most likely to produce new words that are semantically related to other words in their immediate environment (Fourtassi et al., 2020; Hills et al., 2009). Thus, acquisition is driven by properties of the external learning environment rather than internal semantic organization. In contrast, studies focused on characterizing the internal semantic structure of children's lexicons find that perceptual feature organization facilitates early word acquisition (Peters & Borovsky, 2019; Peters et al., 2021). Later, semantic features are activated by taxonomic relations (Hashimoto et al., 2007). Many of these researchers utilize words from the MacArthur-Bates Communicative Development Inventory (MCDI) and corresponding featural relations in the McRae et al. (2005) database. However, this database is missing many of early-occurring nouns in the MCDI. Method We collected semantic features for 174 early nouns from the MCDI (people, places, body parts, foods, and objects) from 85 native English-speaking adults between 18 and 40 years of age using an online survey. We prompted participants to report on physical features of the concept, associated activities, sounds, smells, and tastes. This yielded 5727 features across 174 common nouns. We identified features as encyclopedic, function, taxonomic, thematic, or perceptual. Perceptual features were further subdivided into tactile, taste, smell, sound and visual. The most common features were taxonomic, encyclopedic, and visual (see Figure 1). Results We are calculating metrics for comparability with McRae et al. (2005). We present here data on three metrics: the average number of times features are endorsed across concepts, their distinctiveness, and the number of distinguishing features. The number of times features are endorsed across concepts is higher in our data (x=14.3, SD=21.9) than the McRae et al. (2005) database (x=2.9, SD=7.4) whereas distinctiveness, the inverse of the number of concepts in which a feature occurs, is lower (x=.44, SD=.4 vs. x=.78, SD=.99, respectively). This reflects the high similarity of early nouns, particularly body parts and people. Nevertheless, distinguishing features, associated with only one or two concepts, are similar across data sets (x=.47, SD=.49 vs. x=.40, SD=.47) respectively), suggesting comparable featural separation across studies. We found this particularly for actions, objects, activities, and food (see Figure 2). Discussion We gathered semantic feature data on early nouns to supplement the McRae et al. (2005) feature database. We plan to complete a full array of analyses yielding a complete, publicly available, feature set for nouns on the MCDI available for future semantic network analyses. We aim to facilitate future studies examining developmental changes in semantic organization both longitudinally and across languages.

P2-C-266 - Infant sensitivity toward the timing of sounds generated by a dynamic visual object (Marin)

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Everyday perceptual experiences include dynamic objects that move and give rise to expected sounds. In young healthy adults, perceiving predicted sounds generated by a moving object, like a bouncing ball, results in reduced neural responses that reflect the integration of accurate predictions. To date, there have been no attempts to explore the development of similar perceptual skills in infancy. Here, we plan to test whether 4- to 5-month-old infants are sensitive to the temporal synchrony of expected sounds generated by a dynamic object. We plan to assess the looking time of 24 infants virtually, via their caregiver's local computer webcam. Our experimental paradigm includes a continuous series of ten alternating trials from two conditions of interest: audio-visual synchronous (AVS) and audio-visual asynchronous (AVA), each separated by an attention getter that serves as a central fixation point. In each condition (figure 1), the infant will view a green disk that continually moves along a physically plausible motion path within the boundaries of a 2-D rectangle display. The dynamic disk will bounce off the four boundaries of the display. For the AVS condition, the disk will make a sound precisely when it contacts a boundary, while for the AVA condition, the sound will occur slightly before visual contact. Infants will be shown each condition in one of two run orders, counterbalanced for initial disk onset side (left- vs. right side of the display) and initial presentation (AVS/AVA). Off-line, trained research assistants will blindly code the video recordings to obtain infant looking time for each presentation, which may be up to 20-seconds if the infant faces the screen throughout the entire trial. If the infant does not look at the screen for the entire trial, we will sum the total duration during which they look up until their first 2-second look away, which signals inattention. We will then perform a log transformation on the raw-looking time data in seconds for each trial to account for potential skewness within the data and then average these log-looking times across all valid trials in a condition. We will then perform a 2x2 mixed factorial ANOVA in which we will test for differences in the logged average looking time between the AVA and AVS conditions (2-level within-subjects factor) and a 2-level, between-subjects factor of initial presentation. We predict an overall main effect of condition, in that infants will look longer towards temporally asynchronous AV events compared to synchronous AV events regardless of which condition they saw first. We have currently piloted 5 infants on this paradigm and excluded one due to interference from the parent, resulting in a sample of 4 infants (Mage=4.6 months). The average logged looking time trends towards our predicted outcome (figure 2), where the infants looked longer toward the AVA (Mlog(10)=.94;raw-seconds=10.43) compared to the AVS condition (Mlog(10)=.85;raw-seconds=9.17). This small pilot sample may suggest an early sensitivity to the timing of sounds generated by a moving visual object in infancy. We are currently increasing the sample size (goal: N=24) to draw more meaningful conclusions regarding these preliminary results.

P2-C-267 - BabySINGchrony: Clinical case studies to map a singing intervention for neonates hospitalized due to neonatal opioid withdrawal (Hanson-Abromeit)

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Newborns exposed to opioids in utero experience neonatal opioid withdrawal (NOW). Targeted non-pharmacological interventions are needed to alleviate withdrawal symptoms post birth and potentially reduce the risk of long-term developmental implications from early exposure to opioids, e.g., sensory overstimulation, maladaptive behavioral and emotional regulation and physiological signs of stress (Jones, et al., 2018). Study Objectives: This study aims to operationalize an effective music intervention

to alleviate negative symptoms of NOW and identify emerging clinical context feasibility. Hypothesis: Salient features of improvisational singing matched to neonates' observable behaviors and responsively tailored to shift infant stress response will avert withdrawal symptoms and improve infant coping. Method: This qualitative multi-case clinical study design will use purposive sampling of 2 to 5 hospitalized neonates with suspected or diagnosed NOW. The epistemological approach is constructivist to capture multiple clinical perspectives and infant experiences to operationalize the intervention. At abstract submission, data has not been collected. Analysis Plan: A logic model process of analysis will be used to make interpretations of individual case studies and support cross-case synthesis refining the theoretical intervention components within the clinical context. Ongoing individual case analysis will occur as neonates are enrolled and multiple daily (1-3 days) music intervention sessions are conducted. The interventionist will audio record the sessions and compose a descriptive framework for each case following the daily data collection using session field notes, the case report form and Baby SINGchrony Data Tool. Data will also be entered into a spreadsheet; field notes and audio recordings will be transcribed. Audio recordings will be transcribed to define the music characteristics and analyzed for patterns within the music characteristics. Memos and notes will be used when discussing observations in the data to form a matrix for each case. A cross-case synthesis will compare individual case matrices, identify within case patterns and examine patterns for replication across case studies. Determination of consensus across the cases will identify additional variables from the clinical context. Affirmation, rejection or modification of the theoretical framework constructs and intervention components will be based on comparison of the multi-cases (Yin, 2018). The data on emerging feasibility will use descriptive statistics to assess parent and nursing acceptability and demand, and neonates' behavioral and physiological outcomes. Narrative description will inform implementation factor outcomes using information reported in the field notes, the case report form and Baby SINGchrony Data Tool. The logic analysis and emerging feasibility data will inform the intervention components and manual for use in a subsequent pilot study. Implications: Clinical case study analysis, paired with theoretical constructs formed from existing literature, and parent and nursing acceptability and demand, factors of implementation and limited infant efficacy will inform the components of a music intervention manual targeted at the specific needs for neonates with NOW. Music intervention development based on theoretical and contextual operationalization and stakeholder input fosters clinical relevance and replication within a staged research agenda.

Thematic Poster - A First Look - Conducting Looking Time Studies with Infants Online (P2-C-268, P2-C-269, P2-C-270, P2-C-271)

P2-C-268 - Accuracy and Technical Feasibility of Webcam-based Online Eye-tracking with Infants Using Labvanced (Schmidt)

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Online data collection has gained increasing importance during the COVID-19 pandemic. Many platforms have emerged, including approaches applicable with infant participants such as webcam-based eye-tracking. Despite the many advantages of online testing methods, researchers are facing serious challenges, for instance, possible limitations in data quality and technical feasibility (Gagné & Franzen,

2021). In this presentation, we evaluate both aspects, data quality and feasibility, based on two infant eye-tracking studies conducted via Labvanced.

In Study 1, N = 73 4- to 11-month-olds participated in a preferential looking task with pairwise arranged static faces. In Study 2, N = 47 8- to 11-month-olds took part in a gaze following and object encoding task. Infants and their gaze were automatically recorded. Each study started with a calibration, followed by a sequential presentation of attention-grabbing stimuli in all areas of interest (calibration validation trials). Subsequent to the eye-tracking study, parents were asked to fill out a questionnaire for feedback.

We examined the calibration quality in two ways: First, we relied on a calibration error value provided by Labvanced. The value was calculated with inbuilt Labvanced algorithms and evaluated by using the lower and upper bound threshold for valid calibrations. Strikingly, the number of well-calibrated infants depended strongly on taking the lower or upper bound threshold (44 vs. 7 [Study 1], 19 vs. 2 [Study 2]). Moreover, the lower bound threshold led to a tremendous exclusion rate due to invalid calibration (84.1% [Study 1], 93.6% [Study 2]). Secondly, we examined the accuracy of calibration based on calibration validation trials that we implemented manually in the studies. We interpreted a high congruence between gaze data and stimulus location in these trials as high calibration accuracy (inclusion threshold = 66% of gaze data in the area of the presented stimulus). This criterion turned out to be more liberal than the lower and more conservative than the upper calibration error threshold (cf. Figure 1). We are currently coding infants' gaze direction and looking times in the calibration validation trials manually to examine the concordance between manual coding and the above-mentioned approaches respectively. As manual gaze coding represents a reliable (e.g., Murphy, 2005) and valid method to extract looking durations (Venker et al., 2019), a high concordance would imply high accuracy of the particular approach.

With regard to technical feasibility, we found that a meaningful percentage of participants provided valid data in less than one experimental trial or poor video quality, implying technical difficulties (15.3% [Study 1], 24.4% [Study 2]). Considering infants who finished the study, the vast majority of parents did not report any troubles with frozen displays, cropped stimuli or sound problems.

Summing up, different approaches can be used to determine the quality of Labvanced eye-tracking data. In the presentation, we will critically discuss the two above outlined approaches, make a data-based suggestion about suitable thresholds, and evaluate the technical feasibility.

P2-C-269 - Comparing Online Webcam- and Laboratory-based Eye-tracking for the Assessment of Infants? Audio-visual Synchrony Perception (Bánki)

Anna Bánki[1], Martina de Eccher[2], Lilith Falschlehner[1], Stefanie Hoehl[1], Gabriela Markova[1]

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Online data collection with infants raises special opportunities and challenges for developmental research (Rhodes et al., 2020; Zaadnoordijk et al., 2021). One of the most prevalent methods in infancy research is eye-tracking, which has been widely applied in laboratory settings to assess cognitive development (Gredebäck et al., 2009). Technological advances now allow to conduct eye-tracking online with various populations, including infants. However, the accuracy and reliability of online infant eye-

tracking remains to be comprehensively evaluated (Wass, 2016). No research to date has directly compared webcam-based and in-lab eye-tracking data from infants, similarly to data from adults (Bott et al., 2017; Papoutsaki et al., 2016; Semmelmann & Weigelt, 2018; Xu et al., 2015).

The present study provides a direct comparison of in-lab and webcam-based eye-tracking data from infants who completed an identical looking time paradigm in two different settings (in the laboratory or online at home). In addition, the study explores whether webcam-based eye-tracking is a feasible method to measure infants' basic perception abilities, specifically the detection of audio-visual temporal synchrony (Hannon et al., 2017; Provasi et al., 2017).

We assessed 4-6-month-old infants (N = 38) in a preferential looking paradigm that measured the detection of audio-visual asynchrony between simple, socially meaningful stimuli (i.e., an infant bouncing to maternal singing), compared to complex, less familiar stimuli (i.e., a woman dancing to an instrumental song). Webcam-based and in-lab eye-tracking data were compared on eye-tracking and video data quality, infants' viewing behaviour, and experimental effects.

Results revealed no differences between the in-lab and online setting in the frequency of technical issues and participant attrition rates. Video data quality was comparable between settings in terms of completeness and brightness, despite lower frame rate and resolution online. Eye-tracking data quality was higher in the laboratory than online, except in case of relative sample loss. Gaze data quantity recorded by eye-tracking was significantly lower than by video in both settings. In valid trials, eye-tracking and video data captured infants' viewing behaviour uniformly, irrespective of setting. Despite the common challenges of infant eye-tracking across experimental settings, our results point towards the necessity to further improve the precision of online eye-tracking with infants.

Taken together, online eye-tracking is a promising tool to assess infants' gaze behaviour but requires careful data quality control. The demographic composition of both in-lab and online samples differed from the generic population on caregiver education: our samples consisted of caregivers with higher-than-average education levels, challenging the notion that online studies will per se reach more diverse populations (Sheskin et al., 2020).

P2-C-270 - The Effects of Visual Stimulus Complexity on Infant Curiosity (Zaadnoordijk)

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Infants do not just learn by passively observing but also by actively directing their attention, a behavior that has been dubbed curiosity-driven learning. Curiosity-driven learning has long been theorized to be an important learning mechanism (Berlyne, 1954), hypothesizing that the degree of novelty or complexity determines infants' ability to learn. This spectrum is subdivided into the three zones: relaxation, curiosity, and anxiety (Day, 1982), where relaxation and anxiety are considered to create little opportunity for learning by being too boring or complex. Empirical research using visual and auditory stimulus sequences at different complexities has shown that infants indeed attend longest to stimuli that are at an intermediate level of complexity; a finding that was dubbed 'the Goldilocks effect' (Kidd et al., 2012; 2014). Moreover, recent research showed that infants seek out those stimuli that maximize learning (Poli et al., 2020).

In contrast to previous studies, which tested curiosity-driven learning in infants in the context of sequence complexity, here in several online studies, we investigated whether a similar inverted u-shaped effect would be observed for different visual complexities of the stimuli themselves as well. In three studies, we have shown infants movie stimuli with three levels of complexity. In the first two studies, visual complexity was defined through MPEG-bitrate, a measure that quantifies the compressibility of the visual information. In the third study, complexity was defined according to the rate of information change (i.e., the speed at which the movie was played). Following previous findings, we hypothesized that we would find an effect of intermediacy, i.e., that infants would prefer the medium level of complexity (Goldilocks effect).

1- to 14-month-old infants were shown one movie clip per complexity level (i.e., three in total, with counterbalanced order) in a within-subjects design. We acquired infants' looking behavior measures via online webcam recordings via a home-built browser-based platform. Due to the asynchronous nature of the study, we gave parents very explicit instructions about lighting, parental interference, distractors, and so on. Videos were selected for pre-processing if the baby's eyes were visible (i.e., when there had been enough lighting). Subsequently manual video-tagging was conducted in ELAN (Sloetjes & Wittenburg, 2008).

The preliminary results of the first study, which was based on compressibility of visual information, revealed no significant effect of visual complexity on looking time. These initial findings suggest that infants may not be preferentially attending to every type of stimulus complexity. The data collection for the other two studies is still in progress. In our presentation, we will discuss our full set of results, the strengths and limitations of our study, and how our findings should be interpreted in the context of curiosity-driven learning in infancy.

P2-C-271 - The Interplay Between Parental Input, Children?s Interests and Word Learning in Children (Satarai Madhavan)

Rajalakshmi Satarai Madhavan[1], Bella Davydov[1], Nivedita Mani[1]

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Parental language input is vital for children's vocabulary growth (Hart & Risley, 1995). Every-day activities like shared book-reading have been shown to boost children's language acquisition (Mol et al., 2008), where parents modify their interactiveness according to the child's requirements (e.g., Pattison & Dierking, 2019). As primary caregivers, they can also usually pinpoint what their child likes (Mata et al., 2008; Søndergaard & Edelenbos, 2007), and engage with them in many ways to maintain such interests (Leibham et al., 2005). At the same time, research also suggests that children actively influence their learning environment, by eliciting information they are interested in, and retaining such information better (Mani & Ackermann, 2018). However, the role of parental input and children's interests in language learning have typically been examined in parallel. Against this background, the current study will investigate the extent to which the quality of caregiver-child interaction is modulated by children's active interest in the activities being undertaken.

We examine whether: (1) parents can accurately estimate their child's interests; and (2) the quality of caregiver-child interaction during a semi-naturalistic task (i.e., shared book-reading) is modulated by

children's interest in the content being discussed. Furthermore, (3) we also examine the combined effect of the quality of caregiver-child interaction and children's interests on children's learning.

For this study, our participant group is 70 2-2.5-year-old monolingual German children. This online study has three parts: (1) a shared book-reading task, where parents read two books to their child - one which has previously been determined to be of high and one of low interest to the child (with one novel word-object mapping introduced in each book), (2) an online gaze recording task to assess children's interest in the range of categories being addressed in the books and (3) an online gaze recording task to test later recognition of novel word-object mappings presented during book-reading. The last two tasks are first recorded via webcam and then manually coded using ELAN (Sloetjes & Wittenburg, 2008).

We predict that (1) parents can accurately indicate what their child is interested in, (2) the quality of caregiver-child interaction will be higher during shared book-reading of the high interest book, and (3) children will show improved learning of novel word-object mappings when the quality of interaction during book-reading and their interest in the object category is high.

This online study is different from its in-person counterparts: while previous in-person eye-tracking studies show results that support some of our hypotheses (e.g. Ackermann et al., 2020), this online study extends beyond learning in isolation (information shared with the child in a controlled environment like in-person studies), and allows for us to examine this phenomenon in a semi-naturalistic setting, with learning taking place under a naturally interactive context.

P2-C-272 - Emerging sensitivity to statistical regularities in musical pitch structure in infancy (Kragness)

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Engaging with culturally-familiar music often feels effortless. Most adults can easily tell when someone sings a wrong note at the local open mic night, or clap along to songs on the Billboard Top 40. The same listeners might struggle, however, when presented with foreign music composed using different pitch and metrical patterns. Over time, we implicitly learn patterns common in our culture's music. Fluency with culturally relevant musical patterns enables us to easily clap, dance, sing, and enjoy music with others, which can be socially and emotionally powerful experiences. In the present study, we investigated the emergence of culture-specific knowledge about musical pitch sequences in infancy. We used a preferential listening paradigm to measure older (12-14 months) and younger (6-8 months) Canadian infants' attention to pitch sequences that were relatively predictable or unpredictable given the statistical regularities of Western music. The predictability was characterized by a statistical model trained on a corpus of Western music. If infants have acquired expectations consistent with the statistical regularities in Western pitch sequences, the predictable sequences will sound relatively familiar and the unpredictable sequences relatively novel. We expected that infants lacking such expectations would show no preference for either sequence, but infants who have acquired such expectations would preferentially attend to stimuli in one or the other condition. Families completed the preferential listening task with their infant from the comfort of their home while the experimenter shared their screen over Zoom, presenting the stimuli in a preferential listening paradigm via PyHab (Kominsky, 2019). Visual inspection of a half-sample (current N = 40) suggests that the older infants

preferred the unpredictable sequences (a novelty preference) while the younger infants had no preference. Data collection on the full sample (N = 70) is now complete, and full analyses are underway. Previous studies have suggested that culture-specific expectations for musical pitch are not observable until 3 or 4 years of age (e.g., Corrigall & Trainor, 2013), or perhaps earlier for infants who have attended regular, active group music lessons (Gerry et al., 2012). Notably, these studies relied on stimuli generated from principles derived from Western music theory, rather than from the statistics of music itself. Results suggest that over the first year of life, following general principles of statistical learning, infants begin to implicitly learn the statistical properties of the musical pitch sequences that they hear in their environments.

P2-C-273 - Preferential fixation of hierarchical vs non-hierarchical audiovisual sequences in 8-10 month old and 12-14 month old infants (Schmuckler)

Mark Schmuckler[1], David Lewkowicz[2]

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One critical cognitive skill involves the ability to abstract underlying structure from the constantly variable information presented to our perceptual systems. Although this question has been broached in research investigating infants' statistical learning abilities, this work is limited in that it assesses what are essentially associations between adjacent elements, and thus fails to capture the extraction of higher-level temporal structure inherent in audiovisual event sequences. In contrast, work on serial pattern learning (e.g., Restle, 1970) has investigated adults' sensitivity to pattern structure defined by specific rules and has demonstrated that adults can perceive hierarchically patterned sequences and that they can learn such sequences more easily than yoked non-hierarchical sequences. Lewkowicz, Schmuckler & Mangalindan (2018) investigated learning of hierarchical sequential patterns in infancy and found that 8-10 and 12-14 month-old, but not 4-6 month-old, infants successfully learned them. Using a habituation paradigm, these authors found that infants abstracted the concept of hierarchical structure from multiple exemplars of such sequences and they then discriminated a novel hierarchical sequence from a novel non-hierarchical sequence. The current study extended this work by examining whether infants spontaneously prefer hierarchical versus non-hierarchical audiovisual sequences. Given that adults learn hierarchical sequences more easily than non-hierarchical ones, we predicted that infants would exhibit greater attention - indicative of increased processing - to more difficult, non-hierarchical patterns. To test our prediction, we presented two repetitions of six each of the hierarchical and non-hierarchical audiovisual sequences from Lewkowicz et al. (2018) to 8- to 10-month-old (N = 25, M age = 9.4 mos) and 12- to 14-month-old (N = 19, M age = 12.7 mos) infants and measured their looking. All experimental sessions occurred remotely, with infants viewing these sequences through a YouTube channel hosting the stimulus sequences. Recorded looking behavior was subsequently coded using the ELAN annotation tool. Looking durations (averaged across repetition) were analyzed in a three-way ANOVA, with the factors of Sequence Type (hierarchical, non-hierarchical), Age Group (8-10 month olds, 12-14 month olds), and Order (four different prerecorded random orders). We found a significant main effect of Sequence Type, $F(1,36) = 9.4$, $p = .004$, with greater looking at the non-hierarchical (M = 23.5 secs, SE = 1.14) than the hierarchical sequences (M = 21.4 secs, SE = 1.05). Also, we found a non-significant main effect of Age Group, $F(1,36) = 0.55$, ns, and a non-significant Sequence Type x Age Group interaction, $F(1,36) = 0.04$, ns. Overall, these findings indicate that 8-14 month-old infants prefer non-hierarchical to hierarchical audiovisual sequential patterns and suggest that older infants, like adults, find it more

difficult to perceptually process non-hierarchically structured information. This, in turn, indicates that a preference for hierarchically organized temporal patterns is in place precisely at the time when linguistic abilities, which depend critically on the perception of hierarchical patterns, are emerging.

P2-C-274 - 2-year-olds? selective sensitivity to facial dominance traits (Galusca)

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From early on, infants are sensitive to social hierarchies and they can infer conflict outcomes based on a variety of cues (Thomsen et al., 2011; Pun et al., 2016). By age two, conflict outcome drives their social preferences and behaviour: toddlers prefer to approach winners of zero-sum conflicts (Thomas et al., 2018). Interestingly, for adults seeing novel faces is sufficient to trigger dominance evaluations, even when conflict is absent (Willis & Todorov, 2006). To date, it is unclear if toddlers also make automatic power evaluations in the absence of conflict. Specifically, here we asked if toddlers are sensitive to dominance traits from faces, and if this sensitivity depends on their experience with different types of faces. To address this question, we employed a visual preference paradigm in a set of three experiments to study 18- and 24-month-old toddlers' sensitivity to dominance traits from faces ranging in familiarity (i.e., female, male, artificial). At this age, female faces are highly frequent in infants' environment, male faces are moderately frequent, and artificial faces are completely unfamiliar. Face pairs were selected based on adult ratings, to have a matching level of attractiveness, but a different level of dominance. Experiment 1 tested the visual preference for natural female faces (i.e. highly familiar). For each face pair, we calculated difference scores as the mean difference between proportional looking times to the dominant minus submissive faces. Preliminary results indicate that when faces were presented upright, 24-month-old toddlers (N = 25 out of 32) showed a preference for the dominant character (p = .020), but no preference was found when the same stimuli were inverted (p = .366). Furthermore, toddlers looked significantly longer at the upright than at the inverted dominant female face (p = . 027; see Figure 1). However, the younger group (N = 24 out of 32) showed no preference for upright (p = . 966) or inverted female faces (p = . 643). Experiment 2 presented natural male faces (i.e. moderately familiar) and no preference was found for the upright or inverted conditions for either age groups (ps > .1; N = 26 out of 32 for 18mos and N = 28 out of 32 for 24mos). Experiment 3 presented artificial morphed faces (i.e. unfamiliar) and toddlers showed no sensitivity to dominance traits in either the upright or inverted conditions (ps > .07; N = 17 out of 32 for 18mos and N = 25 out of 32 for 24mos). Taken together, these results show that starting at 2 years of age, infants become sensitive to dominance traits from faces, but only for highly familiar categories, like same race female faces. One possible interpretation is that sensitivity to dominance traits from faces is primarily the product of extensive experience, that begins to unfold in the second year of life. Further studies are needed to confirm that infants if infants' interpretation of dominance traits from faces is similar to adults' and if they use facial appearance to infer conflict outcomes.

P2-C-275 - How does efficient coding of visual textures arise in human development? An infant study (Nallet)

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Neural encoding is believed to be adapted to the statistics of natural stimuli to efficiently process sensory inputs. This principle, known as efficient neural coding, successfully explains many aspects of sensory processing (Simoncelli & Olshausen, 2001). Recently, human adults' sensitivity to visual textures defined by multipoint correlations (Figure 1) has been found to match the variability of these correlations in natural images (Hermundstadt et al., 2014), suggesting that visual perception obeys efficient coding principles at the cortical level, too. Adults showed the highest sensitivity to one- and two-point correlations, followed by four-point and lastly three-point correlations. How does the efficient coding of visual textures arise in human development? To address this question, we are currently conducting an online study (using the Labvanced platform) aimed at measuring the sensitivity of 4-12 month-old human infants to multipoint correlations (one-, two-, three- or four-point correlations; Figure 1). To do this, we use a simple spontaneous looking-time preference paradigm (Figure 2A). In total, twenty-five images are shown to infants corresponding to five different images of each of five experimental conditions: the four types of multipoint correlations as well as white noise patterns as a control. Each image is shown for seven seconds and the order of the images is pseudorandomized across participants. Looking times are then coded offline. Preliminary results from seven infants show statistically significantly different looking time across conditions (ANOVA: $F(4,24)=5,469$; $p=0.0028$). Participants looked significantly longer at the one-point and three-point correlations than at the four-point correlations (Figure 2B). Infants thus show differential responses to different image statistics. We interpret longer looking times to three-point (and one-point) correlations as a potential surprise response. However, additional data is necessary to verify this. If confirmed with the full sample (n=30), these results will provide the first evidence that the developing visual system shows differential sensitivity to image statistics in visual textures.

P2-D-202 - Electronic media, language input, and language output in Latinx infants (Ferjan Ramirez)

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During the first two years of life, infants undergo a remarkable period of linguistic development. Sociocultural theories emphasize the importance of infants' social experiences in this process (Hoff, 2006), and studies demonstrate that infants benefit enormously from live speech compared to language exposure through electronic sources (Kuhl et al. 2003). In monolingual English-speaking North American families, infants' exposure to electronic media is on the rise (Zimmerman et al. 2007), despite multiple studies demonstrating its negative effects on infant language development. Here we characterize the relation between electronic media exposure and parental and infant language in Latinx families, who are linguistically and socioculturally distinct and numerically on the rise (Linton & Gutierrez, 2020). Studying the effects of electronic media in this population can illuminate the mechanisms by which the well-known disparities in language outcomes emerge. Thirty-seven mother-father families with typically developing infants between 4 and 22 mo (18 girls) participated; all infants were of Latinx descent and heard Spanish and English from native speakers in their homes. Using Language Environment Analysis (LENA), we collected two daylong audio recordings from each family. Estimated exposure to electronic media (TVN), Adult Word Counts (AWC), and Child Vocalization Counts (CVC) were provided through LENA's automatic annotation. Further, electronic media exposure (%media) conversational turn count (CTC), infant-directed speech (IDS), and infant babbling were manually annotated (Ramírez-Esparza et

al., 2014). A third measure of electronic media exposure was obtained through a parental questionnaire. Linear regression was used to evaluate associations of electronic media exposure with parental language input and infant language while accounting for demographics (socioeconomic status, infant age, and infant sex). Based on LENA's estimates, infants received an average of 48 minutes of daily media exposure; based on manual annotation, electronic media were detected in 32% of coded segments. According to parental report, the average daily media exposure was 75 minutes. Interestingly, the two objective measures of media exposure (TVN, %media) were significantly correlated with each other (r = .51, p=.001), but neither was associated with parental report (ps>.1), suggesting that parents may over- or underestimate infant media consumption. The association between AWC and exposure to media was not significant for either objective measure of media exposure (ps>.3). However, there was a significant negative association between TVN and parental IDS (p=.024) and a marginally significant association between %media and parental IDS (p=.079). Furthermore, %media was negatively associated with parent-infant turn-taking (CTC; p=.013) and infant babbling (p=.013), while TVN was negatively associated with child language vocalizations (CVC; p=.004). The present findings suggest that exposure to media negatively impacts infant vocal activity by reducing parental IDS and parent-infant turn-taking, both of which are known to positively impact infants' linguistic, socioemotional, and cognitive development. Follow-up manual analyses (completed by the time of conference) will provide understanding of the qualitative and linguistic aspects of infant electronic media exposure (type and language of exposure).

P2-D-203 - Evidence of a consonant bias in French-learning infants? word learning in Cantonese. (Nazzi)

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Nespor et al. (2003) proposed that consonants and vowels carry different functions in language processing, vowels being more important for prosodic and syntactic processes and consonants for lexical-related processes. The C-bias in lexical processing is supported by adult and infant studies in several languages including English or French, although some cross-linguistic variations exist (see Nazzi & Cutler, 2020, for a review). Importantly, a C-bias could not be found in two tonal languages, Mandarin and Cantonese (Wewalaarachchi et al., 2017; Chen et al., 2021, for a review), Chen et al. (2021) even finding a V-bias in Cantonese-learning 30-month-olds: these toddlers could learn pairs of new words differing by a vowel, but failed when the words differ by a consonant or a tone. This provides evidence that phonological biases in lexical processing are acquired and reflect native language properties, with vowel weighting in tonal languages being increased, probably due to the fact that tones are mostly carried by vowels (Khouw & Ciocca, 2007). Here, we test whether, once having acquired a bias through native language exposure, infants use that bias to process stimuli in a new language that leads to the opposite bias, or whether performance is driven by stimulus properties. More specifically, we presented French-learning 30-month-olds, who have a C-bias in native processing (Nazzi, 2005), with Chen et al.'s Cantonese word-learning experiment. The toddlers were taught pairs of words that either differed on a consonant, vowel or tone (between-subject design, 32 toddlers per condition). Preliminary results (Figure 1) show that the task was difficult for these infants, with marginal word-learning only for girls in the C-contrasted condition (p = .051). These findings weakly suggest that native biases are used when processing non-native languages. Chen, H., Lee, D.T., Luo, Z., Lai, R.Y., Cheung, H., & Nazzi, T. (2021).

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P2-D-204 - Vocabulary complexity in paternal and maternal parentese: A longitudinal corpus analysis (Sheth)

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Infant directed speech or parentese is an acoustically exaggerated speech style with simpler phonology and grammar, fewer and simpler lexical items, higher pitch, and exaggerated intonation (Ferguson, 1964; Fernald & Simon, 1984) which has been shown to enhance child language outcomes (Ferjan Ramírez et al., 2020; Ramírez-Esparza et al., 2014). While we have long known that fathers also produce parentese (Fernald et al., 1989), our current understanding of parentese and its role in infant language learning is based almost exclusively on maternal contributions (Saint-Georges et al., 2013). Given recent societal changes, mother-centered models of parentese may be outdated. The present longitudinal study compares the quality of vocabulary within maternal and paternal parentese in the first two years of life. Daylong recordings from the same 23 infants (12 girls) were collected at ages 6, 14 and 24mo, in English-speaking families. Infants wore a lightweight LENA device and were recorded on two weekend days with both parents home. Maternal and paternal parentese was manually transcribed in 100 30-s segments per participant per age, following previously described procedures (Ferjan Ramírez et al., 2020; Ramírez-Esparza et al., 2014). At each age, we consider for mothers and fathers, the number of total words (tokens), unique words (types), and the total number of question (who, what, where, etc.), complexity (and, but, if, actually, etc.), and mental state words (think, feel, want, know, etc.) within their parentese. For both mothers and fathers, we predicted an increase in parentese complexity over time, as their infants become more competent language users. Using paired t-tests, we found that, compared to fathers, mothers had overall more tokens (6mo: $p=.001$; 14mo: $p<0.001$; 24mo: $p=.038$), types (6mo: $p<.001$; 14mo: $p<.001$; 24mo: $p=.006$) question words (6mo: $p=.018$; 14mo: $p=.002$; 24mo: $p=.043$), complexity words (6mo: $p=.002$; 14mo: $p<.001$; 24mo: $p=.019$) and mental state words (6mo: $p<.001$; 14mo: $p=.001$; 24mo: $p=.011$), in agreement with previous findings demonstrating that mothers produce an overall higher quantity of parentese (Shapiro et al., 2021). We then compared the rates of increase between 6-14 mo and 14-24 mo for both mothers and fathers. Mothers had a faster increase in the number of tokens ($p=.03$), types ($p=0.04$), and question words ($p=.01$) between 6-14 mo. In contrast, fathers had a faster increase in the number of tokens ($p=.003$), types ($p=.003$), question ($p=.04$), complexity ($p=.005$) and mental state ($p=.05$) words between 14-24 mo. These findings demonstrate that fathers, like mothers, adjust their parentese complexity as their children become more competent language users. Mothers show the greatest adjustment between 6 and 14 mo. Fathers also show the

same type of adjustment, but later, between 14 and 24 mo (Fig1). These findings are in agreement with previous evidence suggesting that the gap between maternal and paternal parentese is particularly pronounced in early infancy (Shapiro et al., 2021), perhaps as a consequence of fathers spending a greater proportion of time interacting with children in physical play activities (Parke, 2002), which youngest infants many not yet engage in.

P2-D-205 - An infant-like robot can induce mothers to use infant-directed speech as fully as when speaking to their own infants (Iwamoto)

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Background: When mothers speak to their infants, they modify their speech. This is called infant-directed speech (IDS), and is known to have characteristics that differ from adult-directed speech (ADS). Speech modification can occur in other registers as well, for example, when speaking to foreigners or talking to pets. To date, however, no other conversational partners than infants have been found to induce the full range of IDS features. In the present study, we utilized an infant-like robot (Figure 1) as a conversational partner for mothers, and compared their speech to the robot with that toward their own infants. We found that mothers' speech to the infant-like robot exhibited a full range of IDS features that were as strong or even stronger than when they spoke to their own infants. Method: We recorded 2 groups of mothers with infants around 18 months old. One group of mothers spoke to a robot designed to simulate the face and body features of a young child. The mothers were told that the robot was built to have an intellectual ability similar to an 18 month old human infant. They were then given a set of named toys and asked to teach the names to the robot. The responses of the robot were controlled by a hidden operator. We called this the RDS (robot-directed speech) session. Another group of mothers taught the names of the same toys to their own infants (IDS session). Both groups of mothers were also recorded speaking with a female experimenter (ADS). From the recordings, the target words in RDS, IDS, and ADS, were extracted, and the average pitch (F0), F0 range, word duration, and vowel spaces were measured. Also, tokens of the target words were presented randomly to naïve listeners who were asked to rate how likely it would be for the token to be found in infant-directed speech, whether it conveyed positive emotions, or would attract an infant's attention, etc. Results and Discussion: In all measurements, the IDS and RDS tokens showed significantly more IDS-like features than the ADS tokens, except for vowel space, where neither IDS nor RDS differed from ADS. The robot successfully induced mothers to produce IDS as successfully as did real human infants. In some cases, RDS was found to induce significantly higher IDS-like features: e.g., the average F0 was significantly higher in RDS than IDS (Figure 2). In the ratings, RDS was rated higher than IDS as conveying positive emotions and attracting the listener's attention. Taken together, the current results demonstrate that given an appropriate context, an infant-like robot can induce mothers to speak in IDS as fully as when speaking to their own infants, suggesting it is not necessary for the listener to be a real human infant to induce real IDS-like speech. This opens up a new venue for IDS research in which we can manipulate factors related to the infants' side, especially the appearance and type of responses, both verbal and behavioral, and the contingency of those responses.

P2-D-206 - Dissociation of objects from object-specific actions predicts later vocabulary growth of action words (Hagihara)

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Background: Object words are generally learned earlier and more easily than action words. Intuitively, object words correspond semantically to specific object categories; however, some scholars argue that, during the early phase of language development, object words do not sufficiently differentiate into object categories but have undifferentiated meanings in which both objects and object-specific actions are embedded in a fusional way (e.g., Werner & Kaplan, 1963). This account has recently been examined experimentally (Hagihara & Sakagami, 2020). Based on this account, the late growth of action words can be explained differently. That is, when object words have undifferentiated meanings, action words are less necessary for children because they can express both objects and actions simply by object words. Only after these words semantically differentiate into objects that are independent of actions, children are encouraged to use new labels corresponding to specific actions, leading to the vocabulary growth of action words. Objective: To experimentally investigate this account underlying the development of action-word production, we conducted a longitudinal experiment. First, we investigated the extent to which toddlers could dissociate objects from their specific actions when understanding the meanings of object words. We then collected the extent to which the productive vocabulary size of action words increased two months later. We expected that toddlers' action-word vocabulary growth could be predicted by the degree of their former semantic differentiation of object words. Methods: Sixteen monolingual Japanese toddlers (seven, girls) were included in the analysis. The first time, they were 18-19 months old (mean age = 18.6, SD = 0.5) and 20-22 months the second time about two months later (mean age = 21.1, SD = 0.7). At Time 1, participants were asked to look at either of the two juxtaposed videos that matched the object words (e.g., "Which is the cup?"). A video stimulus in which a girl was doing the object-specific action with the filler object (e.g., "drinking with a toy shovel as if it were a cup") was juxtaposed with another where she was doing a meaningless action with the target object (e.g., "making a circular motion with a cup"). The score of looking at the stimulus including the target object was regarded as a measure by which participants could dissociate objects from object-specific actions. We collected participants' productive vocabulary size using the Japanese MacArthur-Bates Communicative Development Inventory at both time points and calculated the difference scores in the number of action words. Results and Discussion: A Bayesian hierarchical generalized linear model demonstrated that the score of looking at the target objects even when they were used unusually significantly predicted an increase in the vocabulary size of action words. Thus, the more toddlers could dissociate objects from object-specific actions when understanding object words, the more their action-word vocabulary increased two months later. This study showed the first experimental evidence of how semantic change in object-word development related to vocabulary growth while bridging both object and action words.

P2-D-208 - Code-switching in Parent-Child Book-Sharing Interactions Among Latinx Families in the US (Guendica)

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Shared reading is a powerful context for promoting early language and literacy development. However, there is limited research on how bilingual parents use both languages when reading with their infants.

Code-switching (CS), the linguistic phenomenon of alternating between languages, is common among bilingual speakers. CS provides a window into the ways bilingual families use their linguistic resources to communicate. In addition, CS may also serve as a teaching mechanism by which parents of bilingual children support language learning in both languages. The present study examines the frequency and types of CS used by Latino parent-child dyads when engaging in shared-reading with a bilingual book. Parent-child dyads were enrolled in a larger study of early literacy in Latinx families when infants were 1-3 years old (M=22 months). At enrollment, information was collected about parents' language, book reading practices, and children's vocabulary in English and Spanish using the MCDI. A subset of parent-child dyads (n=15) participated in a book-sharing observation over Zoom when children were 3-4 years old in which they shared two children's books that we provided: one monolingual (English-only) and one bilingual (English-Spanish) book. The present analysis focuses only on the bilingual book. Observations were coded for code-switches that occurred during extra-textual talk only (i.e., not when reading the book text itself). Four types of code-switches were analyzed: 1) intra-sentential switches, 2) inter-sentential switches, 3) inter-speaker switches, and 4) reading-to-talk code-switches (See Table 1). On average, shared reading interactions lasted approximately six minutes. Of these interactions, 13/15 (87%) of participants engaged in CS during extratextual talk. On average, there were a total of 14.53 code-switches per interaction, equivalent to a rate of 2 code-switches per minute. Results revealed that intra-sentential switches were the most prevalent form of CS ($p<.05$, see Figure 2). In addition, there was a significant difference in the direction of code switches: CS from Spanish to English was more frequent than CS from English to Spanish ($p<.05$). Qualitative analyses of these code-switches revealed that many were translational noun equivalencies or cross-language synonyms representing the same object, which occurred within the same sentence (e.g., El viento means wind) or between sentences (e.g., This is a bear. Un oso). Ongoing analyses are examining individual parents' CS strategies in relation to infants' vocabulary knowledge concurrently and at 22 months. These findings suggest that CS in shared reading is common among bilingual families and may extend to other parent-child enrichment activities. In addition, the use of translational noun equivalencies may be a strategy used by parents to support dual-language vocabulary growth during reading. Finally, the direction of the CS may reflect parental language preferences when reading books to their children. Observing the shared reading practices of parent-child dyads can bring additional insight into how parents code from that obtained by the self-reported use of CS. Together, these findings suggest that the use of CS during shared reading may promote dual-language development.

P2-D-210 - The development of Italian vocabulary, morphology and syntax: an observational study (Burgato)

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Despite increasing attention to language development across typologically different languages, acquisition remains understudied in many languages. Italian, an Indo-European language with moderately complex fusional morphology and Verb-Object word order, is one such example. Indeed, the last corpora were contributed to the CHILDES database in Italian in 2006. To fill this gap, in this study, we document longitudinally the language development of Italian-learning toddlers. Our aim is to track vocabulary growth, morphological development, the emergence of syntax and the interactions between them, as well as to contribute a new Italian corpus to the CHILDES database. The study involved 6

Italian-speaking infants (1 female and 5 males). The participants were recruited from a kindergarten in the north-east of Italy. All children were healthy, with no reported concerns about language development. Infants were first assessed between 18 and 29 months (mean: 23.33 months) and followed longitudinally over 8 months. We assessed vocabulary using the Italian version of the MacArthur-Bates Communicative Development Inventory (CDI; Caselli et al, 2015) during the 1st and the 6th months of the observation period. We tested participants' knowledge of nominal morphology using an adapted Italian version of the Wug Test (Berko, 1958) at the beginning of the period, as well as their spontaneous speech productions recorded during free play and book-reading sessions and other kindergarten activities. Syntactic development was also assessed using spontaneous productions, by calculating the MLU in words and in morphemes. The frequency of lexical categories, non-prototypical word order (not SVO) and the emergence of subordinate clauses were also marked. Children's productions were recorded approximately every two weeks (still ongoing). All recorded speech samples were transcribed into CHAT format (MacWhinney, 2000). The vocabulary scores of subjects on the CDI at month 1 are shown in Table 1. All children were within the norm for their age, despite considerable inter-individual differences. All participants achieved 100% correct responses on the Wug Test, exhibiting complete knowledge of nominal plurals. In confirmation, nominal suffixes for gender and number were correctly produced in spontaneous speech as well, in line with previous findings for Italian (Caprin and Guasti, 2009). The MLU scores in morphemes are shown in Figure 1 for months 1 to 3. MLUs scores increase considerably and most children reach a combinatorial stage within the observation period. In the speech samples open-class words were more frequent than functors and nouns were predominant as expected (Bates et al, 1994; Caselli et al, 1995). A more detailed analysis of lexical categories and of word order is ongoing. Vocabulary size and MLU will be correlated. Languages with more complex morphology than English offer insight into the interactions of different levels of language during development. Our findings suggest that in Italian, nominal morphology is well established before combinatorial grammar emerges.

P2-D-211 - Co-ocurrence lexical networks in Down Syndrome (Rubí)

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During early childhood, infants begin learning new words and incorporating them into their vocabularies this is true for typically developed (TD) as well as for children with Down syndrome (DS) (Abbeduto, Warren, & Conners, 2007; Hoff & Naigles, 2002). Current theories stress the role of associative learning on lexical development. A complementary perspective to examine early language skills, views language learning as a sefl-organized mental lexicon, which can be described by a web-like structure of interacting lexical items. This perspective can provide more detailed information about language acquisition processes. Moreover, network models of language have provided a way of linking cognitive processes to the structure and connectivity of language. Previous studies have examined language development from this perspective. Beckage, Smith and Hills (2011) provided a network representation of the mental lexicon and used the connectivity of language within the vocabulary of young learners and showed that there are differences in the structure of the vocabularies of children at risk for language impairments and those of typically developing children. However, there have been no attempts to describe the

atypical lexical organization in DS. In this work we compared the vocabularies and corresponding semantic networks for 9 Typical development infants (mean chronological = 1.9 years) and 9 children with Down syndrome (mean mental age = 3.5 years). Children's vocabularies were collected via a widely used parent checklist, an adapted version for children with DS of MacArthur-Bates Communicative Development Inventory (Galeote, M., Soto, P., Serrano, A., Pulido, L., Rey, R., & Martínez-Roa, P. 2006). Networks were constructed according the words in each child's vocabulary and also in agreement to the co-occurrence statistics of the words in a normative language-learning environment. Each child's semantic network was derived from the list of words that parents reported their child to use in everyday speech. For each individual child's network, three network statistics (in-degree, clustering coefficient, and geodesic distance) were computed in an open-source software for graph and network analysis (GEPHI 0.9.1). Results showed that the DS lexical networks (M=0.19; SD=.04) have a higher average of clustering coefficient [t (1,16) = 2.37, $p < .05$] than the TD lexical networks (M = 0.13; SD = 0.066). Thus DS networks showed more local structure than TD networks. It has been suggested that children with DS lexical networks have been organized through relations between words as their typical peers, independent of their problems at the oral production level (Barrón-Martínez, J. B., Arias-Trejo, N., & Salvador-Cruz, J. 2020). Furthermore, it is likely that the DS group has developed a capacity for conceptual abstraction that allows them to extract contextual and functional properties of objects. Also, differences between the two grous may be related to the difference sin exposure to contextual relations, independently of children's mental age.. Thus, experience may be playing an important role in providing detailed information, which reduces distance between words (Stella, M., Beckage, N. M., & Brede, M. 2017).

P2-D-212 - Following the early milestones of language development in two sensory modalities: Language development in hearing infants with deaf mothers (Mercure)

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If a deaf mother uses a sign language as her preferred mode of communication, her hearing infant has a different early experience of speech and language to that of infants with hearing mothers. This experience includes both a language in the visual modality, e.g., British Sign Language (BSL), and one in the auditory modality, e.g., English. Research on language development in these bimodal bilingual children is scarce, often based on small samples, frequently associated with contradictory results, and rarely addresses the earliest phases of language development. The present study aimed to fill this gap in the literature by examining language acquisition in bimodal bilinguals in their first two years of life compared to infants acquiring two spoken languages (unimodal bilinguals) and infants acquiring a single language (monolinguals). Data is presented from 31 bimodal bilinguals between 5 and 8 months [with longitudinal data at 15 (n= 22) and 24 months (n=19)], compared to 28 unimodal bilinguals (n = 12 at 15-months and n =16 at 24-months) and 30 monolinguals exposed to English only (n = 22 at 15-months and n = 22 at 24-months). At 5-to-8-months, the Mullen Scales of Early Learning was administered as well as questionnaires of language exposure. At 15 and 24 months, language preferences questionnaires were completed by parents or another respondent close to the child as well as the Communicative Development Inventory (CDI) in English (and BSL in bimodal bilinguals). The Mullen Scales of Early Learning revealed that bimodal bilinguals significantly outperformed monolinguals and unimodal bilinguals in their receptive language skills at 5-to-8-months. At 15-month-old, the CDI suggested no

significant differences between groups in English receptive and expressive vocabulary. Interestingly, there was a significant positive correlation within bimodal bilinguals between their estimated vocabulary in English and in BSL in both receptive and expressive vocabulary. In other words, bimodal bilingual infants who learned vocabulary more successfully, tended to do so in both language modalities. Moreover, increased comprehension of English phrases and increased use of gesture was reported in bimodal bilinguals compared to infants with hearing parents. At 24-months, bimodal bilinguals did not differ from monolinguals in receptive and expressive English vocabulary and outperformed unimodal bilinguals in English receptive vocabulary. Within the bimodal bilingual group, a positive relationship was observed at a non-significant level between English and BSL for expressive and receptive vocabulary. Language preferences in production tended to shift from sign language (at 15 months) to English (at 24-months), while language preferences in perception were more varied and more stable across time points. These results globally suggest successful early language acquisition in bimodal bilinguals compared to both monolinguals and unimodal bilinguals. In addition, bimodal bilinguals demonstrated a transitional preference for sign language production at the beginning of the first year, as well as a positive relationship between spoken and sign language vocabulary. Implications for language development in hearing infants with deaf parents will be discussed.

P2-D-213 - Adaptation of maternal speech in statistical word segmentation of Korean (Ko)

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A prerequisite for infants to build a lexicon is the ability to segment words out of the speech stream (Jusczyk & Aslin, 1995). One of the postulated mechanisms for attaining such an ability is statistical segmentation based on transitional probabilities (TP; Brent & Cartwright, 1996; Harris, 1955; Saffran et al., 1996). Child-Directed Speech (CDS) has been considered to be easier to segment than adult-directed speech (ADS) (Thiessen et al., 2010), but evidence for CDS advantages in statistical word segmentation is debated (Aslin et al., 1998; Cristia et al., 2019). We demonstrate CDS advantages in statistical word segmentation based on Korean spontaneous data, and further show an age effect in the model performance in line with the fine-tuning hypothesis of CDS (Snow, 1972). Given the language-dependent segmentation mechanisms (Saksida et al., 2016), we first set out to find the optimal algorithm likely at work for segmentation in Korean. Our modeling was based on two corpora of spontaneous speech. The Ko corpus (Ko et al., 2020) contains 35 mothers producing CDS to their own children, and ADS to family members and experimenters (149,395 and 24,746 syllable tokens for CDS and ADS). To complement the smaller data size of ADS, we used additional data from the Call Friend Korean corpus containing 100 telephone conversations between friends (122,444 syllable tokens for ADS; Ko et al., 2003). Korean writing is based on phonemes. We converted the phoneme-based transcription to a phonetic corpus by applying a comprehensive set of phonological rules to better approximate the phonetic input infants are likely to use for statistical processing. For model training, we devised the syllable-based TP models by employing two algorithms (i.e., absolute and relative) and two measures (i.e., Forward TP and Backward TP). We then employed the k-fold cross-validation technique to obtain a normalized result from each model (Stone, 1974). Model performance was measured by comparing the word boundaries in the original input sentence with the word boundaries via each model. Our CDS corpus also included three groups of preverbal (M=0;8), early-speech (M=13;0), and multi-word (M=27;0) stage. We then compared the model performance across the developmental stages. We found that the model based on the

relative FTP algorithm yields a better performance (CDS=0.759, ADS=0.673) than the relative BTP (CDS=0.738, ADS=0.644), the absolute FTP (CDS=0.710, ADS=0.664) or the absolute BTP (CDS=0.642, ADS=0.651). These results indicate that our model performs better when trained with CDS than ADS. Additionally, we found an age effect showing a better model performance in the early-speech group (M=0.754, SD=0.019) than the pre-lexical (M=0.751, SD=0.021) or multi-word groups (M=0.753, SD=0.013). Our TP model is one of the first attempts to model statistical word segmentation of Korean, which turned out to be quite different from the models reported in European languages. The difference could be due to typological differences in the language but also to methodological differences such as the data and the derivation of phonetic input based on phonological rules. While these issues need to be further clarified, our results are meaningful in that it provides demonstrations of CDS segmentation advantages based on data approximating ecological validity. Further, our finding of the age effect is one of the first pointing to the CDS fine-tuning hypothesis in statistical word-segmentation.

P2-D-276 - Caregiver interruptions of babbling are predicted by infant vocal maturity (Zhang)

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Over the first year, immature vocalizations (babbling) become more mature and similar to the patterns of the ambient language. Infant communicative development comprises both acoustic changes in vocal production and learning turn-taking patterns. Infants make robust vocal changes after receiving caregiver contingent responses (Goldstein & Schwade, 2008). Infants also exhibit adult-like timing of vocal turn-taking with caregivers, which is characterized by minimal interruptions of each other (Hillbrink, Gattis & Levinson, 2015). Caregiver-infant vocal turn-taking improves the quality of infant babbling to be more speech-like (Bloom, Russell & Wassenberg, 1986). What acoustic and temporal parameters of babbling facilitate turn-taking and minimize interruptions from caregivers?

Fifty-one mothers and their 9-month-old infants participated in a 15-min unstructured play session. The dyads were video-recorded and asked to play as at home in a 3.7-m x 5.5-m playroom containing infant toys. We coded the onset and offset of caregiver and infant vocalizations. Caregiver interruptions of infant vocalizations were defined as a caregiver vocalization that started before the previous infant vocalization had ended. Infant vocalizations were categorized according to Oller's infraphonological acoustic classification system (Oller, 2000). Speech production develops gradually, from the earliest, immature quasi-resonant vowels (QRV), to mature fully resonant vowels (FRV) around 5 months, and immature marginal syllables (MS) around 6-7 months. At 7-8 months, they begin to produce canonical syllables (CS) that meet the acoustic definition of mature speech.

We found that infants with more mature vocalizations were interrupted by caregivers less, while those with more immature vocalizations were interrupted more (Figure 1). Specifically, the proportions of MS and CS in the infant vocal repertoire were negatively correlated with the proportions of infant vocalizations interrupted by caregivers ($r = -0.37$, $p < 0.05$). The proportion of QRV was positively correlated with caregiver interruptions ($r = 0.29$, $p < 0.05$).

Besides the acoustic properties of babbling, these correlational effects may also be explained by the temporal properties of babbling. We tested whether the infant vocalization categories differed in duration and likelihood of being interrupted by caregivers using a 2 x 4 ANOVA (interruption/no

interruption x 4 vocalization categories). We found main effects of interruption and vocalization category, and no interaction between them (Figure 2). Infant vocalizations uninterrupted by caregivers were significantly shorter than ones interrupted.

In summary, caregivers are more likely to interrupt infants when their prelinguistic repertoires have higher proportions of immature, longer-duration syllables. Interruptions in vocal turn-taking are experienced as aversive by adults (Farley, Ashcraft, Stasson & Nusbaum, 2010). It is likely that infants also experience interruptions negatively, since they are involved in adult-like turn-taking with caregivers early on. Canonical syllables, the sound forms of mature speech, are usually short in duration. Caregiver interruptions to long vocalizations may serve as cue guiding infant to babble in a more canonical and mature way. This study is among the first to explore how caregiver interruptions relate to the acoustic and temporal properties of babbling in humans. </p>

P2-D-277 - Social salience in voice processing: a study on functional brain networks in ASD infant siblings (Polver)

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For the developing infant an important canalisation of environmental experience is the interaction with their primary caregiver. Since such interactions mainly occur through vocal mediated information, the human voice can be considered as one of the fundamentals of social communication (Blasi et al., 2015), with one's mother voice being the most salient stimulus during infancy (Abrams et al., 2013). However, early disruptions in the instantiation of brain networks underlying experience-dependent orientation to social stimuli in Autism Spectrum Disorder (ASD) may result in decrease attention to the social world (Elsabbagh et al., 2012). For this reason, impairments in brain networks in ASD might become more apparent at increasing social salience of stimuli. For example, emotional connotations and complex prosody might worsen the processing of complex audio information in ASD. Conversely, infants at high-likelihood of developing ASD, may benefit from artificial vocal stimuli that lack complex prosodic information thus rendering vocal cues more predictable and easier to process. To test these hypotheses, we investigate the role of social salience in voice processing in two groups of 18-months-old infants: one at high-likelihood for ASD (HL-ASD), by virtue of having a diagnosed sibling, and one of typically developing infants (TD). Both groups were presented with audio recordings of a synthesiser (artificial voice), an actress (unfamiliar human voice), and the baby's mother (familiar human voice) narrating the same nursery rhyme, at increasing levels of social salience. We expect HL-ASD infants to process the synthesiser voice more easily, due to the absence of socially salient prosodic cues. This facilitation may be guided by a more straightforward engagement of fronto-parietal attentional nodes. Coherently, we expect HL-ASD infants to show increasing difficulties moving up the social continuum. To characterise social brain networks configurations through time, as the vocal stimulus unfolds, we extracted from EEG data the instantaneous phase, every 100 ms, between each pair of electrodes. On such data we computed the Phase Locking Value, a measure indexing the phase alignment between two signals. By referring to graph theory to characterise networks, we computed a Minimum Spanning Tree (MST) for each time point. On trees we computed the eigenvector centrality, a measure identifying nets of highly interconnected nodes. We then applied the cluster-based statistic. Data collection is still ongoing on both HL-ASD (N = 2) and TD (N = 5) infants. Here we present preliminary evidence on TD infants,

highlighting the presence of a nearly significant increased activity in the delta band, in response to the mother rather than the actress voice (tsum = -63.65, p = 0.062). As the delta band plays a fundamental role in salience orienting (Knyazev, 2012), we may hypothesise an increased preference for their mother's voice in TD infants. By increasing our sample with both TD and HL-ASD infants, we expect to consolidate the results with TD infants and to get insights into the risk factors that may derail the development of social cognition in ASD infants.

P2-D-278 - Joint attention behaviors that predict short-term versus long-term language outcomes in naturalistic caregiver-infant interactions (Jeong)

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Individual differences in infants' ability to engage in joint attention with caregivers predict later vocabulary development (Salo et al., 2018; Tomasello & Farrar, 1986). Most of these findings, however, depend largely on the short laboratory observations of parent-child interactions, assuming such observations represent daily interactions to a certain extent. And only a few studies examined both the role of caregiver and infant in establishing joint attention and how their dynamics relate to short-term language learning outcomes (e.g., Abney et al., 2020; Loy et al., 2018). As part of an ongoing longitudinal study, the present study examined caregiver and infant joint attention behaviors in naturalistic interactions and specifically which joint engagement behaviors predict short-term versus long-term language outcomes. We have also explored caregiver factors that may contribute to the differences in the dynamics of caregiver-infant joint engagement. At Time 1, 30-minute free-play interactions of 70 mother-child dyads were recorded in their homes when the infants were between 14 and 20 months. They were provided with a set of toys and books to use during their interactions so that Early Social Communication Scales (Mundy et al., 2007) can be applied to coding infants' and mothers' initiation of joint attention (IJA) behaviors. Responses to each identified IJA behavior (RJA) were coded and their proportions were calculated for both the caregiver and the infant. When each IJA elicited responses from the partner for a minimum of 3 seconds, these were coded as established joint attention episodes (Loy et al., 2018). We also coded caregivers' mind-related comments on their infant to measure mind-mindedness (Meins et al., 2001). Caregivers also completed MacArthur-Bates CDI to report on their infants' vocabulary and Interpersonal Reactivity Index (IRI, Davis, 1983) to assess differences in caregivers' emphatic abilities. The infants' vocabulary development was assessed again at Time 2 (36 months, n=37) and 3 (54 months, n=35), using a standardized checklist and test. While both infants' pointing and total IJA frequency and caregiver pointing correlated with receptive vocabulary at Time 1, it was only the caregiver pointing and IJA that still predicted vocabulary at Time 3 (see Table 1 & Figure 1). Interestingly, the perspective-taking scores of IRI were positively related to caregiver differences in pointing behaviors (r=.30, p=.006, n=68), suggesting that caregivers with better perspective-taking skills use pointing effectively in interacting with their infants. Unlike prior findings, however, neither joint episodes nor infants' responding to caregivers' IJA predicted short- and long-term language outcomes. Individual differences in infants' RJA were an important factor, leading to more frequent joint episodes (r=.40, p=.0002) and infants were more likely to be responsive to mothers, the more appropriately caregivers labeled their minds (r=.22, p=.036, n=67). These results suggest that caregivers' joint attention initiatives and sensitivity to infants may play an important role in supporting language learning in naturalistic interactions. Although the specific components of caregiver behaviors and factors may

differ from prior findings, our findings shed some light on ecologically meaningful caregiver interaction behaviors that may underlie long-term support in language learning.

P2-D-279 - Audiovisual vowel matching with own- and other-race faces by 3-month-old infants (Fort)

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Face and language processing show intriguing links during development (Pascalis et al., 2014). Newborns initially demonstrate universal perception abilities and become gradually attuned to the languages and the faces they are the most exposed to (Eimas et al., 1971 Nelson, 2001, Kelly et al., 2007). We previously demonstrated that after nine-months, recognition of own- and other-race individuals was impacted by the language they were associated with (de Boisferon et al., 2020; Clerc et al., 2021). Hence, the development of the sensitivity to own- vs. other-race faces could affect language learning processes. One essential skill for language learning is to be able to exploit speech multimodally. Patterson & Werker (1999, 2003) showed that speech is represented inter-modally as early as two months of age. The goal of the study was to test whether this rudimentary audiovisual matching skill is sensitive to the race of faces that produces the speech signal. We tested three-month-old Caucasian French-learning infants in a similar task, using either own- and other-race faces. Infants were presented with two simultaneously displayed talking faces of the same female speaker (one side producing [i], the other [u]) with a synchronous vowel sound (audio /i/ or /u/). Preliminary results show that three-month-olds look longer at the matching face in the own-race condition ($p = 0.017$; $N = 27$) but not in the other-race condition ($p = 0.984$; $N = 22$). Face familiarity could impact how infants learn to exploit multimodal speech cues as soon as 3 months.

P2-D-280 - Exploring the bounds of infants' ability to detect the semantic relations between spoken (but not pictured) words (Paquette-Smith)

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Children acquire words with incredible speed and sophistication: Around age one, their estimated receptive vocabulary contains as many as 75 words (Dale & Fenson, 1996). While there is abundant evidence showing that these early lexical items incorporate word meaning (e.g., Bergelson& Swingley, 2012; Tincoff & Jusczyk, 1999), few studies to date have examined whether infants can access this information in the absence of visual referents (e.g., Delle Luche et al., 2014; Willits et al., 2013). These studies, testing 18-and 24-month-olds, showed significant listening time differences between lists of words that were and lists of words that were not semantically related, suggesting that by the end of their second year of life, infants activate lexico-semantic knowledge in the absence of visual referents. Here, we revisit this issue with a new population, with the ultimate goal of establishing a strong test paradigm that allows us to further explore the nature of semantic activation in children growing up in linguistically diverse settings.

Using the Headturn Preference Procedure, monolingual Canadian-English-learning 18- and 22-month-olds were presented with lists containing either taxonomically related or taxonomically unrelated words. In Experiment 1, these lists were variable (5 unique words; e.g., cow-sheep-horse-cat-dog vs. hand-

bowl-pants-horse-bike), whereas in Experiment 2, they were less variable (2 unique words; e.g., sock-shoe vs. sock-nose). If children are sensitive to the difference in semantic overlap between these conditions, they should attend to these lists differently (cf. Delle Luche et al., 2014; Willits et al., 2013). Contrary to our expectations, this was not the case for Experiment 1, where infants (N=25) listened equally long to the related and unrelated words (see Figure 1). The preliminary results of Experiment 2, however, showed a much more promising pattern of results, with infants (N=13 to date) listening marginally longer to unrelated than related words (see Figure 2). These results suggest that the simpler, less varied stimulus lists used in Experiment 2 (modelled after Willits et al., 2013) might provide a more robust measure of infants' sensitivity to semantic relatedness in auditory-only studies than the more varied word lists used in Experiment 1 (modelled after Delle Luche et al., 2014).

We suggest that task demands may play a major role in how replicable semantic relatedness tasks are with infants. That is, the variability in the stimuli of Experiment 1 may have increased processing costs for lexical access, resulting in relatively shallow semantic processing. In contrast, the lower level of within-trial variability in Experiment 2 may have made lexical access easier, thereby highlighting the semantic commonalities between words. But of course, other differences may also have played a crucial role. For example, it is possible that differences in overall semantic relatedness between the words in the two experiments or the phonological make-up of the stimuli contributed to the observed pattern of results. Moving forward, assuming the preference for unrelated words in Experiment 2 continues to show, we will use the simpler word lists of Experiment 2 to examine how the activation of semantically related words develops in infants growing up in linguistically diverse contexts.

P2-D-281 - COVID-19 pandemic and its influence on the early attention to speaking mouth in infant development (Hata)

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Typically developing infants start to more focus on speaking mouth around 9-month-old, although younger infants pay attention mainly toward the eyes whether the mouth is moving or not. The appearance of canonical babbling seems to be related to their early mouth attention, but it remains unclear what external factors trigger such behavioral change. It has been concerned that COVID-19 pandemic deprives infants of the opportunity for contact with people and the exposure to mouth area because faces are partially occupied with mask. Simultaneously, the pandemic may bring about changes to the parenting and the parents' mental state. The current study investigated the influence of the limited face-to-face interactions and mother's stress due to pandemic to the early mouth looking behavior in infant development. We have collected eye-gaze data from infants aged 6 and 9 months before or during the pandemic in Japan ("before" group: n = 23; "during" group at current timepoint: n = 9, for each month; Note that number will be increased). We presented two video clips, in which a woman who was talking to the infant (20 seconds, respectively), and infant's fixation data was captured using Tobii X120 Eye Tracker system (Tobii, Stockholm, Sweden). The proportion-of-total-looking-time (PTLT) of mouth area (i.e., total looking time at the mouth / total looking time at the face) was calculated and we used a binomial generalized linear mixed model with age or group as fixed effect, including a random intercept for each participant for the analysis. The significant age effect was observed for "before" group ($z = 2.42$, $p < .05$), that is, 9-month-old infants in "before" group showed more interest in moving mouth than infants at age of 6 months. We also found a marginal significant

difference between groups at age of 6 months (z = 1.93, p = .053), in which infants in "during" group showed more interest in moving mouth than infants in "before" group. We performed a linear regression analysis to examine the relationship between the PTLT on mouth at 6-month-olds and the mother stress (the Japanese version of the Parenting Stress Index). Infants in "during" group showed a marginal significant negative relation, indicating that infants whose mother had less stress regarding their parenting showed more interest to moving mouth than infants whose mother had higher stress in "during" group, but not in "before" group (z = -1.92, p < .1). The present study showed that changes in external social stimuli for infants due to COVID-19 pandemic affect the early mouth attention. Although the pandemic may provide the mothers to increase the time spend with their infants, it may also lead in part to increase the mother's stress. Considering the result that infants whose mother had less stress even during the pandemic showed higher interest to moving mouth at age of 6 months, mothers who controlled their stress and used the time spend with infants effectively at home might lead infants to facilitate the interest to moving mouth. We will also examine a correlation between these looking behaviors and infants' social and language ability.

P2-D-282 - Infant detection of code-switching (Exton)

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A wide body of research has examined infants' ability to distinguish between passages of two separate languages (i.e. Nazzi, et al., 1998; Bosch & Sebastian-Galles, 1997, 2001), which finds that with some experience they can distinguish between even relatively similar languages, likely using durational metrics such as vowel and consonant interval variability (Gasparini, et al., 2021). However, as these methods have generally relied on comparing infants' listening preference to passages of two separate languages after some period of familiarization or habituation, is unclear to what extent infants are able to distinguish between two languages in the same utterance such as in a code-switching context. Infants with bilingual parents are regularly exposed to code-switching (Bail, et al., 2015; Kremin, et al., 2021) and show comprehension costs to a code-switch by their second year of life (Byers-Heinlein, et al., 2017; Morini & Newman, 2019; Potter, et al., 2019). However, we do not know the mechanisms that allow listeners to distinguish between two unfamiliar languages in code-switched input, as is required in those early stages of language acquisition. In experiments 1 and 2 of this study, we test infants' ability to distinguish between code-switched and single-language input using a task partially inspired by Schott, et al. (2021), which used headturn preference procedure to test whether 8-12 month old infants could detect a difference between single-language passages and passages consisting of sentences that ended with a single-word insertional code-switch. Their results were inconclusive, which may have been because the single-word insertional switches did not provide infants with enough input from both languages in order to detect a switch. That is, if infants rely on rhythmic and durational properties of languages in order to distinguish between them, perhaps if they instead heard multiple sentences in each language they would be more likely to identify the presence of switching. In this study, 5-14 month old English monolingual infants participated in a central fixation task conducted online via Lookit.mit.edu. Infants listened to recordings of a fluent English-Mandarin bilingual telling children's stories. In experiment 1, infants listened to clips that were English-only, Mandarin-only, and that switched between Mandarin and English. In experiment 2, English was replaced with instrumental music. In both experiments, infants listened to 16 trials of approximately 20 seconds, and all switching

trials contained 4-5 switches. Preliminary results with 12 (Exp1) and 13 (Exp2) infants suggests that there is no difference in looking time between switching and non-switching trials for either experiment. It is unclear whether this lack of an effect is caused by the infants' inability to distinguish between switching and non-switching, or if it is because both stimuli types are equally interesting to the infants. In a planned experiment 3, we will instead test this question using the Anticipatory Eye Movement paradigm (McMurray & Aslin, 2004), which allows us to move away from methods that rely on listening preference. Infants will be trained to associate images on one side of the screen with Mandarin, and images on the other side of the screen with either instrumental music (which should be auditorily distinct) or another language (which may or may not be distinct). We will then test their ability to look to the correct side of the screen following a switch in the auditory domain.

P2-D-283 - The alignment of vocalization onset with head and hand movement in infants and toddlers: speech and language contributions (Benham)

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In early development, canonical vocalizations (a sequence of a consonant and vowel) are tightly coupled with rhythmic stereotypic movements of the arms. This phenomenon has been observed between 6-8 months of age when canonical babbling emerges (Iverson et al., 2010; Thelen, 1979), suggesting that early speech and limb movement share similar temporal and rhythmic organization. The production of more complex phonological forms beyond repetitive consonant-vowel sequences (e.g., first words) has been shown to destabilize aspects of the speech motor system (Iuzzini-Seigel et al., 2015), suggesting a link between lexical, phonological and speech motor systems (Nip et al., 2011). In the present work, we examine how speech, motor, and language relationships extend to the precise temporal coordination between early vocalizations and gross motor skill. Findings from Borjon and colleagues (in prep) show increasing alignment between head and hand movement and the onset of vocalizations as children approach 24 months of age. The objective of the present work is to determine whether differences in the substance of these early vocalizations contribute to the alignment of head and hand movement over time and with increasing lexicon size. Infants were recruited at 9 months, then tested at 3-month intervals until 24 months of age. At each session, parents completed the MacArthur Bates Communicative Development Inventories (Fenson et al., 2007). Parent and child dyads (n=44) interacted with novel objects in a play-based setting. Parents were instructed to play naturally with their child using the novel objects and object labels provided. Head and hand movements were recorded using Polhemus motion capture sensors, and microphones captured the vocalizations (n=3,163). Onsets and offsets of each vocalization were annotated using spectral and waveform cues. Using timelocked movement signals, a measure of synchronicity was computed for each vocalization by detecting the lag time between the onset of the vocalization and the onset of the head and hand movement. Phonetic transcription of the vocalizations is currently underway to obtain an inventory of the consonants, vowels, and syllable shapes at each timepoint for every child, as well as the proportion of canonical and non-canonical utterances. We also use a novel network science approach to detect emergent patterns between the utterances and the synchronicity measure. In this approach, each utterance is a node in a network. Edges connect the nodes if they fall within a similar range of synchronicity (e.g., utterances that are similarly aligned with head or hand movement are connected in the network). The weight of the edge reflects the degree of synchronicity, where a thicker line reveals a more synchronous relationship

(Figure 1). In this way, we capture the phonetic nature of the vocalizations that are more or less aligned with the movement signals. We predict that vocalizations with more complex phonemes and syllable structure will show looser alignment with movement signals and that the differences between relatively more or complex vocalizations will lessen with age and as vocabulary size increases. Findings from this work have the potential to significantly inform the relationship between early lexical, phonological, and motor development.

P2-D-284 - Caregivers' Attitudes towards raising Multilingual Infants (Caunt)

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The attitudes of multilingual caregivers towards the languages they speak can play an important role in the input they direct to their infants. Aside from Ballinger et al. (2020), whose families had infants younger than 3 years, previous studies have not examined parental attitudes in early multilingual development (e.g. Curdt-Christiansen, 2009; Ren & Hu, 2013). The current study examines how caregivers of multilingual infants value the importance of each of their languages (1) emotionally, (2) in everyday life, and (3) in relation to raising their infant. We examine whether these attitudes differ by caregiver gender, and language (L1, L2), and whether they impact the amount of exposure to each language caregivers report to provide to their infants. We predict that caregivers' higher rating of either of their languages on the emotional scale and significance to raising a multilingual infant will result in more exposure to that language in the input. Data collection is still ongoing, but our current sample (n=13) includes a variety of multilingual families (e.g., Dutch, German, and Italian) raising infants between 5 and 19 months in London. Caregivers completed a questionnaire about each of their languages indicating how much they agree with 21 statements on: 1) the importance of language to life (Baker, 1992), 2) emotional feelings towards language (Dewaele, 2012), and 3) the importance of language to bringing up infants (Young & Tran, 1999). Caregivers also completed a language exposure interview, i.e., LEQ (Cattani et al., 2014) which asks them to estimate their infants' exposure to each language. Given our small sample, we performed exploratory analyses only. We aggregated caregivers' L1 and L2 ratings to obtain an average score for each theme. Figure 1 shows an emerging pattern of caregiver difference. Specifically, fathers' responses about the emotional importance of L2 (theme 2) and its importance to life (theme 1) differ from their L1 ratings; however, fathers value the significance of L1 and L2 to bringing up their infant similarly. Mothers' responses show that both L1 and L2 are of equal emotional significance. Interestingly, mothers ranked the importance of language to life higher in their L2 than L1; whereas like the fathers, they ranked both languages equally for bringing up their infant multilingual. Preliminary correlation analyses showed) that caregivers' judgement of how important L1 is for raising their infants is highly correlated with how important they rank that language to be to their lives (mothers: Spearman's $\rho = 0.585$; $p = 0.03$; fathers: Spearman's $\rho = 0.555$; $p = 0.04$). We plan to examine the links between caregivers' attitudes and their estimates about the language input to their infant using our LEQ data.

P2-D-285 - Influence of Speaker Type and Group Child Care Experience on Word Learning in Toddlers (Santos Oliveira)

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Although word learning is heavily studied in the developmental literature, there is a limited body of work on how toddlers learn words from each other (but see Bernier & White, 2019; Cooper, Fecher & Johnson, 2018). The current study aims to examine English-speaking toddlers' ability to both recognize familiar words and learn novel words from toddler speech versus adult speech. Further, we were interested in how frequent exposure to toddler speech via participation in group child care settings might differentially impact word recognition and word learning processes for these two different speech types. We recruited 32- to 34-month-old firstborn children who either regularly attended daycare (N=17) or who primarily stayed at home with a caregiver (N=14). Each family was invited to come into the lab for two testing sessions one week apart; in one of the sessions, participants were exposed to toddler speech, and in the other to adult speech. Type of speech was counterbalanced across sessions. Audio stimuli were recorded by a female English speaker and her 37-month-old daughter, for the adult and toddler conditions, respectively. Each session started with a word learning phase, during which both novel and familiar words were presented in English carrier phrases (e.g., "Look at the blick! It's a blick! Blick!"), followed by a test phase using the looking-while-listening procedure (e.g., "Where's the blick? Blick!"). Following the learning phase, we measured toddler accuracy at looking to the named target in an analysis window of 300ms to 2000ms after word onset, on both familiar and novel word trials. Data from 17 toddlers have been coded to date. In line with best practices, here we present a description of the preliminary data rather than any statistical analyses. As seen in Figures 1 & 2, preliminary data suggests that toddlers who interacted more often with similar-aged peers were more accurate overall on both familiar word recognition and on novel word learning than toddlers who had more limited interaction with other toddlers. Further, while toddlers who stayed home learned novel words better when they were spoken by an adult, toddlers who attended daycare performed better at learning words spoken by a similarly aged toddler. Interestingly, toddlers who had relatively little experience with other children's speech struggled to learn novel words spoken by another toddler. Together, our preliminary findings suggest that frequent experience with the phonological variability of toddler speech may support word learning more broadly, and may specifically support toddlers' ability to learn words from same-aged peers. Data from the full sample will be presented at the conference and will be interpreted in the context of prior work.

P2-D-286 - A test toy with buttons for revealing infants' auditory preferences (Boll-Avetisyan)

Natalie Boll-Avetisyan[1], Mireia Marimon[1], Alan Langus[1], Anna-Sophia Guhl[1]

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Numerous studies have shown that behavioral experimental paradigms can be used to indicate infants' auditory listening preferences. The most widely used behavioral paradigms are two that have been developed in the 1980s: the head-turn preference procedure (Kemler Nelson et al., 1995) and the central fixation paradigm (Cooper & Aslin, 1990), both of which use infants' looking times to a visual stimulus while listening to a sound file as dependent measure. These two methods are ideal for testing infants' auditory preferences in very young infants and give robust group-level results. Importantly, longitudinal studies using such methods have revealed that speech perception abilities in infancy predict later language outcomes (Cristia et al., 2014 for a meta-analysis). That is, in principle, it may be possible to detect a risk for later language problems in infancy. However, current methods cannot be used for that, as they do not yield reliable individual data (low re-test reliability, e.g., Christia et al., 2016).

Neurophysiological methods share this limitation. The present study presents our novel toy test method, a first step towards our aim for developing a simple and robust method for assessing infants' individual performance. Our method was inspired by research from the 1960-1980s (e.g., Friedlander, 1968; Glenn & Cunningham, 1983) that used playpen installations with two switches infants could manipulate to elicit a sound. These studies demonstrated highly consistent auditory preferences reflected by infants' switch preferences. Our test toy is a wooden box with two buttons that can easily be pressed by infants from around 9 months of age (Figure 1). A built-in software is programmed such that a button press triggers the playback of a sound. Button press counts and press durations are recorded and stored. So far, we have tested eleven 9-11 month old German-learning infants. At this age, infants have developed both the play instinct and motoric skills for handling sound-producing toys. Four of the infants had a family risk for language-related disorders (see Table 1). As simuli, we used one trochaic nonword /GAba/ (with initial stress) and one iambic nonword /gaBA/ (with final stress), as German-learning infants typically show a trochaic listening preference (Höhle et al., 2009) but this preference is correlated with later language outcome (Höhle et al.; 2014). As a procedure, first, the experimenter shows the infant that each button activates a different sound. The button the experimenter shows first and whether the trochee is played left or right is counterbalanced. Sessions (free playtime with the caregiver in presence) usually take 10-15 minutes and are stopped once the infant loses interest in the toy. A preliminary qualitative assessment of the data indicates that 9 of 11 infants pressed the button that elicited the playback of the trochee for longer than the button that played the iamb (Table 1). These preliminary results indicate that button press durations may reflect German-learning infants' auditory preference for trochees. This would be in line with previous results from head-turn preference studies (Höhle et al., 2009). These first promising results motivate us to continue probing methods using the test toy for investigating infants' auditory preferences.

P2-D-287 - Development of a touchscreen based language measure for French toddlers (Crimon)

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The aim of this study is to develop a direct, quick, and reliable measure of language development in young children. Basing ourselves on previous efforts to develop a touchscreen based language test (Friend & Keplinger, 2008, Lo et al. 2021), that allows to directly measure word comprehension and speed of processing, we here add several novelties : our test is not only composed of a 2-alternative-forced-choice word comprehension task, but also of a novel word learning and a phonological neighbour distinction task; it is aimed at French children from a wide age-range (20-32 mo) and meant to be easily administered in non-lab settings. Its game appearance is enhanced with a little character enticing them to play with her. In a pilot lab experiment, we tested 22 French children, aged 19-23 months, from a high-SES background. Parents completed the French MBCDI. Our preliminary results show that children find the test engaging, despite it taking about 20 minutes to finish, with children completing on average 77% of the test (SD = 26), and actively answering for 70% of those trials (SD = 0.18). Regarding children's scores, they show an average percentage for correct answers above chance (M = 0.68, SD = 0.17), and this score was significantly correlated with their score at the MBCDI (r=.62, p=0.0023). To further test our game (older children, non-lab setting), we piloted our test with 36 children, aged 19-33 months, in several daycares from the Paris region (varied SES and language exposure). Our results are encouraging : children showed participation rates similar to our lab pilot. Their average percentage of correct answers

was above chance (M = 0.73, SD = 0.15). It also showed a tendency to increase with the subjects' age (see Fig 1), without showing a ceiling effect for older children; and increased with the exposure to French (see Fig 2). This second pilot demonstrated the feasibility of the test in daycares: with a relatively short playing time (it takes a child about 20 mins to complete), minimum set-up requirements or experimenter's training, touchscreen tests prove to be an interesting research avenue for large-scale naturalistic studies. We are in the process of testing toddlers in 30 daycares all over the Paris region (estimated number of about 300 children (140 by summer), coming from a diverse social and linguistic background), as part of an RCT Language Intervention protocol, where our touchscreen game will be used as a pre-post-test language measure, in addition to the CDI.

P2-D-288 - Pandemic-related change in child care, parent stress, and the literacy environment: Implications for early vocabulary (Soria)

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Introduction. As of 2019, 63.8% of mothers with children under the age of three at home participated in the workforce (Bureau of Labor Statistics, 2020). As recently as 2016, 70.5% of three-year-olds participated in nonparental childcare whether this was care by a relative, nonrelative home-based care, or a center-based program (inclusive of preschool; National Center for Educational Statistics, 2019). Indeed, it has been argued that early center-based care should be part of a seamless system of education that promotes school readiness (Hinkle, 2000). Both the home environment and early out-of-home childcare are important to preparing children for school prior to three years of age. Early caregiver-child talk facilitates vocabulary acquisition and supports not only later language and literacy but numeracy as well (Manolitsis, et al., 2013). The Covid-19 pandemic has interrupted access to out-of-home care and disrupted family life. This, in turn, creates changes in the early literacy environment with implications for language, literacy, and numeracy. An early exploratory report found that children in the UK who remained in care during the Covid-19 pandemic fared better than peers who did not on measures of receptive vocabulary and executive function (Davies, et al., 2021). Approach. We are acquiring parent report on pandemic-related disruption to out-of-home care in children in the first five years of life, how this impacted the perceived quality of parent-child interactions, and the relation between changes in care, quality of parent-child interactions, and children's scores on norm-referenced measures of early vocabulary: the MacArthur-Bates Communicative Development Inventory: Words and Sentences (MCDI) for children 20 to 30 months of age and the Peabody Picture Vocabulary Test (PPVT) for children 30 to 60 months of age. We expect low socioeconomic status combined with parent stress and loss of access to out-of-home care to negatively impact early vocabulary acquisition. We have developed an online administration method and begun data collection on this question. Results. We have pilot data on loss of access to out-of-home care, parent stress, and perceived quality of parent-child interactions for parents of nine children from 20 to 58 months of age (x=36.3, SD=13). Vocabulary assessments are in progress. Parents were from the western or midwestern U.S. and relatively high SES. All reported pandemic-related loss of out-of-home care. Parents varied in how often they felt anxious, worried, or overwhelmed but felt this way at least some days each week (see Figure 1). Nevertheless, most parents expressed no change or even an improvement in the quality of interactions with their children. Paradoxically, parents who experienced greater anxiety reported the highest quality interactions (see Figure 2). Of interest are the effects of disruption in care and parent stress on early

vocabulary. Discussion. Data collection is underway with a focus on obtaining a more socioeconomically diverse sample. We will present data evaluating the effects of socioeconomic status, parent stress, and disruption in care on early vocabulary acquisition. Data will be interpreted in terms of the impact of the Covid-19 pandemic on the quality of care environments within and outside the home.

P2-D-289 - Are you surprised to hear me speak français? Bilingual and monolingual infants? ability to form person-language associations (Schott)

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Bilingual infants learn two languages simultaneously, and they might adapt to this learning environment by paying attention to specific cues. In one-person-one-language environments, talker identity is a potentially informative cue to help infants navigate bilingual input. Infants have pre-requisite skills that could help them associate a person and a language, including discriminating between male and female voices (e.g., Johnson, Westrek, Nazzi, & Cutler, 2011), and discriminating between languages (e.g., Bosch & Sebastián-Gallés, 2001; Molnar, Gervain, & Carreiras, 2014). We tested whether bilingual infants are sensitive to talker identity in a bilingual context, in two studies: auditory-only (Study 1) and audiovisual (Study 2). We also included monolingual infants in our study, to assess whether bilingual exposure is necessary to acquire this sensitivity. In Study 1, we tested 5- and 12-month-olds (see Table 1 for the number of participants tested), and in Study 2 we tested 12- and 18-month-olds. Bilinguals heard English and French at home (25-75% of lifetime exposure to each language), and monolinguals heard either English or French at home (> 90%). During familiarization, infants heard a woman speaking English and a man speaking French (or vice-versa) and saw an unrelated still image (a field of flowers, Study 1) or the video recording of the person speaking (Study 2). At test, the two talkers either continued speaking the same language (Same trials) or switched to the other language (Switch trials). A Tobii T60-XL eye-tracker measured both total looking time and pupil dilation during each trial type. To calculate total looking time, we summarized the time infants spent looking at the screen for each trial type. Regardless of study, age group, and language group, no difference was observed for Same and Switch trials as measured both by total looking time (all ps > .05; Figure 1) and pupil dilation (all ps > .05, figure not included for space constraints). Overall, we found no evidence of sensitivity to person-language associations in a bilingual context. Our results have implications for bilingual infants' daily experiences. Many early theorists suggested that bilingual children would benefit from a one-person-one-language environment (e.g., Döpke, 1992) to help them separate the languages in their input. However, our study shows that neither bilingual nor monolingual infants appear to spontaneously encode the language a person speaks. We know that adults do use a person's identity to predict which language that person will start speaking (Martin et al., 2016), thus, the ability to associate a person and the language they speak likely develops at a later age. Furthermore, if infants do not learn person-language associations, a one-person-one-language environment may not be particularly beneficial. Instead, infants might rely on their developing knowledge of language-specific rhythm, sounds, and words to encode input from each language separately.

P2-D-290 - Classroom language during COVID-19: The impact of face-masks on objectively measured teacher and infant vocalizations (Mitsven)

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Over half of US infants are enrolled in preschools, where the quantity and quality of language input from teachers may affect infants' language development. Attending preschool during the COVID-19 pandemic may have created additional barriers to acoustical information for infants as face-masks may degrade the quality of the speech signal. Leveraging repeated objective measurements, we examined infant and teacher speech-related vocalizations in two inclusive preschool classrooms for infants with and without hearing impairment: Cohort 1 (C1) was observed before COVID-19 (no masks); Cohort 2 (C2) was observed during COVID-19 (with masks). Participants included 16 infants with hearing impairment (9 in C1) who wear cochlear implants or hearing aids and 19 infants with typical hearing (TH) (11 in C1) (C1: Mage=42.82 months, 11 boys; C2: Mage=49.58 months, 12 boys). C1 was observed prior to the onset of COVID-19, October 2019-February 2020. C2 was observed March 2021-June 2021 while both infants and teachers wore cloth earloop masks. Vocalization data were collected monthly in C1 (5 observations) and twice monthly in C2 (7 observations) using infant-worn LENA audio recorders. Using LENA software, we calculated the duration and rate per minute of teachers' and infants' speech-related vocalizations. Sphinx speech recognition software was used to calculate phonemic diversity, the number of unique consonants and vowels per vocalization. There was a significant effect of Cohort on infants' language input. Teachers in C2 produced vocalizations that were shorter in duration (M=1409.47 ms; B=-64.87, SE=22.72, t=-2.86, p<.01) and contained fewer unique phonemes (M=9.43; B=-.93, SE=.12, t=-8.03, p<.01) than teachers in C1 (duration: M=1480.09 ms; phonemes: M=10.01). There was not a significant Cohort effect on either the duration or rate of infants' vocalizations. However, infants in C2 produced vocalizations that were more phonemically diverse (M=4.02) than infants in C1 (M=3.89), (B=2.70, SE=.97, t=2.77, p<.01). Infants who were exposed to a larger number of teacher words per minute produced more vocalizations per minute themselves (B=.03, SE=.009, t=3.41, p<.01). Similarly, infants who were exposed to more phonemically diverse teacher vocalizations also produced vocalizations that were more phonemically diverse (B=.12, SE=.06, t=2.07, p=.04). The association between the phonemic diversity of infants' language input and the phonemic diversity of their own production was stronger for infants in C1 (B=-.26, SE=.10, t=-2.63, p=.01). We objectively captured infants' moment-to-moment language experiences in their classroom prior to and during the COVID-19 pandemic. Teachers observed during COVID-19 produced shorter and less phonemically diverse vocalizations than teachers prior to the pandemic. The association between the phonemic diversity of teacher language input and infants' language output was weaker during the pandemic. Infants observed during the pandemic produced more phonemically diverse vocalizations than infants observed prior to the pandemic, however, there were no cohort differences in the duration or rate of infants' speech-related vocalizations. Taken together, these results suggest that face-masks may not impede infants' language production, but may affect the transmission of phonemically diverse speech between teachers and infants.

P2-E-214 - Child directed speech in nursery schools: teachers' multimodal self-repetitions. (Casla)

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One of the characteristics of CDS is that is highly repetitive (Rowe & Snow, 2020). Adults self-repeat their own sentences in sequences that vary in their structure but keep a word or a set of words constant (Schwab & Lew-Williams, 2016). This phenomenon, called "Variation Set" (VS) (Küntay & Slobin, 1996), has been analyzed as a verbal strategy that is related to lexical and morphological development, as well

as other variables, such as pragmatic function and SES (Alam et al., 2021). However, as most of the studies devoted to CDS, the studies that analyze the use of VS have been carried out during mother-child interaction. There are only a few studies that analyze adult's self-repetition during polyadic interaction in early childhood classrooms (Rosemberg et al., 2019). Moreover, the use of VS is usually defined from a verbal point of view, although child directed speech is also highly multimodal (Rodrigo et al., 2006), since the use of gestures is related to linguistic development (Olson & Masur, 2015). The aim of this work is to analyze teacher's use of variation sets from a multimodal point of view, during the interaction that takes place with the groups of two-year-old children. Participants were 16 two-year-old teachers and the children that participated in "the round", a daily narrative space in which children are given the opportunity to present a narrative on the self (Poveda, 2003). The groups ranged from 6 to 19 children (mean = 10.6) and from 20 to 41 months old (mean = 29 months). Sessions ranged from 8 to 34 minutes (mean = 14 minutes). All sessions were video-recorded and transcribed using the Chat program from the CHILDES project. Teachers' communicative behaviors were coded according to 1) modality (verbal or verbal-gestural), 2) the addressee (dyadic or polyadic) and 3) the number of verbal or verbal-gestural utterances included in variation sets. In addition, we also took the number of children of the classroom as a control variable. Results show that 59% of the communicative behaviors of the teachers were included in VS. Moreover, the proportion of verbal-gestural behaviors was significantly higher in variation sets than in the rest of the speech addressed to the children. The proportion of polyadic VS was significantly higher than the proportion of dyadic VS, being the difference higher with verbal-gestural VS. We found positive correlations between the number of children in the classroom and the number of children's responses, the number of VS ($r(16)= .616$, $p=. 011$), and the number of verbal-gestural VS ($r(16)= .538$, $p=. 032$). We discuss the results taking into account that, during mother-child interactions at the age of two, VS start to decrease and are about 20% of CDS (Alam et al., 2021). Our results also show that the use of VS is highly multimodal. The results related to the number of children and the fact that we found more verbal-gestural VS addressed to the group is discussed considering the importance of nursery school's ratios.

P2-E-215 - Do children with hearing loss look less to a speaker's mouth than their typically hearing peers? (Arrieta)

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Oral language outcomes in children with hearing loss (HL) who get a Cochlear Implant (CI) are variable, and part of this variance remains unexplained. For children with HL, oral language is acquired from a speech signal with poor or non-existent auditory information, so this experience may lead to behavioural adaptations to achieve successful learning. One such adaptation may be manifested in the degree to which children attend to visual speech information during spoken language processing. Typically hearing (TH) adults show an increased amount of looks to a speaker's mouth in challenging listening conditions, as the redundant audio-visual information is useful for speech perception (Vatikiotis-Bateson et al., 1998, Barenholtz, 2016). This is also observed during language acquisition as young children direct attention to the speaker's mouth during audio-visual speech presentations. In fact, infants and children direct more looks to the mouth during important language acquisition milestones, which in turn, has been shown to predict later vocabulary scores (Tenenbaum et al., 2014; Young et al., 2009). Due to the evidence on the relation between the amount of looks to the mouth during language

acquisition and later language outcomes in TH children, this work investigates how this relation is modulated by HL. As populations with HL have reduced experience with auditory information compared to TH controls, we predicted that children with HL prior cochlear implantation would look less to a speaker's mouth than TH controls. Five children with HL before cochlear implantation (average age: 25.47 months) and five age-matched TH controls participated in this study (as this is a longitudinal study, data acquisition is still in progress). Children with HL who were candidates for cochlear implantation were identified by an otorhinolaryngologist. The majority of children were growing up in a multilingual community acquiring either Spanish or Basque in monolingual settings or Spanish and Basque in bilingual settings. The dominant language was Spanish for five children and Basque for one (TH controls were matched in language dominance). The stimuli consisted of eight 30-second videos of a woman talking: four videos were presented in Basque and four in Spanish in order to test all participants in their dominant and non-dominant languages. For each of the languages, two videos were presented only visually (sound removed) and two audio-visually. The dependent variable consisted of the ratio of the duration of looks to the mouth and eyes, normalized by the total looking time in each trial. Two sample t-tests were conducted for each of the four conditions (visual-only and audio-visual in both dominant and non-dominant languages), but they did not reach statistical significance. However, a clear trend was seen towards lower looks to the mouth in children with HL compared to TH. These preliminary results show a different behavioural pattern in response to a talking face in children with HL and in TH children, which, as data acquisition continues, will be used as a predictor of language outcomes after cochlear implantation, aiming to explain individual differences in oral language development.

P2-E-216 - Prediction during Sentence Correction in 30-Month-Old Toddlers (Angulo-Chavira)

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Speech errors are highly frequent in language; usually, speakers make an error every ten words (Bortfeld et al., 2001). These errors are not random; in fact, speakers generally make semantic errors to change a word for another that is semantically related (Dell, 1986). For example, in the sentence "I forgot to feed my cat ... uh, I meant ... my dog," the wrong noun, cat, and the correct noun, dog, are highly semantically associated by their hypernym (animal) and their co-occurrence in context and speech. Adult speakers can use these regularities in speech errors to predict the semantically related word in a wrong sentence (Lowder & Ferreira, 2016) by selecting the correct noun based on the speaker's intention (Pickering & Gambi, 2018). While 24-month-old toddlers can predict the next upcoming noun using semantically related verbs (Mani & Huettig, 2012), it is unclear if they can use prediction to select the intended upcoming noun when a speech error occurs. Thus, this research aims to explore if 30-month-old children can use speech errors to predict semantically related information. Forty-five 30-month-old toddlers and 52 young adults were evaluated using a visual world paradigm. They heard a sentence that had an error marked by the adverb no (In the yard I saw a dog, no, a rabbit), or a copulative coordinate sentence using the conjunction and (In the yard I saw a dog and a rabbit). They also saw four images from the same semantic category: the first noun heard (N1; dog), the second noun heard (N2; rabbit), an unheard associatively related distractor (AD; cat), and an unrelated distractor (UD; tiger). Mixed effect fixed models were used to analyzed three temporal windows: the auditory presentation of the N1, the presentation of the error or conjunction (no/and), and the presentation of the N2. As expected, when the error was presented adults looked at the AD (β = -0.03, SE = 0.01,

t(2926)= -3.21, p = 0.001); this effect only occurred before the presentation of the N2 (β = 0.001, SE = 0.01, t(2922)= 0.14, p = 0.88). By contrast, toddlers showed the opposite pattern of results, they looked at the AD more in the coordinate sentence (β = -0.04, SE = 0.01, t(2926)= -3.51, p < 0.001), and this effect lasted even after the N2 was presented (β = -0.11, SE = 0.01, t(2922)= -8.23, p < 0.001). Furthermore, we found that expressive but not receptive vocabulary interacted with the found effects in toddlers; participants with lower expressive vocabulary looked more at the AD when they heard the conjunction due to its relationship with the N1(β = 0.01, SE = 0.004, t(637)= 3.99, p < 0.001). In toddlers, we expected adult-like behavior or that the AD would attract the most attention in both types of sentences; however, toddlers seem to process speech errors and conjunctions differently. A possible explanation is that this type of error suppresses the coactivation between related concepts. Maybe, once they have more experience with the production of speech errors, toddlers start to process information like adults.

P2-E-291 - Caregivers differ based on verbal and nonverbal responsiveness during early interactions (van der Klis)

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Caregivers differ based on their verbal responsiveness which positively relates to children's language outcomes (e.g., Tamis-LeMonda & Bornstein, 2002; McGillion et al., 2013; Olson & Masur, 2015). These studies have not taken nonverbal responsiveness into account, while earlier studies examining caregivers' nonverbal behaviours, such as handing over a toy, found them to predict language outcomes (e.g., Ruddy & Bornstein, 1982). Nonverbal responses have not been analysed individually, and we do not know whether they also form a unique source of variation among caregivers. The present study aims to answer 1) which verbal and nonverbal responses occur, 2) how often each type of response occurs, and 3) whether caregivers differ based on verbal and nonverbal responsiveness during early caregiver-child interactions. This allows us to analyse caregiver responsiveness more accurately in future studies. We observed 117 Dutch caregivers and their 10-month-old infants (66 girls, mean age 45.3 weeks, range 40-54 weeks) who were filmed while playing with a standard set of toys. We annotated six minutes of free play. We developed a coding scheme to annotate infant vocalisations and gestures and to annotate caregivers' verbal (e.g., labelling, infant imitation), gestural (e.g., pointing, passing), facial (e.g., smiling, surprised), and bodily (e.g., leaning closer, turning) responses during or within 2 seconds after the offset of the infant behaviour. We defined each type of response by using non-overlapping markers in the definition. We achieved high reliability among coders (all k > 0.79). In total, we annotated 2022 infant behaviours of which 87% received a caregiver response. We summarised the frequency counts of each response in Table 1. The most frequent response type was verbal: semantically incontingent (n=722), such as an affirmation; semantically contingent (or follow-in) (n=663), such as labelling an object the infant was playing with; and infant imitations (n=127). We also identified occurrences of gestures, such as showing (n=101), passing (n=74), and pointing (n=60). To a lesser extent, caregivers used their face or body to respond. Caregivers relatively frequently started smiling (n=162) or showed an affective behaviour, like stroking the infant's cheek (n=36). Caregivers also frequently manipulated toys during their response (n=384). Secondly, we examined whether caregivers differ based on their verbal and nonverbal responsiveness. In Graph 1, each caregiver is depicted by their verbal (i.e., including all types of verbal responses) and nonverbal (i.e., including all gestural, facial, and bodily responses)

responsiveness rates. The graph shows that high verbal responsiveness does not necessarily coincide with high nonverbal responsiveness. In fact, caregivers differ largely based on their verbal and nonverbal responsiveness rates, but the two types seem unrelated. Caregivers use a range of verbal and nonverbal responses during early interactions. Verbal responses are by far the most frequent, but the data also show a wide variety of gestural responses, and to a lesser extent, some facial and bodily responses. Caregivers show large individual differences based on both verbal and nonverbal responsiveness. These results show we should not disregard caregivers' nonverbal responses in future studies as they may be a unique source of variation among caregivers, which could in turn influence children's developmental outcomes.

P2-E-292 - Measuring spontaneous pointing in infants and caregivers with a new online paradigm (Liszkowski)

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Pointing is a milestone in the emergence of referential communication and predictive of language and social cognition (Liszkowski, 2018). Scientists have used a variety of paradigms to observe infants' pointing, ranging from diary observations (Carpendale & Carpendale, 2010) to parent reports (Fenson et al., 2007), to field observations (Salomo & Liszkowski, 2013), and experimental elicitation (Butterworth et al., 2002). Interaction-based paradigms seem most suited to elicit spontaneous infants' pointing given the communicativeness of this gesture. Furthermore, these paradigms provide the opportunity to measure parents' pointing and reactions as well (Liszkowski et al., 2012). With the outbreak of the Covid-pandemic and the necessity to distance from direct social interactions, the need for a social, yet remote paradigm arose. A social, remote paradigm is useful also beyond pandemic times, as it provides potential for worldwide, diversified data collection and diagnostics, for example in case of language delay (Lüke et al. 2017; 2020). We developed an online paradigm derived from the interaction-based "decorated-room" (Liszkowski et al., 2012); a method previously shown to elicit spontaneous infant and parent pointing across a variety of settings and populations. In the online set-up, participants joined a videochat to watch a PowerPoint presentation via screen sharing while the spontaneous interaction between parents and infants was video-recorded with the web cam. Caregivers were told to "look at the following slides together with your child and act as naturally as possible". The main aim was to test whether this situation would elicit spontaneous pointing in infants. To characterize the communicativeness of pointing, we further coded the hand shapes of infant pointing and accompanying vocalizations. Because infants' pointing has been shown to be influenced by parental behavior (Ger et al., 2018; Salo et al., 2019) we also tested for relations to parents' pointing, and contingent reactions to infants' gestures (verbal, facial), specifically their contingent pointing reactions (Liszkowski et al., 2012; Kishimoto, 2017). In experiment 1 (N=24; mean age=12;17; SD=9.07), slides varied in the number of displayed items and their familiarity (as in the live analog; Liszkowski et al., 2012). Behavioral data displayed in Table 1 corresponded to findings from several direct interaction-based paradigms. Only infants' pointing frequency was lower than expected. Regression analyses revealed a positive significant relation between the proportion of parents' contingent points (relative to their initiating points) and of infants' pointing frequency. In experiment 2 (N=47, mean age=12;16, SD=7.08), we modified the stimuli aiming to increase infants' pointing frequency. Main changes pertained to the presentation of one familiar object per slide; half of which included a face. A hexagon initially occluded the stimuli and then

moved sideways to a corner of the slide (see Figure 1). This modification lead to a significant increase of infants' pointing frequency (see Table 1). Regression analyses replicated results of Experiment 1. Findings reveal that the online decorated-room is a useful paradigm to measure spontaneous preverbal referential interaction between infants and caregivers. They confirm the social proto-conversational structure of parent-infant pointing, and reveal subtle influences of the nature of stimuli on uninstructed interactions.

P2-F-217 - The spatial representation of serial order in infancy (Bettoni)

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When Western adults and children remember ordered items, they spontaneously generate an internal spatial template, where items are mapped on a horizontal continuum whose orientation matches their reading-writing habits (i.e., left-to-right). While early order-space associations have been observed for numerical quantities in preverbal infants, no study has insofar investigated whether infants, like adults, represent any kind of ordinal information onto space. Here, we aimed to investigate (1) whether 6-month-old infants spatially organize in working memory the visual sequences they are habituated to, as indexed by lateral looking preference at Test1, (2) whether the mapping of order into space is associated with the efficiency of learning, as indexed by habituation times, and (3) whether the direction of order-space mapping is associated to exposure to culturally-driven directional routines in the home environment. Infants (N=22) were first habituated to 4-item sequences appearing sequentially at the center of the screen, then viewed two paired-comparison test trials in which the first or last item of the sequence was presented bilaterally on the screen (Test1), followed by two post-test trials in which the familiar items appeared, alternately, in the familiar and a novel order (Test2). The spontaneous directional behaviors produced by the caregivers were also measured during two sessions of joint reading and toy construction. To test whether infants showed an order-space association, a lateral preference score, computed as the difference in numbers of orienting responses toward the left vs. right item at Test1, was entered as the dependent variable in a linear mixed-effects model, with the item position in the sequence (first vs. fourth) as a fixed effect, and subjects as random intercepts. Next, we extracted from this model the individual-level random slopes for each subject as an index of the inter-participant variability in the tendency to associate the first item with the left space and the last item with the right space. We thus correlated these values with the total looking time during habituation and the number of left-to-right directional behaviors performed by the caregiver during the joint activity sessions. Data collection is still in progress. Results from the first 22 infants showed a tendency to orient more frequently toward the left versus the right on Test1 trials in which the first item of the sequence was presented ($B = -.064$, $SE = 0.04$, $p = .113$), suggesting that infants perceived the association first-left as more salient than the association first-right. This tendency was stronger for infants with shorter habituation times ($r = .47$; $p = .028$), suggesting that infants for whom the learning process occurred more efficiently, were those who also spontaneously generated an internal spatial representation of the sequence. Finally, even though the analysis did not reach significance ($r = -.40$; $p < .19$), the magnitude of the lateral preference score at Test1 was associated with the number of the caregiver's directional points during joint reading, suggesting that passive exposure and/or active imitation to directionally relevant culturally-driven routines may contribute to shape order-space associations.

P2-F-218 - Attention is a matter of time: effects of rhythmic stimulation on newborns' attentional disengagement (Arioli)

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The Dynamic Attending Theory postulates that ongoing temporal structure of events entrains attention and affects perception (Jones et al., 2002). According to this theory, rhythm, defined as a sequence of short repeated intervals with regularities that allow us to build expectancies, is one of the main temporal cue which guides attention and facilitates performances in both visual and auditory domains. Evidence from the adult literature supports this hypothesis, showing that rhythm boosts perception (e.g., Elbaz & Yeshurun, 2020). However, no study has explored whether the rhythmic structure of external stimuli improves the efficiency with which infants attend to and process them. Given the ubiquitous nature of rhythms in the perceptual environment of the infant across the perinatal period, this question appears compelling. Indeed, it has been shown that foetuses in the last trimester of gestation are responsive to rhythmic stimulation that reaches them through the auditory, vestibular and tactile sensory channels (Lecanuet & Schaal, 2002), and it is claimed that this early exposure to rhythm plays a key role in the development of early communicative and cognitive abilities (Provasi et al., 2014). On this ground, we hypothesised that exposing the foetus to an enriched rhythmic environment might affect early infants' attentional capabilities, which could be boosted by prenatal experience. The current study is part of a larger project aimed at testing this hypothesis, and was planned as a pilot investigation of the impact of rhythm on the orienting of visual spatial attention at birth. Two-day-old newborns were tested in an overlap task where a central stimulus, S1, was followed by a peripheral target, S2, (see Figure 1) and saccadic reaction times towards S2 were recorded as measure of attentional disengagement. S1 remained on the screen until the infant's gaze landed on S2. On each trial, the same image was presented as S1 and S2. We manipulated the attributes of S1 within-subjects to obtain three different S1 conditions: the static condition, in which S1 remained still on the screen, the rhythmic condition, in which S1 flickered at the rate of 500 ms on and 400 ms off, and the random condition, in which S1 flickered at a random rate. We planned to reach a sample size of at least N = 28, as resulting from an a-priori power analysis. Data collection is still in progress. Preliminary results from the first 6 newborns suggest that both the dynamic and rhythmic nature of the central stimulus affected saccadic latency, as the static condition induced the fastest latencies, and the rhythmic condition is associated with the slowest latencies. If confirmed by the data from the final sample, this pattern of results would suggest that rhythm is perceived as particularly salient and captivating at birth, thus constraining the efficiency of attentional orienting.

P2-F-219 - Examining Visual Short-Term Memory in Toddlers and Young Children Using an Eye-Tracking Change-Localization Task (Pham)

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Visual short-term memory (VSTM) is the memory system responsible for the brief storage and maintenance of visual information, and is important for holding information through interferences that can occur during eye movements, eye blinks, and other visual disruptions (Luck, 2007). In the traditional change detection paradigm used to assess VSTM, participants view a sample array containing a few items, followed by a brief delay, and lastly, a test array containing the previously shown items, in which one or more items may have changed, and participants indicate that they have detected that a change has occurred or which item changed from the sample to test. Variations of this task have been used to assess VSTM in participants as young as 4 months to adults. However, no study to date has used the same task to bridge the gap from infancy to the preschool period, which was the goal of this study. We used the same eye-tracking task to assess VSTM in a group of 12- to 30-month-old toddlers and, for comparison, a group of 36- to 48-month-old preschoolers. To make the task appropriate for all ages, we used a version of the eye-tracking task typically used with preverbal infants. Our primary sample included 41 12- to 30-month-old toddlers. We also collected data from 35 36- to 48-month-old preschool children for comparison. Children viewed up to 32 trials with the following sequence: a 500-ms sample array of three colored circles, followed by a 300-ms delay array with a blank screen, and finally a 2000-ms test array in which one of the three circles changed color from the sample. Because our measure was how much children looked at the changed item on each trial, this task is a change localization task. For each child, we calculated a change localization score by dividing the duration of looking at the changed item by the total duration of looking at all three items (changed or unchanged) during the test array. If children detected and localized the change, their change localization score should be greater than chance (.33, or equal looking at the three items). Our toddlers had a mean change localization score that was significantly above chance, $t(40) = 2.36$, $p = .02$ (see Figure 1), indicating that children at this age detected the change. In addition, toddlers' change localization scores were not correlated with age, $r = -.03$, $p = .88$ (see Figure 2), suggesting that there was no change over this age range in children's localization of and interest in the changed item. Our comparison group of preschoolers also had a mean change localization score that was significantly above chance, $t(34) = 3.19$, $p = .003$ (see Figure 1), and their change localization score was not correlated with age, $r = -.09$, $p = 62$ (see Figure 2). In summary, these data suggest that an eye-tracking change localization task can be used successfully to examine VSTM in toddlers, and that there is little evidence of developmental change in their response across the period from infancy to preschool.

P2-F-220 - Object Play in the Everyday Home Environment: Learning Opportunities for Hispanic Infants (Ho)

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Infants everywhere engage with objects throughout the day, even if the objects of play differ across cultures. Indeed, object play is a universal context for learning and is ubiquitous across animal species and children all over the world. Yet, the characteristics of object play at home remain largely unexamined, especially in infants from non-English-speaking backgrounds. We extend our understanding of infants' everyday object play using a sample of 50 infants (11-25-month-olds) from low-income, Hispanic immigrant families. We investigate: (1) the amount and distribution of time infants spend in object play, (2) infants' time with toys and non-toys, and (3) the number and variety of unique objects with which infants played. Through frame-by-frame video coding, we documented infants'

object interactions during 1-2 hours of naturalistic home observation. Videos were coded for bouts of object interaction, defined as infants' manual displacement of an object (e.g., playing with a toy, carrying a sippy-cup). Coders labeled each bout as involving only toys (i.e., objects designed for child play such as dolls and books), only non-toys (i.e., household objects such as cups and socks), or a mix of toys and non-toys. Coders annotated each unique object of play, generating a list of objects engaged throughout the visit. Our examination revealed infants' exuberant activity with objects. Infants interacted with a wide variety of toys and non-toys in brief bouts accumulating to ~60% of their time. Most infants (78%) spent more time at play than not, and time with objects increased with age, $r(48) = .58$, $p < .001$ (Figure 1). Across the dataset, most bouts of object interaction (87.8%) lasted less than 1 minute (Mdn = 8.4s), interspersed with similarly brief, empty-handed breaks. Analysis of toy, non-toy, and mixed bouts revealed equal distribution (36.6%, 30.0%, and 33.4%, respectively) across the visit. At an individual level, infants varied widely in their time spent in each type of bout (toy = 3-82%; non-toy = 5-96%; mixed = 0-68%). Figure 2a depicts timelines of infants' transitions among types of bouts, illuminating the sheer amount of play, bout brevity, and object variety in infants' everyday activities. Figures 2b and 2c zoom in on the distribution of play for an example infant, with the final timescale detailing the specific objects of play during a 5-minute period (4 unique toys and 4 unique non-toys, often returning to the same objects). Indeed, infants engaged with dozens of unique objects, averaging 30 per hour (range = 14-60). Several common object types were seen across multiple infants: Most infants interacted with food (84%), children's books (78%), boxes/bins (76%), and toy vehicles (74%). In summary, this first study of Hispanic infants' object play during home activities offers a rich portrayal of what infants do in naturalistic, unconstrained settings. As infants transition among different objects, they serendipitously create a curriculum for learning that supports development across domains. Our findings on object interactions mirror the immense amounts of varied and time-distributed exuberant play of infants from non-Hispanic white, middle-income families (Karasik et al., 2011; Herzberg et al., 2021).

P2-F-221 - Effects of Intersensory Redundancy in Attention to and Recognition of Faces in 5- and 12-Month-Olds (Bursalıoğlu)

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The goal of this study was to examine the role of audiovisual synchrony in 5- and 12-month-old infants' attention to and processing of face stimuli. One hundred two infants (35 5-month-olds and 67 12-month-olds) were tested using an online platform called Lookit. In the first phase of the experiment, infants were familiarized with two videos presented simultaneously and side-by-side. Each video displayed a woman speaking in an infant-directed manner. A soundtrack was played that matched one of the videos (experimental condition) or neither of the videos (control condition). It was hypothesized that synchronous audiovisual presentation would attract infants' attention and promote processing, especially among 12-month-olds, as evidence of specialized face processing is seen at this age (e.g., Conte et al., 2020; Halit et al., 2003). Visual-paired comparison (VPC) trials were completed to measure looking preferences for the faces presented synchronously and asynchronously during familiarization and for novel faces. The results showed that 12-month-olds spent a longer time fixated on the videos during the familiarization period (M = 29.44 s), compared to 5-month-olds (M = 28.23 s, $p = .046$).

However, results from the one-sample t-tests showed that neither 5- nor 12-month-olds displayed a novelty preference during the VPC trials. Across control and experimental conditions, 5-month-olds showed a familiarity preference. Specifically, their looking time to a particular face during familiarization (whether synchronous or asynchronous) was significantly and positively correlated with looking to the same face during the VPC trials ($r = .759$, $p = .048$ for the experimental group, $r = .490$, $p = .024$ for the control group). Twelve-month-olds showed no significant correlations between looking times during the familiarization and VPC trials. It is possible that the complexity of the familiarization stimuli led to attention being directed to amodal properties (Bahrick & Lickliter, 2000) or made audiovisual synchrony more difficult to detect (Lewkowicz & Hansen-Tift, 2012). This can be because 12 months is a time where infants start to transition from a familiarity to a novelty preference, and that they were more sensitive to the synchronous, amodal properties than the unimodal, visual properties of the faces. Taken together, the results from this study indicate that 12-month-olds may have been more engaged during familiarization than 5-month-olds, but that their exposure was not sufficient for face processing. It is possible that the stimuli were too complex to be processed during the familiarization period or that the multimodal stimulus presentation attracted infants' attention to other stimulus properties. Future research addressing remaining questions will be presented, including modification of the familiarization stimuli, extension of the ages tested, and use of event-related potentials for investigation of neural correlates.

P2-F-293 - Do infants predict and generalize the value of information? A pupillometry study (Ghilardi)

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Infants show sophisticated learning abilities from the first year of life. Research shows they tailor their attention to maximize information gain, both in social and non-social contexts. However, little is known about how infants learn to assess the informativity of incoming stimuli. Moreover, it is an open question whether infants attribute informativity to novel stimuli based on prior knowledge by generalizing what they know about a set of stimuli to new, unseen stimuli. 6In a pupillometry study, we presented 7-month-old infants (current sample N = 10, final sample N = 40) with multiple static shapes, that had either smooth or pointy borders and a red or blue color (Figure 1). One feature (e.g., border type) predicted whether the shapes would be informative of the target location (by moving in its direction) or not (by moving randomly). Across multiple trials, infants could thus learn what stimuli were predictive of later events. In the generalization phase, two shapes (a pointy and a smooth one) were exchanged with new shapes. We expected infants to learn about the expected informativity of the shapes. Throughout the task, we recorded infants' pupil dilation and expected an increase in pupil dilation for stimuli with higher expected informativity. Moreover, we expected infants to quickly generalize informativity to new shapes with the same features. Preliminary data shows that infants display different patterns of pupillary response for informative and uninformative stimuli. When analyzing the time window that preceded the moment in which infants were exposed to the level of informativity of the stimuli (in yellow in Figure 1), they showed greater baseline-corrected pupil dilation for uninformative compared to informative stimuli at the start of the task, but this pattern reversed in the second half of the task (Figure 2). These preliminary results may suggest that across repeated exposure to informative and uninformative stimuli, infants learned when to expect information, and these expectations were reflected in greater pupil dilation. Moreover, when comparing familiar and novel stimuli, pupil dilation

was greater for novel stimuli, but more so for informative ones, suggesting a quick generalization of informativity to stimuli that had never been seen before. This data suggests that infants quickly learn about the informativity of stimuli and generalize informativity to novel stimuli on the basis of their perceptual features. This may offer an explanation of how infants can be so proficient in finding information even when they know little yet about the world around them.

P2-F-294 - Objective assessment of visual attention in toddlerhood (Braithwaite)

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Visual attention is an important mechanism through which children learn about their environment, and individual differences could substantially shape later development. Eye-tracking allows us to objectively assess visual attention with high temporal and spatial fidelity, making it a suitable measure of development for large-scale studies. However, most eye-tracking studies of visual attention use study-specific experiments in small groups of infants. This approach makes it challenging to assess the generalisation of results across samples, and to pool data. Here we investigate the feasibility of a comprehensive assessment of visual attention that includes measures of working memory, visual search, orienting speed, reversal learning, and spontaneous attention to faces. We present data from 350 (166 females) term-born 18-month-olds recruited as neonates http://www.developingconnectome.org/). We examined the percentage of valid data obtained, how metrics varied with data quality, and whether expected profiles of task performance were elicited. We then used structural equation modelling to characterise the interrelationship between performance on key task measures. Analyses showed the expected condition effects for seven out of eight tasks (p-values ranged from <.001 to .04) and that quality and quantity of data collected was generally high. Consistent with theoretical models of visual attention, performance could be explained by four latent factors representing social attention, exogenous orienting, memory-guided choice and search; the fit of the model was good: RMSEA=0.044 (CI=0.035-0.052, p=.90); CFI=0.933; TLI=0.906; AIC=15468.78; BIC=15943.30; $\chi2(196)=326.66$, $p<=0.001$, $\chi2/df=1.67$. In summary, comprehensive eye-tracking batteries can be used on a large scale to objectively measure core components of visual attention in toddlerhood.

P2-F-295 - A computer-vision based approach to co-register frames from egocentric video recordings (Mu)

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Wearable eye-trackers enable us to record eye movement dynamics from an egocentric viewpoint. Although the data collected from wearable eye-trackers can index our looking patterns in naturalistic settings, current data analyses focus on the correspondence between fixation locations and an individual frame from the egocentric video recording. This analysis approach separates the continuous eye movement dynamics into isolated frames, thereby hindering the study of the temporal dynamics of eye movement patterns, such as building computational models to predict eye movement during interpersonal interactions. The challenges are largely caused by the fact that the recorded eye

movement data includes both eye movement and head/body motion, but there is no reliable method to isolate the head/body motion.

Therefore, separating eye movement from and head/body motion may potentially facilitate computational models to focus on finding features relevant for predicting fixation dynamics. To this end, we adopt methods in computer vision to correct observers' head/body motion by co-registering frames of videos taken by head-mounted cameras. The end results are a series of images as if taken from a static camera.

Towards this goal, we first used semantic segmentation algorithms based on deep learning to identify stationary objects (e.g., a table & wall) in each frame. Next, we calculated the dense optic flows between every two consecutive frames based on the pixels automatically selected from the stationary objects. The global frame-by-frame movement is then estimated as a series of affine transformations and is used to warp and align consecutive frames. We tested our method on eye-tracking data and egocentric videos simultaneously recorded by head-mounted cameras from infants aged 9-18 months exploring a lab environment. Ongoing works are testing existing models of saliency prediction on the aligned videos.

P2-F-296 - Differences in scanning efficiency between short and long-lookers (Reynolds)

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Visual attention is an important component of early cognitive development. Visual attention measures derived from behavioral coding typically rely on looking time (LT), or total oriented gaze toward the stimulus. Studies examining infants' performance in habituation tasks have found that differences in LT are related to numerous long-term outcomes (Colombo, 1993). Specifically, short-lookers (i.e., shorter peak LT) have more developmentally advanced outcomes compared to long-lookers (i.e., longer peak LT). Although several mechanisms have been posited, such as processing speed and efficiency, one underexplored possibility is variations in low-level eye movements. Specifically, it may be the case that differences in scanning efficiency, the pattern of fixations and saccades that make up each bout of looking contribute to these individual differences. Infant scanning efficiency has been shown to change in response to scene content and perceptual load (Ross-Sheehy, Reynolds, & Eschman, under review). Additionally, adults who demonstrated greater scanning efficiency (i.e., longer fixation duration and greater saccade amplitudes) displayed better visual search performance. If scanning efficiency contributes to the differences between long and short-lookers, then we would expect to see systematic differences in scanning efficiency between the look profiles. Specifically, we expect short-lookers to display efficient scanning with longer fixation durations followed by longer subsequent saccades. A pilot sample of 5- and 7-month-old infants (N=18) were habituated to either a male or female face. Upon successful habituation, infants were presented with three additional test trials: familiar, novel, and control (Figure 1). Infants were excluded if their LT to the control trial was less than their LT to the familiar trial (N=3). Gaze was assessed continuously using an Eyelink 1000 Plus eye-tracker. Next, a median split of peak LTs was used to determine the look profiles: Short-lookers (N=9) and Long-lookers (N=9). Lastly, scanning efficiency scores were calculated for each habituation trial, as the correlation between fixation duration (ms) and the saccade amplitude (degrees) for the subsequent saccade. When infants engage in longer fixation durations, facilitating greater encoding of an area, paired with

strategically larger saccades from that location, results in the effective encoding of the entire habituation stimulus. Therefore, strong positive correlations indicate efficient scanning, while weak correlations indicate inefficient scanning. Preliminary results indicate that scanning efficiency varies between look profiles. As can be seen in Figure 2, short-lookers demonstrate efficient scanning t (87)=2.306, p=.024, while long-lookers do not, t (85)=1.358, p=.178. These results suggest that scanning efficiency contributes to differences between looking profiles, specifically that short-lookers efficient scanning may facilitate increased processing speed and efficiency. Furthermore, it is possible that variations in scanning efficiency contribute to the concurrent and long-term developmental differences found between long and short-lookers, with efficient scanning optimizing learning opportunities; however, more research will need to be done to explore this idea. Taken together, these findings highlight that scanning efficiency may contribute to meaningful individual differences in the development of attention.

P2-F-297 - Proactive interference disrupts toddlers visual working memory (Hamilton)

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Introduction: Proactive interference (PI) occurs when memories that were learned previously compete with currently relevant information (Keppel & Underwood, 1962; Kane & Engle, 2000). Despite extensive literature investigating the effect in adults, little work has been done in young children (Kail, 2002). In two pre-registered experiments (https://osf.io/3eg6h, https://osf.io/cjukf), we used a Delayed Match Retrieval paradigm (Kaldy, Guillory & Blaser, 2016) to investigate the effect of PI on visual working memory in 30-42-month-old toddlers. In this task, participants are presented with a set of cards (on a touch-screen tablet), first face-up. After this encoding period, the cards are turned face-down, and a target card is revealed that matches one of the previously seen cards. The participant is asked to touch the face-down card that matches the target. PI is induced by repeating items across trials. Experiment 1 measured the magnitude of the PI effect using a blocked design. Experiment 2 sought to identify the source of PI: whether PI is coming from lingering information from the previous trial in WM, or from the reactivation of information in long(er) term memory. Participants: Experiment 1: 36 toddlers participated (M=34.8 months, SD=3.5). Experiment 2: Preliminary data has been collected from 16 toddlers to date (M=37.52 months, SD=4.71). Stimuli and Procedure: Testing took place in a quiet room in the laboratory and all sessions were videotaped. Stimuli were unfamiliar objects from the NOUN database (Horst & Hout, 2016). Toddlers played 16 trials of a tablet-based version of Delayed Match Retrieval (see Figure 1). Exp. 1: The test consisted of two blocked conditions, each with 8 trials (with block order counterbalanced across participants): (1) PI trials: the same two items were repeated in every trial, (2) No_PI trials: a new, unique pair of items was presented in every trial. Exp. 2: The test consisted of one block of 16 trials, where PI trials with reused stimuli ('A') were interleaved with the No_PI trials with unique stimuli ('B', 'C', 'D', etc.) like so: {ABACAD... }. Data analysis: We compared performance (mean percent correct) in PI vs. No_PI condition. Results and Discussion: Exp. 1: Overall performance was significantly higher in the No_PI (M=76.6%, SD=15.8) than in the PI condition (M=62.8%, SD=16.0) (paired t-test, t(35)=5.231, $p < 0.00001$, see Figure 2). Exp. 2: Preliminary results reveal a similar trend: No_PI (M=77.8%, SD=20.51), PI condition (M=66.62%, SD=12.7, t(15)=1.97, p=0.057, see Figure 2). These results show that children are highly sensitive to the effects of PI, and preliminary evidence suggests that these effects can come from a reactivation of information in long-

term memory, not simply from information lingering in WM from the previous trial. These results also suggest that WM capacity limitations in toddlers stem from, to an extent, a difficulty inhibiting recently learned, irrelevant information. Our finding also has important methodological implications for the field: we frequently measure various cognitive abilities in toddlers and young babies by showing them information repeated over a series of trials, inadvertently triggering PI, and potentially causing us to underestimate children's abilities.

P2-F-298 - Prenatal stress is associated with reduced infant working memory (Garcia Brizuela)

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Robust evidence from animal models has shown that prenatal stress alters offspring neurodevelopment leading to deficits such as shorter attention span and impairments in cognitive function. Results from human studies are more mixed which, in part, may reflect different conceptualizations of stress, reliance on retrospective reports and lack of temporal specificity. Furthermore, most studies have examined general cognitive capacity (e.g., IQ) as an outcome, as opposed to more narrowly defined dimensions of neurodevelopment (e.g., attention, working memory, cognitive speed), which may increase the specificity of associations between neural systems impacted by prenatal stress. In the current prospective study, we tested the hypothesis that prenatal stress would be associated with infant working memory after accounting for concurrent maternal stress. Infants (N=88, 47% female, mean age=7.14 months, SD=1.38) enrolled in a community-based study examining preconception and prenatal influences on child health outcomes, completed the Delayed Match Retrieval task (DMRT, Kaldy, Guillory & Blaser, 2016) to assess anticipation-based visual working memory using a Tobii eye-tracking platform. Briefly, infants viewed two consecutive stimuli that are potential matches and non-matches to a sample object, displayed briefly and then obscured. Following a short delay, the sample object is revealed, and the infant seeks the now-hidden match. Working memory was thus operationalized as the time taken for the infant to fixate on the correct location of the hidden match. Mothers reported on experiences of negative life events, perceived stress and discrimination stress during pregnancy and at the time of the infant visit. Infants were included in the current analyses if they completed at least 3 of 12 DMRT trials (n=63, 75%). Results showed that average performance based on time to first fixation (TFF) on the location of the hidden match was significantly greater than chance ($p<.001$). TFF did not vary by child sex, birthweight, age, or head circumference. Hierarchical multiple regression models were run to examine the impact of each of the three types of maternal stress exposure: negative life events, perceived stress and discrimination stress on infant working memory (TFF) after accounting for infant sex and age. Results revealed a significant negative effect of prenatal negative life events on TFF (beta = -.26, $t = -2.05$, $p < .05$) that became negligible once concurrent negative life events were included in the model. Prenatal perceived stress had a significant negative effect on TFF (beta = -.29, $t = -2.35$, $p < .05$), which remained significant when concurrent perceived stress was also accounted for (beta = -.29, $t = -2.07$, $p < .05$). Maternal reports of discrimination stress during pregnancy and in the postpartum period were unrelated to infant working memory performance. These findings suggest that fetal exposure to maternal stress may be uniquely associated with reduced infant working memory independent of concurrent or ongoing maternal perceptions of stress. Potential explanations for this link include stress-

related disruptions in maternal endocrine, cardiovascular or immune functioning; effects that may also operate through epigenetic modification.

P2-F-299 - A preliminary investigation of sleep inertia in infancy (DeMasi)

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Sleep inertia is the behavioral state during the brief transition from sleep to wakefulness that results in impaired neurobehavioral performance and reduced alertness (Santhi et al., 2013). From 5 years to adulthood, the most severe impairments in cognitive performance related to sleep inertia occur within the first 10 minutes of awakening from sleep (Dinges, 1990; Wertz et al., 2006; Kinderknecht, 2013). Yet, no extant study has investigated whether the effects of sleep inertia exist for children who take regular daytime naps (e.g., infants and toddlers). The current study asks whether attention is diminished when infants wake from sleep, as compared to a time when they have been awake for a while. Neural complexity requires a gradual awakening process (Trotti, 2017). Because infants' brains (and sleep) are still immature (e.g., have fewer neural connections than adults), it is possible their brains can be "booted up" immediately from sleep. Determining whether infants experience sleep inertia will shed light on the development of chronobiological rhythms and mechanisms of sleep-related learning. A lack of sleep inertia could explain why napping frequently does not deter (and, in fact, facilitates) infants' learning, despite the potential for many instances of sleep inertia throughout the day. Thus far, two infants (mean age = 7.64 months) were tested on the focused attention (FA) task within 5 minutes after waking from a nap (Inertia Trial) and within 1.5-2 hours of the nap (Baseline Trial). One infant was first tested within 5 minutes of waking from a nap and then 2 hours later (Inertia First); the other was first tested 2 hours prior to the nap and then within 5 minutes of waking from it (Baseline First). During the FA task, infants are allowed unrestricted interaction with three toys presented consecutively for 60 seconds each. FA was coded as any bout during toy presentation where infants look at the toy while manipulating it deliberately with a serious facial expression, a decrease in extraneous body movements, no vocalizations, and no social bids (Lawson & Ruff, 2001). Data collection is ongoing. Infants spent less time engaged in FA on the second trial, regardless of condition (see Figure 1). Longest bout of FA was also higher during the first FA trial than during the second. Trial order accounted for within-subjects changes in FA more than sleep inertia did. The effect of trial order may indicate that infants habituate to objects they have seen multiple times, although similarly aged infants' active examination of objects does not decrease after multiple presentations (Oakes et al., 1991). Thus, it is possible that the FA trajectories of the two infants in the current study represent broader individual differences in chronotype (the natural inclination to sleep at certain times). Individual differences could exist in infants' vulnerability to sleep inertia, as they do in adulthood (Lundholm et al., 2021). Therefore, this basic research is positioned well to disambiguate the effects of individual inclinations to sleep at certain times and declining interest in object exploration on sleep inertia in early life.

P2-G-222 - The link between early maternal language and infants' vocabulary knowledge in English and Spanish (Castellana)

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Twenty-two percent of children in the United States hear a language other than English in the home and are faced with the task of dual language learning (US Census Bureau, 2019). A majority of these children live in low-income households, a factor negatively linked with language development (Hoff, 2013). In monolingual environments, the link between income and language skills has been consistently attributed to the quantity and quality of speech that caregivers direct to infants (Golinkoff et al., 2019). Although the quantity of caregivers' speech in each language has been linked to young children's dual language development (Marchman et al., 2010; Pearson et al., 1997), the contributions of qualitative features of caregivers' speech is less clear (Song et al., 2011; Tamis-LeMonda et al., 2014). In this study, we examined how the quantity and quality of speech of Spanish-speaking Mexican-American mothers' from low-income households directed to their 24-month-old infant (N=107) predicts infants' emerging dual vocabulary skills 1 year later (at 36 months). Method. Participants were part of a longitudinal study examining the health of Mexican-American mother-infant dyads from low-income households (Curci et al., 2020). Mother's speech during a five-minute free-play at infant age 24 months was transcribed and coded for quantitative features (number of utterances and word tokens), and qualitative features (number of word types and mean length of utterance-MLU; Hurtado et al., 2008), irrespective of language (speech was predominantly Spanish; 95% of word tokens). Infants' expressive vocabulary knowledge in Spanish and English at 36 months were assessed using the Woodcock Muñoz Language-Revised Normative Update Survey (Schrank et al., 2010) and composited for a total vocabulary score. Results. Infants' total vocabulary scores averaged 10.84 (SD=5.63) with Spanish vocabulary knowledge (M=7.55, SD=4.60) being significantly higher than English (M=3.29, SD=4.33), $t(105)=6.313$, $p<0.001$ (Figure 1). All measures of maternal speech independently predicted infants' Spanish vocabulary (Table 1): MLU, $F(1,105)=20.214$, $p<0.001$, number of utterances, $F(1,105)=4.103$, $p=0.045$, number of word types, $F(1,105)=18.694$, $p<0.001$, and number of word tokens, $F(1,105)=13.495$, $p<0.001$. No measures predicted infants' English vocabulary. MLU, $F(1,105)=16.102$, $p<0.001$, number of word types, $F(1,111)=10.717$, $p=0.001$, and number of word tokens, $F(1,105)=5.374$, $p=0.022$, all independently predicted infants' total vocabulary. Conclusions. These findings indicate that although quantitative features of mothers' speech predicted Spanish vocabulary, qualitative features predicted infants' total vocabulary scores (Spanish and English) one year later. Further, predominantly Spanish input did not negatively affect infants' English vocabulary development one year later, suggesting no negative cross language effects. These results suggest that high quality early maternal input provides an early foundation for infants' emerging dual vocabulary skills.

P2-G-223 - How Language Environments & Vocabulary Change Longitudinally: An Examination of the Language Assessment Tool at 18, 24, & 36 months (Rocha Hidalgo)

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Purpose. Using 3 waves of longitudinal data collected between 2016-2021 from 245 children (see Fig. 1), we aim to identify 1. trajectories of exposure to different languages, and 2. English vocabulary development. The study will also examine whether language exposure patterns predict vocabulary at 3 years. We predict that there will be a large variation in language exposure across time in the sample. Additional factors surrounding language exposure including fluency of different speakers will be added along with exposure to different languages to conduct a latent profile analysis on language exposure.

We will use a data-driven approach to determine the profiles at 18, 24, and 36months which will be used to predict children's vocabulary. Methods Language exposure measure. The Language Exposure Assessment Tool (LEAT) was used to assess language exposure (DeAnda, Bosch, Poulin-Dubois, Zesiger, & Friend, 2016). The LEAT is a parent-report measure of language exposure through a systematic interview. The LEAT acquires information on the people the child is surrounded by on a regular basis, the languages they speak, whether they are native speakers or not, the amount of time the child interacts with each of them, how these interactions vary over time and across languages. Additional variables were added to the questionnaire for the current study such as the speakers' level of fluency (0=not fluent at all to 4=very fluent) and what language is spoken at home between parents. Vocabulary measures. Parents completed the Communicative Development Inventory Words and Sentences Short Form (MCDI, level II) when their children were 18mo and 24 months old. When their children were between 36-40 months old, to measure children's vocabulary (English only), children completed the Peabody Picture Vocabulary Test administered on an iPad Air (9.7-inch retina display) through the NIH toolbox application. Each trial of the PPVT consisted of a page with four pictures; there were 149 potential sets of pictures. Analysis plan. A growth curve will be estimated using a mixed-effects model, also referred to as a multilevel analysis to study the trajectories of 2nd language exposure in typically developing children from 18 months to 36 months. Our fixed effects will model the main variable of interest: age in months (centered) and centered covariates: parental education and Parent Income (ZipCode Median income). Latent growth class analysis (LCGA), which permits tracking of individual differences in growth over time, while grouping children with similar trajectories together will be used to assess language profile trajectories. We will test if these language profiles will predict English vocabulary at 36 months. Impact. In the past 19 years, the U.S. population of children between 0 to 8 years of age raised in a bilingual home has grown 24%. Young dual language learners now comprise a substantial proportion of young children in the United States (nearly a third of them). Despite this consistent increase, most of the research with this population has focused on children older than three from monolingual backgrounds. The prospective nature of the study allows us to assess how trajectories of language exposure during early childhood are related to linguistic outcomes in preschoolers. This study will provide a unique look at monolingual and bilingual children's language exposure experience and lexical development across three-time developmental points (18mo, 24mo, & 36mo).

P2-G-224 - Infants? expectations of moral behaviour across moral subdomains (Gill)

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Evidence suggests that adults use information about an individual's moral character to make inferences about how they will behave across contexts (Siegel, Crockett & Dolan, 2017). Moreover, past work suggests that roots of moral sensitivity can be traced back to infancy: preverbal infants prefer agents who help others over those who hinder others in their goal pursuit (Hamlin & Wynn, 2011; Hamlin, Wynn & Bloom, 2010), and by the start of the second year of life, infants showed pronounced attention to unequal resource distributions (Schmidt & Sommerville, 2011), prefer individuals that distribute resources equally (Geraci & Surian, 2011; Burns & Sommerville, 2014) and perceive fair individuals to be morally praiseworthy (Deschamps, Eason & Sommerville, 2018). However, it is unclear whether infants generalize behavior from one moral subdomain to another. Existing evidence suggests that this ability may be within infants' purview: 15-month-old expect a protagonist who previously helped another

agent to distribute resources equally, but suspend this expectation when the protagonist previously hindered another agent (Surian, Ueno, Itakura & Meristo, 2016). We investigated whether infants expect agents who are fair to subsequently be helpful, and for agents that are unfair to subsequently be unhelpful. In a control experiment, 12- to 24-month old infants received neutral information about a protagonist during familiarization trails followed by test events in which the protagonist helped (by opening a box to allow her to retrieve her toy) and hindered (by closing the box lid) another agent in her goal. The results established that, after receiving neutral information about a protagonist, younger (12- to 15-months) infants looked longer to the helping event, $t(11) = 2.53$, $p = .028$, and older (16- to 24-months) infants looked equally to the helping and hindering events, $t(20) = .606$, $p = .55$. When familiarized to a protagonist distributing cookies between two individuals fairly, younger infants showed an overarching preference for the helping event, $t(16) = 2.30$, $p = .035$, compared to older infants, $t(14) = .20$, $p = .84$, who showed no preference between the helping or hindering events and looked equally to both test events. In the unfair condition, younger infants looked longer to the helping event, $t(14) = 1.618$, $p = .130$, not unlike the younger infants in the fair condition, but older infants looked longer to the helping test event, $t(17) = 3.191$, $p = .005$, as well. Our results show that infants aged 16 months and older can use prior distributive behaviour to infer the likelihood that an individual will subsequently help or hinder another's goal pursuit in a different context. Interestingly, these results were only found when the protagonist engaged in unequal resource distributions; equal resource distribution did not appear to provide infants with a basis for predicting future behaviour related to help/harm. Together, these results suggest that infants form different inferences from others' behaviour based on whether they behaviour is norm-consistent or not.

P2-G-225 - Dynamic relations between infant and parent looking during joint puzzle play (Nelson)

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A large body of research confirms the importance of parent/infant play behavior during the first year of life. These interactions have long-ranging effects on infants' subsequent object manipulation abilities (Deák et al., 2018), socio-cognitive skills (Brandes-Aitken et al., 2020), and sustained attention (Wass et al., 2018). Prior studies of joint play have shown that toddlers spend relatively little time looking at their parents' faces during dyadic play (Smith & Yu, 2013; 2016; 2017), parents most often use multi-modal behaviors to draw toddlers' attention (Suarez-Rivera, Smith & Yu, 2019), and instances of joint-attention most-often follow parent action, rather than gaze (Deák et al., 2014). However, much of this previous research has been done in the second year of life, and thus little is known about the origins of these relations in the first year. The current study sought to extend our understanding of these dyadic interactions to younger infants. We recorded parents and their 9-month-old infants during naturalistic puzzle play. We recorded the direction of gaze by each play partner using head-mounted eye trackers (see Figure 1) and then coded the datastream for instances of looking at the partner's face, partner's hand, and puzzle. To date, we have analyzed the looking behaviors of 41 mother-infant dyads. Initial analyses confirmed, as found in other studies, that infants rarely looked at parents' faces, looking instead at the parents' hand and the puzzle. Overall, infants' looking was related to parents' looking; specifically, the proportion of infants' looking at the puzzle was positively correlated with the proportion of parents' looking at infants' face, infants' hand, and the puzzle (see Figure 2). Ongoing time-course analyses are examining how these relations between infant and parent looking unfold over time. We are

using regression analyses with lagged predictors and cross-recurrence quantification analyses of dyadic interactions. Preliminary results suggest that the relations are dynamic and bidirectional, with both partners responding to the behavior of the other. Overall, our preliminary results suggest that during puzzle play, infants use their parents' hands and puzzle more than parents' faces as a cue for attention. This pattern is consistent with the findings of Deák and colleagues (2014) that episodes of shared attention with 3-11-month-old infants were more likely to follow parents' actions, rather than other behaviors, such as gaze. In conclusion, the relationship between parent and infant-looking behaviors is bidirectional, multimodal, and highly dynamic.

P2-G-226 - Executive Function and Language in Infancy: Associations with Academic Outcomes in Preschool (Castillo)

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Executive function encompasses a broad range of cognitive processes that are interrelated and responsible for goal-directed behavior (Diamond, 2013). Executive function develops rapidly in early childhood, as does the acquisition of language. Research suggests that these executive function plays an important role in language development (Gandolfi & Viterbori, 2020) and vice versa (Kuhn et al., 2014). However, findings remain inconsistent. A longitudinal study suggests that early executive function is more predictive of attentional and behavioral outcomes at age 6 than early language skills (Gooch et al., 2015). In this study, infants from low-income backgrounds were assessed in infancy and two years later to examine associations between early language and executive function abilities and later language, executive function, and math skills. Data were collected for a larger ongoing study in Fall 2019 (Age M = 28) and Fall 2021 (Age M = 52). Infants (N=30) were ethnically diverse (65% of children Hispanic and 20% Black) and from families of low socioeconomic status. In 2019, direct assessments included an executive function assessment (Minnesota Executive Function Scale; MEFS App, Carlson & Zelazo, 2014) and an expressive vocabulary assessment (The Expressive One-Word Picture Vocabulary Test; EOWPVT; Henninger, 2011). Two years later, direct assessments included two direct executive function measures (Snack Delay & MEFS), one caretaker-reported self-regulation subscale (Devereux Early Childhood Assessment for Toddlers; DECA-T; Mackrain et al., 2007), assessments of literacy and numeracy (Early Learning Quick Assessments;ELQA; Kimmel et al., 2021), and an assessment of language proficiency (Quick Interactive Language Screener; QUILS; Golinkoff et al., 2017). Correlations were conducted. Expressive vocabulary in infancy was related to performance on Snack Delay, $r(27) = .53$, $p = .04$, and expressive vocabulary, $r(27) = .45$, $p = .01$, two years later. Executive function in infancy was related to both, expressive vocabulary, $r(30) = .36$, $p = .04$, and receptive vocabulary, $r(30) = .44$, $p = .01$, two years later. Additionally, executive function in infancy was related to executive function MEFS, $r(29) = .46$, $p = .01$, and early numeracy abilities, such as algebraic thinking, $r(30) = .51$, $p = .01$, and numbers and operations, $r(30) = .45$, $p = .02$. The poster will present inferential statistics. Executive function in infancy was related to executive function assessed by MEFS but not Snack Delay, early numeracy abilities, and expressive and receptive vocabulary two years later. Yet, expressive vocabulary in infancy was only related to Snack Delay performance and expressive vocabulary two years later. Thus, our findings suggest that while early executive function abilities may be predictive of specific executive function tasks in early childhood, expressive vocabulary may be more predictive for others. Linking early

language and executive function with standard early childhood preschool assessments provides insight into how infants' early cognitive abilities relate to their later skills. In sum, our findings highlight the importance of supporting executive function skills in infancy to promote children's later academic outcomes (Carlson and Zelazo, 2020).

Thematic Poster - Human Action Understanding: The Development of Performance, Language, and Reasoning (P2-G-300, P2-G-301, P2-G-302, P2-G-303)

P2-G-300 - The Perceptual-Motor and Social Factors in Children's Learning of the Designed Actions of Objects (Kaplan)

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Many cultural artifacts require specific actions to use as their designers intended. Despite the ease with which adults twist open bottles, pull open lids, and unzip jackets, designed actions are not obvious to children and must be discovered to perform the activities of daily living. Previous work (Rachwani, et al., 2020) identified a developmental progression in learning designed actions--from non-designed exploratory actions, to display of the designed action, to successful implementation. However, performing the designed action did not guarantee successful implementation because children must both know what to do and have the motor skills to execute the action. In two studies, we investigated the perceptual-motor and social factors that influence how children learn the designed actions of everyday objects, namely containers that require twists or pulls. Between 18 and 24 months, children know to twist the lid of a twist-off container, but twist repeatedly back and forth instead of continuously to the left, suggesting that perceptual feedback keeps children on task, but fails to inform them how to open the container. Experiment 1 tested the role of perceptual feedback in children's learning of designed actions. We encouraged 72 20- to 60-month-old children to open two types of containers that provided perceptual feedback (lids that twisted and opened normally or lids that twisted endlessly but never opened) and containers that did not provide perceptual feedback (lids did not twist). To test the generalizability of children's learning, half of the children received containers that twisted conventionally to the left ("leftie-loosie rule") and half that twisted to the right. Preliminary results show that both younger and older children opened the conventional left-twist containers (M=82%), but only older children used perceptual feedback (lid tightening to the left) to overcome the "righty-tighty, lefty-loosie" rule and successfully opened the right-twist containers (M=53%). Children persisted longer with twistable lids than stuck lids, $t(27)=2.21$, $p=.04$ and typically twisted for the entire 30-s trial (considerably longer than the usual time to open the container). With stuck lids, children quickly switched to alternative strategies (e.g., shaking, banging). Experiment 2 examined social factors that influence children's learning. Caregivers are cultural experts who likely provide social information to help children overcome the difficulties of discovering and implementing designed actions. However, researchers know little about whether or how caregivers scaffold designed actions. We asked 74 mothers to teach their 12- to 36-month-old children to open containers with twist-off or pull-off lids. Preliminary findings show that mothers verbally and manually drew children's attention to the task (70% of trials), highlighted what to do (62% of trials), indicated where to direct the action (34% of trials), and assisted with implementation (46% of trials). Mothers' manual teaching behaviors were brief (M=1.54s), unlikely to be repeated (M=1.32 times per trial), and were more often accompanied by attention-getting

language (72% of trials) than language that matched what they were teaching with their hands (43% of trials). Plans are to examine how mothers tailor their teaching behaviors to children's actions in real time. Findings provide insights into the complex processes involved in children's learning to use the artifacts of their culture.

P2-G-301 - Compensatory motor strategies in children with limb differences (Bird)

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How does a child tie their shoelaces when they are born with one hand? Each year, around 500 babies born in the UK are affected by congenital upper limb malformations: from fused digits to total absence of the hand and arm. Despite their limb difference, these individuals demonstrate remarkable motor skills and functional capabilities, completing everyday tasks with ease. Here we study how this is achieved through functional adaptations in 17 children (2 years 11 months - 9 years) born with one functional hand, whereby 'function' is defined as the ability to pincer grip. In a series of everyday tasks such as doing up buttons and separating Lego bricks, children compensated for their missing hand by using multiple different body parts (hereafter 'effectors'), including the residual limb, torso, mouth, legs, and feet. Effector use was measured as the proportion of task time during which each body part was engaged. There was frequent use of alternative effectors (torso 18%, mouth 2%, legs 37%, and feet 8%). Use of the residual limb was, however, consistently higher than these (78% of task time; $p<.001$ for each comparison). We found hints that effector use may change with age or experience: whilst the balance of effectors used was highly variable between participants, at around 5.5 years we observed a marginally significant reduction in foot use (13% for children <5.5 years compared to 1.3% for children >5.5 years, $p = .054$). Our data provide evidence for the recent theory that motor development is highly flexible. Specifically, they demonstrate how end state development can be achieved by following different paths. Here, skilled motor action is executed using alternative effectors. Further data will explore how compensatory strategies change throughout childhood, converging towards the upper body.

P2-G-302 - Learning the Language of Designed Actions of Physical Support (Lakusta)

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Sticking a picture to a wall and hanging a coat on a hook are common actions for young children, and recent research sheds light on how children acquire 'designed actions'. Yet, aside from performing actions, children need to learn how to communicate about them. How do children learn the mappings between the lexical expressions in their language and specific actions? To test this question, we focus on the domain of physical support - a domain whose semantic space is broad, yet highly differentiated. For instance, in English, the expression BE on can be used across a broad set of configurations, including solid support from below (SFB; block is on box) and support via adhesion (ADH; block is on side of box). Despite this breadth, the semantic space is highly differentiated; e.g., in English, specific lexical verbs are used to encode actions involving specific mechanisms (stick to, hang from). In two studies, we ask how children learn these broad, yet highly differentiated mappings of language to action. In Study 1, we tested whether 20-month-olds would map is on broadly, to SFB and ADH. Using the Intermodal

Preferential Looking Paradigm, 20-month-olds (N = 24) were first presented with a Salience phase, followed by a Test phase. For both phases, infants were simultaneously presented with a SFB event and an ADH event (Figure 1). During Salience, they heard neutral language ("Look here! What do you see? Look here!") and during Test, they heard spatial language ("Look at the toy that IS ON the box. Find the toy that IS ON the box"). A Tobii X2-60 eye-tracker measured looking durations at the two events. Infants hearing is on looked at SFB longer during Test compared to Salience, suggesting that is on maps preferentially to SFB (relative to ADH) rather than mapping broadly to both support types (Figure 2). In Study 2, we tested whether slightly older children would 1) continue to show a bias for mapping is on to SFB, and 2) map the specific lexical expression - sticks to - to ADH. 2-3.5 year-olds saw the same events as in Study 1 (cube put on top vs. on side of box), but heard two different expressions. One group of children heard, "Point to the toy that IS ON the box. Can you point to the toy that IS ON the box?" (N = 24) while another group heard, "Point to the toy that STICKS TO the box. Can you point to the toy that STICKS TO the box?" (N = 24). For children who heard is on, 13 pointed to SFB and 11 pointed to ADH. In contrast, for children who heard sticks to, 6 pointed to SFB and 18 pointed to ADH, $X2$ (1, n = 48) = 4.27, p = .039. Thus, prior to 2 years, is on maps preferentially to SFB over ADH, but by 2 years 1) is on may be broadening to cover both kinds of support, and 2) sticks to maps to ADH over SFB, suggesting linguistic differentiation.

P2-G-303 - Early understanding of agents' abilities through actions (Cao)

Qiong Cao[1], Lisa Feigenson[1]

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From early in life, children use action as a window to understanding others. For instance, infants use actions to infer agents' goals and preferences, and to predict who will affiliate with whom. For adults, an important component of representing others' actions is how successfully they are executed. We notice when others complete tasks well, versus when they try but persistently fail; further, we know that these successes and failures sometimes reflect limitations outside the agent's control, but other times implicate enduring aspects of their competence. In the present work we examined the developmental origins of children's ability to think about the relationship between actions and competence. In Experiment 1, we asked whether preschool-aged children expect of certain kinds of agents to exhibit more competence than others, based on enduring traits including their age or species. In a forced-choice task, we found that young children predicted that an adult would execute tasks (building a block tower or drawing a picture) more successfully than a child, and that a human would execute these tasks more successfully than an animal. In Experiment 2, we explored whether children also consider temporary constraints when evaluating others' competence. Preschoolers watched simple movies of two people engaging in a task, then were shown a successful outcome (a tall block tower or a well-drawn picture) or a poorer outcome (a short tower or a messy scribble), and were asked which person had produced it. We found that preschoolers considered the agents' physical access to materials when inferring the outcome of the agents' actions (e.g., being able vs. unable to reach blocks or drawing materials in one condition; having unimpeded vs. impeded manual dexterity caused by wearing mittens in another). Children also showed sensitivity to the agents' perceptual access (e.g., whether they were/ were not wearing a blindfold while building or drawing) and their attentional allocation (e.g., whether they were/ were not talking on the phone while building or drawing). We also observed evidence in developmental change in the ability to consider these temporary constraints on the agents'

competence; in particular, young children had some difficulty reasoning about how perceptual access might impair the agents. Collectively, our findings suggest that by the preschool years, children represent the ways that other people's abilities are affected by both longer-term characteristics and by temporary constraints.

P2-G-304 - Semantic categories related to space in mental rotation task (Peyrot)

Ixchel Peyrot[1], Elda Canto[1]

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Previous works on mental rotation have described some variables related to the assessment of mental rotation in the first year of life, such as sex differences at 5 months of age, and motor development such as crawling at 9 months of age. In the present research vocabulary size is proposed as another variable related to the spatial skill of mental rotation at 12 months old, an age at which it is considered that infants begin to link words to representations of absent objects (Luchkina and Waxman, 2021). The present pilot study was carried out under the Intermodal Preferential Looking Paradigm and only infants with typical development participated. The tasks are based on a familiarization phase which consisted of 10 trials of 10,000 ms each with a 2D visual stimulus representation of a 3D object (as used in Moore & Johnson, 2008). Following this phase, 8 silent test trials of 5,000 ms each with two test stimuli were presented: the familiar test stimulus and the novel mirror object. Two conditions were designed, one with the label "Look Mibo" and another condition without a label during the familiarization phase; 8 infants and 5 infants participated in the two conditions respectively. During the visit to the lab, parents answered the parental report (CDI). The measures obtained were the Differential of Looking Time which is the difference between the total time to the novel stimulus minus the total time to the familiar stimulus, and the total of comprehended words of CDI. A non-parametric Mann-Whitney test showed no differences in the infant's visual preference to the novel Z = -.582 (p = .561) nor to the familiar object Z = -.258 (p = .796) in both conditions. But there were correlations observed between the semantic categories of CDI parental report and the novelty preference, regardless of sex or condition (n = 13). Pearson correlations showed r = .680, p = .011 for Locative Adverbs, r = .598, p = .031 for Furniture and rooms, r = .587, p = .035 for People and r = .570, p = .042 for Vehicles (real or toy). The correlation was consistent with the previous literature that found individual differences in a mental rotation task explained by crawling regardless of the sex of the infant. For this research, the semantic categories explained the individual differences. Furthermore, language has been described as a facilitator for recognizing geometrical shapes; the child´s ability to recognize different shapes when presented under rotations was founded up to 4 months earlier than previously reported in the literature. Specifically, the linguistic abilities of the child were measured by means of semantic categories which refer to spatial words (there, on, up, down, etc.), mobile objects (train, car, airplane, etc.), places in the house (bed, bathroom, kitchen, etc.) and the people near the infants who teach them words (mom, dad, grandmother, etc.). These findings showed indicators that infants who have a better performance during a mental rotation task know more about spatial relations of objects in their environment.

P2-G-305 - Does object naming influence object representations in 7-month-olds? (Chan)

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The uniquely human link between language and cognition endows us with exceptional conceptual flexibility. A cornerstone of this flexibility is our ability to represent any object (my cat Felix) either as a distinct individual (Felix) or as a member of a category (cat, animal), and to switch effortlessly between these two different representations. This flexibility is supported by language: how an object is named - either as an individual or as a member of a category - is instrumental to how we mentally represent it (Dewar & Xu, 2009; Waxman & Braun, 2005). To assess how object naming influences 12-month-old infants' representations of the same object, LaTourrette & Waxman (2020) developed a novel recognition memory paradigm (Figure 1). During the Learning phase, all infants viewed four different objects of the same category. Infants in the Consistent Name (CN) condition heard the same name applied to each object; in the Distinct Name (DN) condition, infants heard a different name for each. During the Test phase, infants were presented with the same Learning objects, presented side-by-side with a new object of the same category. If a tight coupling between naming and representation is available to infants, then infants in the CN condition should focus on commonalities among the Learning objects, but at the expense of encoding distinctions among them; therefore, they should represent these objects as members of an overarching category without sufficient specificity to distinguish each individual within the category. In contrast, infants in the DN condition should focus on distinctions among the Learning objects, but at the expense of encoding commonalities; therefore, infants should represent the objects as unique individuals with enough specificity to discriminate between category members. Results from 12-month-old infants supported these predictions. What remains unknown is how early infants begin to establish this tight link between naming and representation. To address this, we build upon LaTourrette & Waxman (2020), this time tracing the effect of naming on 7 to 8.5-month-old infants' representations of objects as either category members or individuals. Although data collection is still underway, the results suggest that this link is in place early: how an object is named guides how 7-month-old infants represent it. Infants in the DN condition (n=7), but not the CN condition (n=6), were able to distinguish the Learning objects from new category members presented at Test, suggesting they represented them as unique individuals. These results are consistent with the possibility that infants' nascent representational abilities, established in the context of naming, are available early enough to support their reasoning and learning about objects and their names.

P2-G-306 - How the home environment has negatively impacted on infant development during the pandemic (Chere)

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Given that much of the first two years of development are spent within the home, how the home environment affects early development has long been explored within the field (Marsh et al., 2020). With the current COVID-19 pandemic forcing families all over the world to spend the vast majority of their time at home, this question has never been more important. The current study was specifically developed to both address what characteristics of the home environment impact on key aspects of infant development, such as temperament, language, and sensory processing, as well as how the pandemic might have influenced this relationship. An online questionnaire study was run asking 117 primary caregivers of infants aged 8 to 18 months to fill out the Parental Stress Questionnaire, the home Confusion Hubbub and Order Scales, a Home Environment and Noise questionnaire, and a COVID-19 impact questionnaire. Additionally, they filled in three measures of infant development- a Temperament

questionnaire (the Infant Behavioural Questionnaire or the Early Childhood Behavioural Questionnaire depending on the infant's age), the Communicative Development Indices, and the Sensory Profile questionnaire. Preliminary correlations that controlled for infant age revealed that higher parental stress significantly correlated with higher in-home chaos ($p = .002$) and with infants having a worse effortful control temperament score ($p < .001$), a worse general sensory processing score ($p < .001$), and a worse behavioural sensory processing score ($p < .001$). More children living in the home correlated with infants understanding a higher number of words ($p = .033$) and having a more chaotic ($p < .001$) and noisier home ($p = .003$). A more chaotic home significantly correlated with coming from a noisier home ($p < .001$), a higher parental stress score ($p = .002$) and worse infant auditory sensory processing ability ($p = .001$). Lastly, living in a noisier home correlated with infants having a worse negative affect temperament score ($p = .016$). Further preliminary results using paired-samples t-tests revealed significant findings in terms of how the pandemic has impacted the life of families compared to what their life would have been like under normal circumstances. Parents reported that infants interacted significantly less with other adults ($p < .001$) and infants ($p < .001$), attended daycare ($p < .001$) and social groups ($p < .001$) far less frequently, and infants had significantly more screen time ($p < .001$). Furthermore, parents reported the home as being less chaotic ($p = .043$) but noisier ($p = .011$), that they have experienced more stress ($p < .001$), and that their socioeconomic status was negatively impacted ($p < .001$). Overall, the correlations revealed that the home environment, such as the number of children in the home, parental stress levels, and in-home noise and chaos negatively impact on key aspects of infant development. Additionally, further results poignantly showed that infants born during the pandemic have developed within significantly different home environments and have had significantly different exposures to resources and people outside of the home. Further structural equation modelling is planned to further analyse the complexity of these relationships.

P2-G-307 - Exploring relations between socioeconomic status and toddlers' number knowledge (Silver)

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Children's early number skills are foundational to later math performance (e.g., Chu et al., 2015), which in turn predicts school achievement and other long-term educational outcomes (e.g., Duncan et al., 2007). Previous work has identified a general timeline for children's acquisition of number words, suggesting children understand the meaning of exact number words very slowly (Wynn, 1990; 1992). Additionally, there are individual differences in the process of number word acquisition, such that children's own domain-general and domain-specific cognitive abilities are related to their number learning (Geary et al., 2018). However, little is known about how environmental influences may relate to early number knowledge. Some work suggests family socioeconomic status (SES) may relate to children's number word learning, particularly in preschool- and school-aged children (e.g., Fluck & Henderson, 1996; Jordan & Levine, 2009). Although these SES disparities seem to emerge early, it is crucial for early intervention efforts to understand the timing as well as specificity in which aspects of number knowledge may be most disparate among low- and high-SES children. Here, we used a series of three number skills assessments to examine whether SES may relate to toddlers' developing number knowledge and if there are similar relations across number tasks (N = 79; M age = 2 years 8 months, range 2-3 years). We tested knowledge of the count list by asking toddlers to count as high as they could, where scores were the highest number they correctly counted to. We tested recognition of

number words via the Point-to-X task (Silver et al., 2021), a forced-choice task presenting two quantities of identical objects where toddlers were asked to point to a specific quantity ranging from 1 to 10. Scores on the Point-to-X task were the percentage of correct responses (out of 12 items). Finally, we tested cardinality understanding via the Give-N task (Wynn, 1990; 1992), where we asked toddlers to produce sets of items ranging from 1 to 6. Scores on the Give-N task were the highest number at which toddlers successfully created the set twice. Additionally, we asked parents to report their education and income to create an SES composite score and children's vocabulary via the Developmental Vocabulary Assessment for Parents (Libertus et al., 2015). Toddlers recited the count list correctly to approximately 9 on average (M = 9.10, SD = 6.24), with wide variability ranging from 0 to 30. Performance on the Point-to-X task also varied, with scores ranging from 33.33 to 100 (M = 67.09, SD = 17.34), as did performance in the Give-N task, with scores ranging from 0 to 6 (M = 2.15, SD = 1.59). Given the variability observed in toddlers' number knowledge, we explored whether individual differences in these tasks were related to family SES. Although family SES varied widely in this sample (with parental education ranging from less than high school degree to graduate degree, and family income from less than $20,000 to more than $250,000 per year), SES did not significantly predict toddlers' performance in any of the number knowledge assessments, but SES did relate to other commonly studied outcomes such as vocabulary (see Table 1). As such, it seems that the association between number skills and SES may not yet be present in toddlerhood, suggesting opportunity to intervene.

P2-G-308 - In defence of low inhibitory control: evidence for problem-solving advantages amongst toddlers with low scores on inhibitory control measures (Hendry)

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Low inhibitory control (IC) is sometimes associated with enhanced problem-solving amongst adults, yet for young children high IC is primarily framed as inherently better than low IC. Here, we explore associations between IC as measured through parent report and behavioural tasks, and performance on a novel problem-solving task, amongst 102 English 2- and 3-year-olds (Study 1) and 84 Swedish children, seen longitudinally at 18-months and 4-years (Study 2). Generativity during problem-solving was negatively associated with IC, as measured by prohibition-compliance (Study 1, both ages, Study 2 longitudinally from 18-months). High parent-reported IC was associated with poorer overall problem-solving success, and greater perseveration (Study 1, 3-year-olds only). Benefits of high parent-reported IC on persistence could be accounted for by developmental level. No concurrent association was observed between problem-solving performance and IC as measured with a Delay-of-Gratification task (Study 2, concurrent associations at 4-years). We suggest that, for young children, high IC may confer burden on insight- and analytic-aspects of problem-solving. Our findings highlight the importance of considering the context-specific advantages and disadvantages of individual differences in IC.

P2-G-309 - Habituation, Part I. Design Choices in the Infant Habituation Paradigm: A Crowd-sourced Systematic Review and Meta-Analysis (Visser)

Ingmar Visser[1], Martina Stefanova Zaharieva[1], ?imon Kucharský[1], Tongyu Gu[1], Ines Luttenbacher[1], Lilli Mannsdörfer1[1], Magda Matetovici[1], Urte Mickute[1], Janneke Staaks[1], Zoltan Torma[1], Cristina Colonnesi[1], Maartje Raijmakers[1]

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The habituation paradigm is among the most prominent methods for studying infant cognition. Experimental designs and protocols, as well as reporting practices, vary greatly between studies. These methodological variations and lack of consistency in reporting practices pose considerable challenges to the interpretation and generalizability of the outcomes derived from habituation studies. With the aim of devising a set of specific reporting guidelines for habituation studies and weighing the impact of otherwise potentially arbitrary methodological design choices, the proposed work addresses two primary goals. The first goal is to map out experimental design choices used in habituation studies, including the criteria applied to determine whether habituation has taken place. The second goal is to assess the relationship between various design choices and the resulting effect sizes as a function of the moderating effect of age. The development of this project has been coordinated with the review project that is part of ManyBabies 5 (https://manybabies.github.io/MB5/) in such a way that both projects have complementary goals. Following the PRISMA 2020 reporting guidelines, we perform a systematic review of the design choices and post-habituation measures used in habituation study samples aged 0-18 months, with a focus on the visual response modality literature (i.e., habituation experiments with looking time as the dependent variable). A total of 2,853 papers published in peer-reviewed journals between 2000-2019 were extracted from PsycInfo and Web of Science and screened for eligibility, see Figure 1 for an overview of the screening criteria. Figure 2 presents the PRISMA flow diagram for this study. The screening was performed by 6 blind raters (inter-rater reliability Fleiss kappa = .60, 95% CI [.40 - .80]), yielding 785 (27.5%) papers for results extraction. The protocol for conducting the systematic review and meta-analysis has been submitted as a registered report (https://psyarxiv.com/bdtx9/). After in principle acceptance data collection can start in which researchers from the infant research community are asked to join our team as raters in a large-scale collaborative effort. Using an online platform for crowd-sourced reviews (sysrev.com), each paper is randomly assigned for blind coding to at least two raters who subsequently discuss and resolve coding disagreements. With this workflow, we aim to maximize the accuracy and reliability of the data extraction. The results of our systematic review will yield a detailed overview of current practices in infant habituation research. In the meta-analysis, we will establish the design choices that impact the magnitude and direction of the effect (i.e., novelty/familiarity preference) in the post-habituation phase of the task. In the presentation we will outline the development of the study protocol and discuss best practices for designing and conducting large-scale collaborative meta analytic projects.

P2-G-310 - Exploring the effects of socioeconomic status, parental attitudes, and activities during the 2020 Covid-19 pandemic on early Executive Functions (Hendry)

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Executive Functions (EFs) are the skills that enable us to resist acting on impulse, adjust our actions during a changing situation, and work towards goals. Early EFs have strong links to children's language, social and academic functioning, and can predict later educational outcomes (Cortés Pascual, Moyano Muñoz, & Quílez Robres, 2019; Diamond, 2013; Hendry, Jones, & Charman, 2016). If spotted early, EF difficulties may be rectified through interventions (Scionti, Cavallero, Zogmaister, & Marzocchi, 2020). However, to target and refine such interventions we need to understand the factors associated with optimum EF development, and how these factors are affected by the context within which a child is developing. In this parent-report study of 575 UK-based 8- to 36-month-olds (218 followed longitudinally), we investigate how variation in the home environment was associated with children's emergent EF skills during the first year of the COVID-19 pandemic, using data collected in Spring and Winter 2020 using the Early Executive Functions Questionnaire (Hendry and Holmboe, 2021). Specifically, we aimed to understand the practical, day-to-day mechanisms by which the broad contextual factors of SES and parental attitudes influence EF skills. Parent-infant enriching activities were positively associated with infant Cognitive Executive Function (CEF) (encompassing inhibitory control, working memory, cognitive flexibility). During the most-restrictive UK lockdown - but not subsequently - Socio-Economic Status (SES) was positively associated with levels of parent-infant enriching activities. Parents who regard fostering early learning, affection and attachment as important were more likely to engage in parent-infant enriching activities, yet there was no significant pathway from parental attitudes or SES to CEF via activities. Infant screen use was negatively associated with CEF and Regulation. Screen use fully mediated the effect of SES on CEF, and partially mediated the effect of SES on Regulation. Parental attitudes toward early learning, affection and attachment did not significantly influence screen use. These results indicate that although parental attitudes influence the development of early EFs, interventions targeting attitudes as a means of increasing enriching activities, and thus EF, are likely to be less effective than reducing barriers to engaging in enriching activities.

P2-G-311 - 5-months-old infants prefer spatially congruent view of their own legs: a (partial) replication of Rochat & Morgan (1995) (Hinz)

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Measures of an implicit sense of self in infancy often use preferential looking paradigms comparing sensory information congruent and incongruent with the infant's own actions (e.g., Bahrick & Watson, 1985; Rochat & Morgan, 1995). For instance, in a widely cited paper by Rochat & Morgan (1995), 3-to-5-month-olds were shown a real-time video of their own legs in a spatially congruent (from above) and a spatially incongruent (from the front) perspective. This study found a looking preference for the spatially incongruent view, which is explained with a novelty preference: infants are used to the visual information being spatially congruent with their own actions. We replicated this study with a sample of 108 5- to 6-month-old infants (mean age = 171 days, 47 female). As in Rochat & Morgan (1995), infants were lying in a seat in front of a screen, which was divided in two halves. On one side of the screen infants saw a live video of their own legs from above (ego view), on the other side, the same view was horizontally and vertically mirrored (observer's view). The task was divided into four trials, between which the screen side showing the two views was counterbalanced. The looking behavior was coded offline from a video recording of the face of the infant. Coding reliability between two coders was r = .99. Only 18 children showed a preference for the observer's view, while 90 children showed a

preference for the ego view. The average looking duration towards the ego view (see Figure 1) was significantly greater than the looking duration towards the observer's view ($t(110) = 5.85$, $p < .001$). Age in days did not affect the preference for any of the views ($F(106) = .06$, $p = .81$). The effect decreased over time (see Figure 2), but was still significant to the Bonferroni-corrected p-value of .0125 in every trial. Our findings show the opposite pattern as Rochat & Morgan (1995). Rochat and Morgan themselves replicated their findings in a couple of studies (Morgan & Rochat, 1997, Rochat & Morgan, 1998), although with small sample sizes (around 20 participants). However, in one study (Rochat & Morgan, 1998) they found a pattern like ours: here, infants showed a preference for the familiar (ego) view if there was an object present in the visual display, which the infants could kick with their feet. Rochat & Morgan (1998) hypothesized that in an action context, the familiar view would be beneficial for performance of the action, while in a solely exploratory context (as presented here), the preference is to learn from the unfamiliar (novel) view. In the present study there was no action context present, rendering this account unlikely. The infants in the present study still discriminate between both views, suggesting their ability to differentiate between a familiar and an unfamiliar view. However, the results also show that we need caution in interpreting preferential looking patterns, apart from them showing a discriminative ability, as the preference for a specific view does not seem to be a reliable finding.

P2-G-313 - The Relation between Eye-Tracking Measures of Endogenous Attention and Face-to-Face Attention and Emotion Regulation in 3- to 4-Month-Old Infants (Zaharieva)

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The way infants differ in employing the attention and emotion control mechanisms they acquire over the first year of life has been of primary interest to understanding, predicting, and even enhancing the developmental course of crucial later-life socio-cognitive outcomes such as executive functioning. Rothbart and colleagues (1992) have shown that some of the earliest emotion (co-)regulation strategies rely on attention skills, as is for instance in the case with the ability to avert gaze away from stimuli that are overwhelming or stressful. The goal of the current paper is to establish 1) whether individual differences in early-infancy endogenous attention are stable across non-social and social measurement contexts, and 2) which endogenous attentional mechanisms are involved in emotion regulation. We used eye-tracking to obtain reliable, fine-grained individual-level measures of several basic endogenous attention mechanisms in 49 3- to 4-month-old infants (N male = 30; M = 125.7 days, SD = 12.9). We derived looking time response and peripheral arousal measures of shifting attention, sustaining and recovering focused attention, and information processing from three gaze-contingent eye-tracking protocols - the Gap-Overlap (Hood & Atkinson, 1993), Habituation (Fantz, 1958), and the Butterfly task (Wass et al, 2011). We take on a multi-method approach to study the relation between the eye-tracking measures of endogenous attention and 1) micro-coded video measures of emotion and attention regulation during a semi-structured face-to-face interaction with the caregiver (the Still-Face paradigm, Tronick, 1978), and 2) global self-regulation measures at the level of temperament (Putnam et al, 2014), sleep (Sadeh, 2004), and feeding (Llewellyn et al., 2011) obtained via caregiver questionnaires. Video data from the Still-Face paradigm are recorded from both interaction partners simultaneously using a dual-lens mobile camera. Emotional valence, the display of emotion regulation strategies, and focused attention are coded manually by multiple blind raters (trained until inter-rater reliability of $r > .80$) using the coding scheme from Colonnesi et al. (2012). Multilevel modeling will be used to assess correlations

among the constructs of interest nested within infants. Preliminary results from a subset of 18 infants showed a significant group-level increase in the display of negative affect in response to the caregiver's disengagement from the free-play interaction and during the subsequent re-engagement compared to the baseline. The use of self-distraction during the caregiver's disengagement correlated to shorter sustained attention span, $r = -0.91$, $p < .001$. Faster shifting attention correlated marginally with longer focused attention towards the social interaction partner, $r = -0.51$, $p < .10$. The results of our study will yield a detailed overview of how attention and emotional-affective processes measured at the lab interact with more global and ecologically valid measures of self-regulation. We further discuss and offer solutions to common methodological challenges when studying fast-paced cognitive processes in preverbal infants (e.g., using gaze-contingent protocols and stimulus characteristics to maximize task engagement). We conclude on a detailed evaluation of eye-tracking as a method for studying attention and emotion control processes in young infant samples.

P2-H-227 - Longitudinal Associations between RSA Suppression and Later Social Communication Skills in Infants at Low and Elevated Likelihood for ASD (Djiko)

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Respiratory sinus arrythmia (RSA) is a measure of parasympathetic activation that has been linked to both typical and atypical social development (Porges, 2007). Early vagal tone during infancy, as measured through RSA suppression, has been found to be associated with later social functioning (Porges et al., 1996; Provenzi et al., 2015). Past research has demonstrated associations between RSA suppression at 3-4 months of age and parent-report of social communication skills at 9 months of age (Bradshaw & Abney, 2021), but these associations have yet to be explored in direct observation of social communication. The present study aims to examine predictive associations of vagal tone at 6 months and later emerging social communication skills at 12 months via the Communication and Symbolic Behavior Scales - Behavior Sample (CSBS-BS; Wetherby & Prizant, 2002). It is hypothesized that greater RSA suppression at 6 months will be associated with higher social communication skills at 12 months. Participants included 24 infants (n female = 12) at either low or elevated familial likelihood for Autism Spectrum Disorder (ASD). At 6 months of age, infant cardiac data was collected during a modified 9 minute still-face procedure as part of a larger longitudinal study. Average RSA estimates were calculated for each phase of the still-face procedure (i.e., play, ignore, and reunion phases), with greater change in RSA between the ignore and play phases indicative of higher vagal tone. At 12 months of age, infants were administered the CSBS-BS to evaluate emerging social communication skills. Infants at elevated likelihood for ASD were found to have significantly lower scores on the Social composite of the CSBS-BS ($M=7.4$, $SD=1.8$) compared to low likelihood infants, $t(21)=-2.23$, $p=.04$. Total score on the CSBS-BS was also found to be significantly lower for elevated likelihood infants ($M=83.2$, $SD=5$), $t(20)=-2.61$, $p=.02$. Pearson correlations and linear regressions were calculated to examine associations between RSA suppression and standard scores of social communication on the CSBS-BS. Due to small sample size, participants were collapsed across likelihood status and analyzed together. Correlations were not found to be statistically significant, perhaps due to sample size restrictions. A negative correlation between RSA suppression and the Symbolic subscale was found to be trending towards significance, $r(13)=-.43$, $p=.11$. Controlling for likelihood status, RSA suppression was found to be predictive of Total standard score on the CSBS-BS, adjusted $R2=.34$, $F(2,12)=4.69$, $p=.03$. Data collection is ongoing, and these

preliminary results provide support for associations between vagal tone during infancy and later emerging social communication skills. Further, the negative correlation trending towards significance between RSA suppression and later symbolic play skills is indicative of the high degree of regulation required for infants to engage in this task. Symbolic play is a more socially demanding task on the CSBS-BS that involves a higher degree of play and self-regulation skills, including listening and responding appropriately to the caregiver and examiner, manipulating objects functionally, and joint attention. With increased sample size, future analyses will explore associations between early RSA suppression and later social communication skills predicted by ASD likelihood status.

P2-H-228 - Face race biases stereotypical reasoning in preverbal infants (Liu)

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Infants are primarily exposed to own-race faces, such as their family members, and have little exposure to other-race faces. Recent theoretical advances suggest that asymmetrical face-race experiences may lead to biased perceptual and social processing in infancy (the perceptual-social linkage hypothesis, Lee et al., 2017). In accord with this hypothesis, recent studies reported that infants were biased to follow the gaze of own-race individuals over other-race individuals (Singh et al., 2019; Xiao et al., 2017). The present study further investigated the early emergence of race-based social biases by studying how face-race biases infants' stereotypical reasoning.

Previous child and adult studies suggest a tendency to process other-race faces at a categorical level, but own-race faces at an individual level. Thus, we predicted that infants may exhibit stronger stereotypical reasoning about other-race individuals compared to own-race individuals.

We examined this hypothesis with 9- to 14-month-old Caucasian infants (n = 49), who had little to no exposure to other-race faces. Infants completed an online gaze-following task (Figure 1), where they learned the reliability (50% or 100% reliable, between-subject) of a female prior informant and were tested on how they would follow the gaze of a new person, whose reliability was never revealed to infants. If infants engage in stereotypical reasoning, their gaze following of the new person will be influenced by the reliability of the informants. For example, after learning that the informant is unreliable, infants would not follow the gaze of the new person. The informant and the new person were either own-race or other-race to participants (within-subject).

We conducted two two-way mixed ANOVA analyses to compare infants' gaze-following of the new person (proportional looking time to the gazed-at location). When infants learned from own-race informants, gaze-following of new persons did not differ regardless of the new person's race ($p = 0.471$) or the reliability ($p = 0.904$), suggesting infants did not generalize learned reliability from an own-race individual to others. When infants learned from other-race informants, gaze-following of new persons did not differ regardless of the new person's race ($p = 0.171$), but the reliability was marginally significant ($p = 0.063$). Furthermore, the learned reliability from other-race informants significantly influenced their gaze-following of other-race new persons ($p = 0.026$). Infants exhibited reliable gaze-following of the new other-race person when the other-race informant was 100% reliable ($p < 0.001$). No gaze-following was found when the other-race informant was 50% reliable ($p = 0.115$). By contrast, their gaze-following of own-race new persons was not affected by learned reliability ($p = 0.458$).

Together, these findings were consistent with our prediction by demonstrating that perceptual experience with face race influenced how infants generalize learned reliability. Infants' limited other-race experience led them to perceive different other-race faces as part of an unfamiliar yet holistic category, leading to greater stereotypical reasoning of their behavior. Meanwhile, infants may judge own-race people's behavior on an individual level, limiting their stereotypical reasoning. Overall, infants' perceptual experiences with face race may contribute to the early emergence of social biases.

P2-H-231 - Toddlers' selective information transmission: Pitting self-discovered information against instructed information (Karadag)

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Children effectively acquire information from their immediate environment in two main ways: learning through exploration and learning from others. Research has suggested that preschool-aged children might reason differently about the information that they acquired through others' instruction compared to the information that they self-discovered (e.g., Bonawitz et al., 2011, Pinkham & Jaswal, 2011, Ronfard et al., 2016). The aim of the current study was to investigate whether 24-month-old toddlers make a distinction between these two types of information when they themselves transmit information. In this study, 24-month-old toddlers (Mage = 24.03; Range = 22.87- 24.93 months) were presented with two sets of two simple novel boxes) that were perceptually identical except for the orientation of a different-coloured button on top of each box. Pressing a button played different but similar tunes or turned on different coloured light bulbs (e.g., a black button playing tune A on the top-left side of Box 1, a silver button playing tune B on the top-right side of Box 2). In the Information Acquisition phase, children were instructed how to operate one of the novel boxes in one trial and were given an opportunity to independently explore the other box in another trial (counterbalanced). After children learned the functions associated with both boxes, they were presented with both boxes. At this Information Transmission phase, children were asked to demonstrate how the boxes worked to a naïve adult. The same procedure was then repeated with a different set of boxes (where the buttons activated lights; counterbalanced). We then measured whether children preferentially transmitted self-discovered or instructed information by examining the first function they transmitted and the frequency of their engagement with each type of information. Preliminary findings (n = 4, data collection is currently on-going for a full sample size based on power analysis n = 34) shows that during the information acquisition phase, in the first block, children activated the instructed function slightly more often (M = 3.75 times) than the self-discovered function (M = 3.00), whereas in the second block, they activated both functions equally often (M = 4.00 times). In the information transmission phase, in the first block, each toddler showed a different transmission preference (respectively, both simultaneously, none, instructed, self-discovered); however, in the second block, all toddlers transmitted the instructed function first. Across blocks in the information transmission phase, toddlers transmitted the instructed function as the first function in 5 out of 8 trials, the self-discovered function in 1 trial, and none or both functions simultaneously in the remaining two trials. However, overall toddlers activated the self-discovered function more frequently (M = 4.25) than the instructed function (M = 4.00). Acknowledging that the current sample size is too small to interpret the data, emerging behaviour pattern might suggest that even though toddlers seem to prioritise transmission of the instructed function first, they

engage more with the self-discovered function. The results and implications will be discussed based on the full sample.

P2-H-232 - Childhood Maltreatment Predicts Lower Maternal Sensitivity to Infant Distress via Mothers' Negative Attributions About Crying (Girod)

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Previous research has shown that childhood maltreatment is related to lower maternal sensitivity (Fuchs et al., 2015), however the mechanisms explaining this association are unknown. A separate line of research has demonstrated that early relationships shape emotion regulation skills, cognition, and subsequent sensitive parenting (Ainsworth et al., 1978, Crick & Dodge, 1994; Dix, 1991). The goal of this study was to test multiple indirect pathways that may explain how childhood maltreatment predicts later maternal sensitivity to distress. Specifically, infant crying is aversive, and a history of childhood maltreatment may prompt maladaptive attributions about infant crying and poorer emotion regulation skills, which may in turn undermine sensitivity. The sample included 259 primiparous mothers (131 Black, 128 White) and their infants (52% female). During their third trimester, mothers completed the Difficulties in Emotion Regulation Questionnaire (DERS; Gratz & Roemer, 2004) and viewed four clips of crying infants and were interviewed about why each infant was crying. Three causal attribution scores were created: emotion minimizing attributions (e.g., baby was hungry), negative attributions (e.g., baby is spoiled), and situational attributions (e.g., baby was trying to let someone know they need help; an adaptive attribution in relation to parenting). When infants were 6 months old, maternal sensitivity was rated during distress eliciting tasks using Ainsworth's (1978) sensitivity scale. Mothers' reported childhood maltreatment on the Childhood Trauma Questionnaire (CTQ; Bernstein et al., 1994). A path analysis was conducted to examine if the proposed negative associations between maternal childhood maltreatment and sensitivity to distress at 6 months was indirect via mothers' emotion regulation difficulties and causal attributions about infant crying during pregnancy (Figure 1). Maternal race, education, age, income-to-needs, and marital status were entered as covariates. Maternal childhood maltreatment was associated with higher emotion regulation difficulties and more negative causal attributions about infant crying while pregnant. In turn, higher emotion regulation difficulties and negative causal attributions about crying were significantly associated with lower maternal sensitivity to distress. Bootstrapped confidence intervals indicated the indirect effect from maternal childhood maltreatment to lower sensitivity via more negative causal attributions about crying was significant (b = -.03, SE = .02, 90% CI [-.01, -.001]). The indirect pathway via emotion regulation difficulties was not significant nor were the predicted direct effect of childhood maltreatment and indirect effects via minimizing and situational attributions. Results suggest that experiences of childhood maltreatment prompt poorer emotion regulation and more negative causal attributions about crying during the transition to parenthood. Both were found to undermine subsequent parenting, although the indirect effect was statistically significant only for negative attributions about crying. Given there are multiple ways in which a mother may be insensitive, future research should determine if such effects are stronger in relation to negative behaviors such as intrusiveness or non-responsiveness compared to global measures of sensitivity. An important next step is replicating the work in higher-risk samples to determine if altering attributions would be a useful preventative intervention target during the prenatal period to reduce the intergenerational transmission of maladaptive parenting.

P2-H-233 - Infant Responsivity to Maternal Touch: Links with Autism Symptom Severity and Language in Infants at Elevated Likelihood for ASD (Siew)

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Challenges in social communication are among the defining features of autism spectrum disorder (ASD). Evidence increasingly suggests that the infant's social environment - particularly parent-infant interactions - plays a crucial role in shaping early development. One key channel influencing the quality of parent-infant interactions is touch. Parents use touch to regulate attention and demonstrate affection towards their infant, and in turn, this is thought to facilitate the development of early social-communicative skills (for a review, see Rocha et al., 2019). Moreover, prior research demonstrates that children with ASD are sometimes hypo- or hyper-reactive to touch. Atypical responses to touch have been linked to altered social and communicative development (Foss-Feig et al. 2012; Hilton et al. 2010), and may also be an early indicator of ASD symptom severity (Kadlaskar et al., 2019). However, at present, the majority of research exploring touch and responsivity to touch in the context of parent-child interactions is focused on school-aged children. Thus, how these dimensions of touch may contribute to the developmental trajectory of ASD in early infancy remains relatively unexplored. Therefore, within a group of infants at elevated likelihood for ASD (N = 27; comprising n = 14 very pre-term born infants and n = 13 younger siblings of children diagnosed with ASD), maternal touch and infant responsivity to touch (10-months) was examined in relation to ASD symptom severity (14-months) and language outcomes (10- and 14-months). Maternal touch (i.e., total duration, comforting and affectionate, and stimulating and intrusive touch) was assessed via. observations of mother-infant interactions; whereas ASD symptom severity language outcomes were examined via. parent self-report using the Q-CHAT and N-CDI, respectively. Preliminary findings indicate that a failure to shift attention in response to maternal touch predicted the severity of ASD symptoms at 14-months ($r = 0.38$, $p = 0.045$). Furthermore, failure to respond to maternal touch was concurrently linked to language production scores at 10-months ($r = -0.40$, $p = 0.03$); however, there was no such association at 14-months. In addition, there was no association between any of the dimensions of maternal touch and neither the severity of ASD symptoms, nor language scores (p values > 0.05). Data presented here, although preliminary at present, support emerging work suggesting that atypical response to touch may be an early indicator of autism severity (Kadlaskar et al., 2019). We additionally report that failure to respond to touch may also influence the early development of language acquisition, as early as 10-months. The data presented at the ICIS 2022 conference will be extended - comprising a larger sample, longitudinal data and analyses at 24- and 36-months, as well as data from the ADOS-2 and the Bayley Scales of Infant and Toddler Development. In addition, within a larger sample, we will explore differences in associations within the elevated likelihood group - i.e., pre-term born group and sibling group.

P2-H-234 - Effectiveness of the parenting program "ACT-Raising Safe Kids" in mothers of infants (Lotto)

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Universal parenting programs provide prevention of violence against children by strengthening the caregiver's ability to manage aggression and relationship conflicts, reduce stress, and promote positive parenting practices and child development at early ages (Altafim & Linhares, 2016; Branco et al., 2021; Raman et al., 2020). The ACT-Raising Safe Kids (Silva, 2011) is an evidence-based parenting program to prevent child abuse, which is recommended by World Health Organization (Hardcastle et al., 2015; WHO, 2018). In developing countries, previous studies were performed with children from 3 years of age (Altafim & Linhares, 2019). The present study expanded this age group, including infants and more than one measure of parenting practices (ACT and PAFAS scales). Therefore, the present study aimed to examine the effectiveness of the ACT-Raising Safe Kids program delivered to mothers of infants (1-3 years old) to strengthen mothers' parenting positive practices. The sample comprised 39 mothers of 1-to-3 infants. The data collection included 9 weekly sessions. In the first session (pre-intervention), the mothers answered the following questionnaires: Sociodemographic characteristics assessment; ACT scale (Silva, 2011; Brazilian version of Altafim et al., 2018), that assess parenting (emotional and behavioral regulation, positive discipline, and communication); and Parenting and family adjustment scales (PAFAS, Sanders, et al., 2014; Brazilian version Santana, 2018), that evaluate parenting (parental inconsistency, coercive parenting, positive encouragement, and parent-child relationship). The researcher read and explained each instrument and the mothers self-answered. Subsequently, the mothers participated in 8 sessions of the ACT program. The post-intervention assessment was performed at the last session using the ACT and PAFAS scales. In the data analysis, the within-group comparisons were performed (SPSS 25.0; Wilcoxon test; $p \leq 0.05$). The results showed that, in the post-intervention assessment, there were statistically significant increase of mothers' emotional and behavioral regulation (pre-intervention, mean = 25.87 ±4.95; post-intervention, mean = 28.59 ±4.05; p=0.001) and positive discipline (pre-intervention, mean = 22.79 ±2.22; post-intervention, mean = 23.44 ±1.90; p=0.04), and decrease in coercive practices (pre-intervention, mean = 3.95 ±1.93; post-intervention, mean = 2.31 ±1.64; $p \leq 0.0001$) and parental inconsistency (pre-intervention, mean = 2.74 ±1.80; post-intervention, mean = 1.95 ±1.27; p=0.01), in comparison to the pre-intervention. In conclusion, the ACT Program was effective to improve maternal parenting practices of children at early ages.

P2-H-236 - Waiting for the reward: Toddlers' self-regulation behaviors during a snack delay task (Alonso)

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Objective: Children's self-regulation, or their ability to regulate their thoughts, emotions, and behaviors, has been linked with positive outcomes across domains (e.g., academic achievement, fewer internalizing problems) and development (Robson et al., 2020). Notably, these associations have been observed across ethnic groups (Kia-Keating et al., 2018), suggesting that self-regulation is a promotive factor for adaptive development. However, few studies have examined the variability in ethnic minority children's use of self-regulatory behaviors, particularly during toddlerhood when self-regulation skills are emerging (Eisenberg et al., 2011). Therefore, we examined ethnically diverse toddlers' performance and self-regulatory behaviors during an effortful control task and addressed the following research questions: (1) How do toddlers perform on trials of varying wait lengths? (2) What self-regulatory behaviors do toddlers engage in during each trial? (3) What sets of behaviors predict success on each trial? Methods:

We used data from a subset (anticipated N = 75) of ethnically and socioeconomically diverse families participating in a longitudinal, randomized controlled trial of a parenting intervention for first-time parents with infants (Table 1). When children were 24 months, they completed a video-recorded snack delay task, which consisted of four trials of varying wait lengths (10, 20, 30, and 15 seconds). The examiner placed a goldfish cracker on a plate and then a clear cup over the snack and instructed the child to wait to eat the snack until told so. For each trial, children's performance was scored as pass (i.e., waited and did not touch the snack or cup) or fail (i.e., ate the snack or touched the snack/cup before the trial ended). Trained coders indicated the regulatory behaviors that children engaged in during each trial, with behaviors falling into one of four categories: attention to task (e.g., staring at treat); self-talk (e.g., counting); active distractions (e.g., playing with hair); and redirecting attention (e.g., looking around room). We summed the number of behaviors within each category and included standardized receptive vocabulary scores (assessed at 24 months) as a control variable in our analyses. Results: Slightly less than half of children passed each trial (Table 2). Across all trials, the most common self-regulatory behaviors were attention to task and active distractions. To examine whether behaviors predicted success on each trial, we ran four binary logistic regression models with a Bonferroni-adjusted alpha of .0125. Preliminary analyses (n = 63) suggest that for every one-unit increase in redirecting attention behaviors, the odds of passing in the 30s trial increased by 4.18 (p = .011), controlling for receptive vocabulary scores and other behavior types. The number of active distraction behaviors was marginally significant (p = .013), with the odds of passing in the 30s trial increasing by 2.37 for every one-unit increase in active distraction behaviors, controlling for receptive vocabulary scores and other behavior types. Conclusions: Children who engaged in more redirecting attention strategies (i.e., focused their attention away from the snack) had greater odds of passing on the longest, 30s trial. These findings suggest that parents can potentially scaffold toddlers' self-regulation by encouraging them to direct their attention away from an appealing object.

P2-H-237 - Sweet mothers and sour fathers? A qualitative study of Chinese parents' beliefs and goals influence child social capacities. (He)

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The past few decades have seen a rising enthusiasm on studying fathers and their involvement in their children's lives. Emerging research shows fathers make direct impact on their children's well-being and development (Cabrera et al. 2017; Volling et al., 2019). Compared to fruitful research on mother-child relationship, sparse information is known about the fathers' roles for children under age 3, a developmental period both demanding for parents and foundational for children to develop critical capacities such as language (Thomason & La Paro, 2009). Chinese fathers are the largest ethnic group of the world's fathers, and the father role has been a central figure in the Confucian ethics (Hwang, 2001). Early research suggested that Chinese fathers, unlike typical Euro-American fathers, do not engage in play but rather in educational activities (Sun & Roopnarine, 1996). Despite a recent trend in shifting from distant and harsh disciplinarians towards nurturant caregivers, Chinese fathers are still less accepting than mothers and see childcare as a primarily maternal responsibility especially when children are young (Putnick et al., 2015; Tam & Lam, 2013). Based on recent national dataset (China National Center for Children, 2017), only 18.1% urban fathers and 11.5% rural fathers in mainland China were involved in the daily care of 0-to-5-year-old children. The uneven progress in Chinese fathers' roles in

major Chinese societies may continue to exert powerful influences on child development (Li, 2020). According to the ecocultural theory (Weisner, 2002), parents create meaningful daily routines that reflect their values and beliefs and incorporate the social expectations and economic demands of the host country (Arzubiaga et al., 2000). Therefore, understanding parents' values and beliefs are windows into the way parents shape the developmental context for their children and how it might influence developmental outcomes (Adolney & Cabrera, 2016). This study aims to illustrate what values and beliefs Chinese mothers and fathers hold and how they transmit those they wish their young children to internalize. We will also examine how gender role and cultural values influence parenting by comparing Chinese mothers and fathers. Third, we will explore how mothers and fathers influence, individually and jointly, their children's social and communicative development. Our research approach includes focus group interview (6 groups of mothers and 6 groups of fathers, 48 total, in progress) and videotaped mother-child and father-child interaction (in progress). Focus groups are a good method to use with underrepresented groups because they may see the group as a welcoming and non-threating setting in which to share difficult experiences (Umaña-Taylor & Bámaca, 2004). Topics for discussion are adapted from Aldoney & Cabrera (2016) and include five central questions: 1) parenting beliefs; 2) goals/expectations; 3) cultures and traditions; 4) social support; 5) routines. Interviews will be transcribed and coded using Atlas-Ti package and follow the principles of Grounded Theory through discovery of emergent themes in the data (LaRossa, 2005). Video-taped mother-child interaction and father-child interaction will be coded for parent's and child's emotionality, content and quality of conversations. The results will illustrate any qualitative and quantitative division between mothers and fathers in parenting values and practices, possibly mediated by gender roles, education, and support. There may be unique and joint contribution from mothers and fathers to their children's social and communicative development.

P2-H-314 - Do Infants Expect Imitators to be More Prosocial? (Pepe)

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Previous research finds that, after viewing imitative and non-imitative interactions, preverbal infants preferentially look and reach to imitators over non-imitators (Powell & Spelke, 2018a), and expect that imitators prefer to affiliate with those they imitate (Powell & Spelke, 2018b). While this provides evidence that infants use imitation to generate preferences and expectations about other social agents, it does not explain why imitation provides an early-emerging cue that engenders such inferences. Here we test the hypothesis that infants take imitation as evidence of prosociality. One possible conception of affiliation or prosociality is as the weight one person places on the rewards of another when calculating the utility of possible actions (Jara-Ettinger et al., 2016; Powell, in press). In this framework, imitation can be interpreted as the imitator adopting their social partner's goal into a shared utility function, illustrating an affiliative or prosocial stance, thus allowing an observer to infer that an imitator is more likely to act prosocially towards the target of their imitation. If infants use imitation to generate inferences about the imitator's probability of prosociality, they may be 1) less surprised when the imitator helps their target than when a non-imitator helps the target, and 2) more surprised when an imitator hinders their target than when a non-imitator hinders. To test these hypotheses, we showed infants animated imitation, helping, and hindering events featuring 3D geometric characters with faces. In familiarization events, a central agent turned to one of two side agents and performed a distinct

action. Across alternating events, one side agent responded by imitating that action, while the other responded by performing an alternative action. Then the central agent demonstrated a desired goal, moving through an alleyway to jump onto a colorful platform, while in view of the other agents. Finally, in each helping block test trial a gray wall blocked access to the central agent's goal, while in each hindering block test trial the wall was next to one of the side characters. In alternating test trials, each side character either pushed the wall out of the central agent's path, thus providing help (helping block), or pushed the wall into the central agent's path, thus hindering them (hindering block). We compared infants' log-transformed looking times to unexpected and expected trials for each test block using repeated measures ANOVA, with test order and block order as between-participant factors. In the helping block, there was a significant effect of trial type on looking time, $F(1,28) = 5.57$, $p = < .05$, reflecting longer looking when the non-imitator helped than when the imitator helped. However, there was no significant effect of trial type on looking time in the hindering block, $F(1, 28) = 0.14$, $p > .90$. The findings in the helping block are consistent with the hypothesis that infants view imitators as establishing an affiliative stance towards the target of their imitation, and thus infer that an imitator will be more likely to promote the target's goals in other situations. We are currently replicating and extending the positive helping findings, examining whether prosocial expectations for imitators generalize beyond the target of imitation to novel social agents. We also plan to follow-up on the null hindering result by providing stronger cues of (non)affiliation and more salient test events.

P2-H-315 - Social Versus Non-social Inhibition: Differential Developmental Trajectories From Infancy to Adolescence (Tan)

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Behavioral inhibition (BI) is a temperamental style characterized by cautious and fearful behaviors in unfamiliar and novel situations (Kagan, 1989). Higher levels of behavioral inhibition in toddlerhood have been associated with less adaptive social functioning (e.g., fewer close friends) and greater risk for developing internalizing problems, such as anxiety and depression, in adolescence and adulthood (Sandstrom et al., 2020; Tang et al., 2020). Although a growing literature suggests that children's fearful responses to social (e.g., unfamiliar people) versus non-social (e.g., unfamiliar objects) novelty are not highly correlated (e.g., Buss et al., 2004; Kochanska, 1991; Rubin et al., 1997; Talge et al., 2008), no research to date has investigated the long-term implications of this dissociation. To address this gap, the present study examined whether infants and young children' wariness toward social versus non-social novelty predicts different aspects of psychosocial functioning at 15 years. Participants were part of a cohort of children (N=291) participating in a large-scale, longitudinal study of child temperament and socioemotional development (Hane et al., 2008). To measure social BI, we coded children's behaviors when they interacted with unfamiliar adults and peers at 24 and 36 months, and collected parent reports of children's social fear on the Toddler Behavior Assessment Questionnaire (TBAQ) at 24 and 36 months and shyness on the Children's Behavior Questionnaire (CBQ) at 48 months. For non-social BI, we coded children's fear and avoidance responses to masks and an unpredictable toy at 9 months, and collected parent reports of children's distress to non-social novelty on the Infant Behavior Questionnaire

(IBQ) at 9 months as well as children's (non-social) fear responses on the CBQ fear subscale at 48 months. For 15-year psychosocial outcomes, children's anxiety problems were reported by both parents and children using the Screen for Child Anxiety-Related Disorders (SCARED), and children's general internalizing and externalizing problems were reported by parents using the Child Behavior Checklist (CBCL). Confirmatory factor analysis showed that, for BI measures, a two-factor (social and non-social BI) model fit the data significantly better than a single-factor (BI) model, $\chi2(1)=7.44$, $p=.006$, providing evidence for the dissociation between social and non-social BI in early childhood. Moreover, social and non-social BI in early childhood predicted different aspects of psychosocial functioning in adolescence. Specifically, although adolescent social phobia (average score across parent- and child-reports) was predicted by both social BI ($r=.27$, $p<.001$) and non-social BI ($r=.16$, $p=.03$), when these two predictors were entered into a regression model, only social BI reached statistical significance. By contrast, adolescent panic disorder ($r=.16$, $p=.04$) and separation anxiety ($r=.22$, $p=.003$) were predicted by non-social (but not social) BI. Finally, neither social BI nor non-social BI predicted general internalizing/externalizing problems, providing evidence for the specific relations between BI and anxiety problems. Together, these results suggest that infants and young children's inhibited responses in social versus non-social situations predict different subtypes of anxiety problems in adolescence, highlighting the divergent developmental trajectories of infant temperamental traits.

P2-H-316 - The ontogenetic emergence of normativity: Psychological mechanisms supporting infants' norm enforcement (Christner)

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The ontogenetic emergence of early normativity presents a major topic in current developmental psychology. Research showed that young children enforce norms in others (e.g., Schmidt et al., 2019). Yet, the psychological mechanisms underlying the developmental emergence of norm enforcement are unclear. With the current study, we tested two theoretical accounts against each other: First, children's imitation behavior leads them to engage in compliant behavior (cf. Forman & Kochanska, 2001), which in turn leads children to expect this behavior from others and predicts norm enforcement. Second, according to a social-cognitive account, imitation behavior leads children to mentally represent and internalize the normatively required behavior. When children then observe a norm transgression in others, they experience self-distress due to the discrepancy between the internalized and observed behavior, which in turn leads to norm enforcement. By testing these two theoretical models, the current study aimed at providing theoretical progress in this vivid research area. To this end, we measured 18-months-olds' (N = 97) inclination to imitate in four tasks. Additionally, infants' own behavioral compliance with maternal directives was assessed in two tasks (Do, Don't). Self-distress was coded following an observed norm violation, i.e., a puppet sorting objects against a previously established norm. Norm enforcement behavior was assessed as children's spontaneous protest against the norm violation of others. In order to test the relative contribution of the two hypothesized paths, we computed a combined path model. We computed the model twice, in a first step relying on a mean imitation score aggregated across tasks and in a second step relying on a single indicator of imitation. First, infants' imitation positively predicted both compliance (beta = .23, p = .030) and tended to predict self-distress following others' norm violation (beta = .24, p = .055). Only infants' self-distress but not compliance in turn predicted norm enforcement behavior (beta = .28, p = .026). Second, when focusing

on the clearest indicator of imitation that correlated with distress, the model revealed that imitation predicted self-distress (beta = .32, p = .017), which in turn predicted norm enforcement (beta = .27, p = .035). The study provides first empirical evidence on the early emergence of normativity. Supporting a social-cognitive account, the findings suggest that early norm enforcement builds on the internalized representation of a norm. Externally requested compliance seems to be an insufficient motivator of young children's norm enforcement behavior. The results support the pivotal role of imitation for the emergence of normativity. Overall, this study makes a novel contribution to revealing the psychological mechanisms that support the emergence of norm enforcement in infancy.

P2-H-317 - The Influence of Multiple Emotional Signals on Infants' Object Choice (Fang)

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Prior studies have shown that emotional signals play significant roles in guiding infants? behaviours such as learning, inference, and action reproduction (e.g., Patzeald et al., 2018; Ruba et al., 2019; Repacholi, 1998; Wu et al., 2018). Specifically, emotional valences can effectively modulate infants? social behaviours. For example, infants are more likely to approach objects or imitate behaviours after seeing positive emotions, as opposed to negative ones (Mumme and Fernald, 2003; Patzeald et al., 2018). Despite converging evidence, prior research exclusively focused on how infants utilized emotional signals from a single informant over repeated encounters. In real life, infants often interact with multiple people who can express either consistent or inconsistent emotions. It is unclear how infants integrate emotional signals from multiple informants and use it to guide their behaviors. To this end, the current study investigated how emotional cues from multiple informants bias infants? visual exploration of novel objects. We recruited 20 Caucasian infants between 12 to 24 months of age (11 female, 394 to 708 days). In the learning phase, participants first watched a series of videos, which depicted a Caucasian female informant looking at a partially occluded novel object. As shown in Figure 1, infants watched videos of 8 different informants: 4 exhibited emotional facial expression (emotion block) to one object (emotion-related object), and 4 exhibited emotionally neutral facial expression (neutral block) to another object (neutral-related object). After watching the videos, infants saw the two objects on screen side-by-side for 4 trials (5s each) to counterbalance object locations (the test phase). The display of the objects aimed to probe visual exploration of the objects via infants? looking preference. To further explore the role of different emotional valences, we designed positive and negative emotion sessions (order counterbalanced across participants), where informants showed happy (the Happy-Neutral condition) and sad emotions (the Sad-Neutral condition) respectively. This study was conducted online (Pavlovia.org), and we recorded infants? looking behaviors using Zoom and coded looking directions with Datavyu. We calculated the infants? proportional looking time to the novel objects in the test phase. The results showed that in the Sad-Neutral condition, infants looked longer at the object associated with neutral interactions (M = 59.61%, SD = 12.41%, One-sample t-test compared to the chance of 50%, p = .003) over the object associated with sad interactions. In the Happy-Neutral condition, no preference was shown between the happy-related and neutral-related objects (Mhappy-related = 46.17%, SD = 13.34%, One-sample t-test, p = .214, Figure 2). These findings indicated that when infants learned a novel object associated with sad emotion, they would show decreased visual exploration compared to a neutral-related object. In contrast, the happy emotion did not affect visual exploration. These findings replicated previous findings examining infants? learning from a single

informant (Mumme & Fernald, 2003; Repacholi, 1998), suggesting that infants can effectively integrate emotional cues from multiple individuals to adapt their following behaviors accordingly. This study opened an avenue to examine the impact of mixed emotional cues in the future.

P2-H-318 - Emotionally conveyed information and infants' interactions with novel toys over videoconferencing (sharma)

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The COVID-19 pandemic resulted in an increase in infants' engagement with screens (Ribner et. al., 2021), leaving parents wondering how screen-based and in-person interactions compare. Much prior research has investigated how infants' learning outcomes are affected by screen-based instruction, suggesting interactions over screens underperform relative to in-person learning (e.g., DeLoache, et. al., 2010: Troseth et al., 2019; Kirkorian et al., 2016). However, during the pandemic, families relied on videoconferencing not just for education but also for socio-emotional connection. To this end, the ability to reference others' emotions is key to the development of emotional signaling and learning in infancy (Sorce et. al, 1985) and infants as young as 12 months old utilize emotional information in laboratory settings to shape interactions with novel toys (Mumme & Fernald, 1996, 2003). Thus, the present study sought to extend these classical paradigms to this new ecological context to understand whether infants would utilize emotional information conveyed over videoconferencing. Specifically, we tested 16- to 30-month-olds (n = 53; 16.89 - 3.26 months; M = 22.66 months; 22 males, 31 females) in their own homes. Toys were delivered to participants' homes using a contactless delivery procedure, and the experimental session was hosted afterward over Zoom. During the study, infants watched a video demonstration in which an experimenter introduced a novel toy and displayed an emotion in response to opening the toy (either happiness or disgust). This was immediately followed by an 1-minute test trial in which the parent brought out the toy and gave the infant an opportunity to engage with the toy. As the study was within-subjects, participants then watched a demonstration and completed a test trial for the second toy. To control for confounding, the location where the child sat and where the toys were placed were standardized and trial order and toy-emotion pairing were counterbalanced between participants (Figure 1). Infants displayed high levels of engagement with the toys (touching the toys on 90% of trials). As infants were led to believe the toys contained an object inside but the toys were empty, we hypothesized that infants would socially reference their parents more after engaging with the toys than before. Indeed, infants looked to their parents and requested help more after engaging than before (MDiff = 0.94; $t(97) = 9.36$, $p < .001$). Significant differences also emerged as a function of experimenter emotion and participant age. Specifically, the data revealed a trend such that infants engaged more quickly when a toy was paired with a happy reaction relative to a disgusted reaction ($t(52) = -1.94$, $p = .06$, $\beta = -3.84$, $SE = 1.98$). When this analysis was repeated utilizing a median split to separate younger and older infants, the effect was not significant for younger infants ($p = .73$) but was for older infants ($t(25) = -2.12$, $p = .04$, $\beta = -7.07$, $SE = 3.33$; Figure 2). Thus, the results revealed that all infants in our age range seemed to develop expectations about the toys from the demonstrations (i.e., that something interesting was inside) but only older infants appeared to make specific inferences about the toys based on the experimenter's emotional displays. This complements earlier work by suggesting that emotional understanding over videoconferencing may develop slightly later than in contexts with salient, in-person components.

P2-H-319 - Pregnancy Perceived Stress, Perceptions of Parent-Infant Closeness, and the Moderating Effect of Social Support During COVID-19 (Becker)

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Introduction: Pregnant individuals are experiencing elevated mental health problems and increased stress during COVID-19 (López-Morales et al., 2021). Prenatal stress exposure can be harmful to the fetus (Graignic-Philippe et al., 2014), and poses a threat to the parent-child relationship. Higher reports of parental stress during the pandemic have been associated with reduced parent-child closeness (Chung et al., 2020). Social support acts as a protective factor buffering against mental health problems pregnant individuals may experience (Provenzi et al., 2021). However, it is unclear whether social support buffers the effect of stress on parent-child closeness during the COVID-19 pandemic. We hypothesized that (1) higher levels of perceived stress during pregnancy would be associated with lower levels of parent-infant closeness at 6 months postpartum; (2) Perceived stress would be negatively associated with parent-infant closeness only for individuals with low levels of social support; however, individuals who had high levels of perceived stress and high levels of social support would have buffered perceptions of closeness to the infant. Method: In total, 181 participants completed a series of questionnaires during pregnancy and at 6 months postpartum. The Inclusion of Other in the Self Scale (IOS; Aron et al., 1992) was used to measure parent-infant closeness at 6 months postpartum. The Perceived Stress Scale (PSS; Cohen et al., 1983) was used to measure perceived stress during pregnancy. Social support during pregnancy was assessed using the Multidimensional Scale of Perceived Social Support (MSPSS; Zimet et al., 1988). Postpartum depressive symptoms were measured by the 10-item Center for Epidemiologic Studies Depression Scale (CES-D; Andresen et al., 1994). Analyses: A hierarchical linear regression analysis was conducted using SPSS 27 to assess whether social support moderated the effect of stress during pregnancy on parent-infant closeness at 6 months postpartum (see Table 1). Regression analyses controlled for relevant covariates and postpartum levels of depression. Results: The final model, which included the interaction between stress and social support, was significant PSSxMSPSS $F(6, 176) = 2.32$, $p = <.05$, adjusted $R^2 = .043$. We found that the interaction between perceived stress and perceived social support on perceptions of closeness with infant at six months postpartum was significant ($p = .029$) (see Table 1). As depicted in Figure 1, social support moderated the impact of stress on perceptions of parent-infant closeness. Those who experienced high levels of stress combined with high levels of social support reported the strongest closeness to their infant. In contrast, those with low perceived social support saw little change in level of parent-infant closeness across differing levels of stress. Discussion: Our findings suggest that social support buffers the adverse effects of pregnancy stress on parent-infant closeness. These results suggest the importance of social support for pregnant individuals, particularly during times of high stress, as perceptions of mother-infant closeness could be impacted. Future research should assess the potential buffering effect of social support, in the prenatal and postnatal period, on mother-infant relationship quality and infant development.

P2-H-320 - Deictic gesturing, sensitive parenting and dyadic synchrony during infant-parent free-play (Stotler)

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Background Deictic gestures are used to direct the attention of another person towards a referent object or event (Liskowski, 2010) and are used in joint attention (Sodian & Kristen-Antonow, 2015). Parental sensitivity, associated with secure attachments, can be characterized as responsiveness to joint attentional bids (Bigelow et al., 2010). Although there is a link between deictic gesture use in infants and their parent's gesturing (Liszkowski & Tomasello, 2010), no studies have explored the relationship between deictic gestures and parental sensitivity. Here, we sought to identify relationships between deictic gesturing and sensitive parenting. Additionally, we explored relationships between dyadic gesture use and overall synchronization during play interactions. Approach 36 infant-parent dyads (18 male infants) aged 12 to 27 months (M = 18M, SD = 4.06) participated in an online free-play session conducted via Zoom. Parents were instructed to play with their infant as they normally would using toys they had at home. The Coding Interactive Behavior (CIB) scale (Feldman, 1998) was used to code parental sensitivity, parental intrusiveness, infant involvement, child withdrawal, dyadic synchrony and dyadic negative states from the recorded four-minute interactions. A lab-developed coding scheme was used to code infant and parent deictic gestures during the interaction (showing, giving, reaching, and index-finger pointing). Analysis Spearman's rho correlational analyses were used to assess the relationships between infant deictic gesture frequencies, parent deictic gesture frequencies, and CIB composite scores. Results Correlational analyses revealed relationships between parental sensitivity (M= 3.78, SD= .62) and parent index-finger pointing (M= 4.72, SD= 4.41, r(34) = .373, p = .025) and between parental sensitivity and infant index-finger pointing (M= 1.56, SD= 2, r(34)= .338, p = .044). Parental intrusiveness (M=1.39, SD= .42) was associated with parent holdout/showing gestures (M= 3.75, SD=3.69, r(34)= .384, p = .021). Infant involvement (M= 3.79, SD= .62) was associated with infant-initiated proximal gestures (M = 1.86, SD=2.63, (r(34)= .330, p = .049). No associations between infant withdrawal and any deictic gesture use (parent or infant) were identified. Dyadic synchrony (M= 3.94, SD= .98) was associated with parent index-finger pointing (M=4.72, SD= 4.41, r(34)= .429, p= .009). Finally, we identified an association between the total number of gestures infants produced generally (M =5.11, SD= 2.76) and dyadic negative states (M= 1.63, SD=1.78, r(34)=-.412, p = .013). Conclusion These findings outline the relationship between parent/infant deictic gestures and dyadic synchrony, infant involvement, and parental sensitivity. In particular, the relationships between 1) parent index-finger pointing and parental sensitivity and 2) infant gesturing and dyadic negative states highlight the importance of nonverbal communications during play-based interactions between caregivers and infants. Infants elicit more sensitive, synchronous caregiving when they exhibit a high frequency of initiated communication attempts via gesture. Parents use more pointing gestures when engaging in sensitive parenting, presumably due to engagement in joint-attention with their infant. Future research should aim to contextualize when these gestures occur during the course of interaction.

P2-H-321 - Mouth-Fixation and Language Development in Infants with and without Autism Spectrum Disorder: Considering Communicative Context (Hines-Wilson)

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Background: Typically developing (TD) infants show increases in mouth-looking around the time of first spoken words (Lewkowicz et al., 2012), and this is positively associated with expressive language

abilities (Habayeb et al., 2021). Infants later diagnosed with autism spectrum disorder (ASD) exhibit persistent mouth-looking over the first two years of life (Jones&Klin,2008), the adaptive value of which may differ depending on specific child and stimuli characteristics. Prior studies, predominantly focus on infant-directed speech (ID-speech). However, infant-directed song (ID-song) exaggerates the characteristics of ID-speech through increased rhythmic predictability, repetition, and audiovisual synchrony, which promotes attention to the mouth (Sahoo et al., 2021). Additionally, infants with ASD attend to ID-song for longer periods, and at levels comparable to TD infants, than ID-speech (Macari et al., 2020). Objective: Investigate the differential adaptive value of visual attention to ID-speech and ID-song on language development in infants with and without ASD. Methods: Participants were chronological age-matched infants between the ages of 10 and 25 months (ASD (n=54, Mage(SD)=20.43 (3.59) months); TD (n= 28, Mage(SD)=19.09 (4.18) months). Eye-tracking data was collected while infants viewed videos of actresses across three communicative contexts: ID-speech, ID-song-with-gestures (i.e., fingerplay), and ID-song-without-gestures (ID-song with and without gestures are both ecologically valid social interaction styles but are associated with different patterns of visual engagement (Nicholson et al., 2021).Visual fixation to the actresses' mouth was compared across communicative contexts in TD and ASD infants; within-group correlations tested for associations between visual fixation and concurrent Mullen receptive and expressive language age equivalence scores within each communicative context. Results: There was a significant effect of communicative context on levels of mouth fixation ($p<.001$) such that ASD and TD infants look more to mouths in ID-song-without gestures than ID-song-with gestures or ID-speech contexts, which did not differ from each other. TD infants fixated more on mouths than ASD infants overall ($p=0.006$). Among TD infants, mouth-looking to ID-speech was positively associated with expressive language ($r=0.491$, $p=0.013$) and mouth-looking to ID-song-with-gestures was positively associated with expressive ($r=0.491$, $p=0.028$) and receptive language ($r=0.729$, $p<.001$). In ASD infants, mouth-looking to ID-speech, ID-song-with-gestures, and ID-song-without-gestures were not associated with language ability. However, among ASD-infants that acquired first words, mouth-looking to ID-song-without-gestures was positively associated with receptive language ($r=0.493$, $p=.010$) and expressive language ($r=.402$, $p=.042$) and mouth-looking to ID-song-with-gesture was positively associated with receptive language ($r=.469$, $p=.010$). Conclusion: Although ASD and TD infants' visual fixation patterns varied similarly across different communicative contexts, the adaptive value of mouth-looking to ID-speech and ID-song (with and without gestures) on language development differed by diagnosis and communicative context, potentially reflecting different underlying mechanisms. Future research will examine the processes linking mouth looking during ID-song and ID-speech contexts with language development in ASD and TD infants for early interventions.

P2-H-322 - Seeking Social Information: Infant-caregiver interactions in Tajikistan (Kahraman-Colosky)

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Social understanding -- infants' ability to look to others in situations of uncertainty or challenge-- emerges between 12 to 18 months. Examining social information-seeking while engaging with novel toys is particularly interesting because interactions with objects involve perception, action, and cognition. Through their visual-manual interactions, infants learn about the properties of objects and their functions, and use their manual skills to implement their designed actions (e.g., sorting shapes).

Incorporating caregivers into object engagements creates conditions for language learning as mothers are likely to label objects infants are holding. Evidence for social understanding comes primarily from studies of infants and mothers from Western childrearing traditions, which emphasize abundant opportunities to move, explore, and interact. Environments abound with objects. Caregivers provide the setting for play and keenly scaffold object engagement. In Tajikistan, the environment and childrearing practices offer alternate opportunities for toy exploration and adult feedback, potentially affecting infants' social information-seeking and object behaviors. Notably, caregivers contain infants in a gahvora cradle for hours, restricting infants' spontaneous movement, which results in motor lags. With age, the practice of cradling is reduced, opening opportunities for movement and exploration, but early cradling may have enduring effects on infants' willingness to explore novel objects and discover their properties and functions. The environment also is toy-scarce; objects are available but lack complexity and diversity. However, adults and peers are always present, providing an environment potentially rich with social information. We asked whether Tajik infants show similar gains in social information-seeking at times comparable to Western counterparts and whether they attempt to discover the functions of objects and successfully implement actions. We observed 45 Tajik infant-mother dyads longitudinally during a shape-sorting task at 12, 16, and 20 months and coded the frequency of infant social bids and attempts to fit shapes during the 3-minute task. We expected that, given the unique opportunities for motor, object, and social interactions for Tajik infants, social bidding may be frequent at all ages or attenuate with age as infants discover and implement the designed actions successfully on their own. Preliminary results show age-related changes in social-information seeking and success at sorting shapes. Infants bid more frequently to their caregivers over age. They also succeeded more and faster at sorting shapes as they get older. Additionally, with an increase in failed attempts, infants' bidding also increased, suggesting that infants might be reaching out for help during this novel task when they are struggling, and see their caregiver as a useful source. This study provides a potentially promising new avenue in which investigations of social interactions in Tajikistan, wherein a highly specific practice -- gahvora cradling -- offer a view of intersections among culture, experience, and child development in a sample typically underrepresented in developmental literature.

P2-H-323 - The sub-second dynamics of spontaneous mimicry: A electromyography study tracking infant-caregiver dyads during free play (Viswanathan)

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Spontaneous mimicry (SM) is a ubiquitous feature of human communication (Heyes, 2021; Meltzoff & Williamson, 2017). Research shows that SM is both reflexive and flexible (Wang & Hamilton, 2012). It is sensitive to cues that signify implicit social rules and social hierarchy, suggesting that it is at least partly socially shaped. However, we have yet to map the ontogeny of SM, or its developmental factors (Slaughter, 2021). A marked difference in SM behaviour has been observed in atypical populations (e.g., ASD; Arnold & Winkielman, 2020) increasing the onus for further study. In infants, facial mimicry has been studied extensively and is the central focus of a long running debate surrounding the presence of SM in early infancy (Slaughter, 2021). However, most of these studies have used lab-based tasks or non-naturalistic block-design paradigms (Slaughter, 2021; Meltzoff & Williamson, 2017). The few studies that have observed naturalistic interactions used hand-coded video data, scoring onset and offsets of

actions: mimicry was operationalised as an action onset in the observer that occurs within a specific timespan of a prior action onset in the interacting partner (Markodimitraki & Kalpidou, 2019). Here, SM behaviour is gauged in terms of frequency and total number of mimicked actions. They do not measure the magnitude of the action i.e. they cannot record graded changes in action. Employing electromyography (EMG) allows us to decipher moment-to-moment dynamics and sub-second changes. In the present study, we investigated facial SM behaviour in free-play interactions between 5-months-old infants and their caregivers. EMG electrodes are placed on the facial regions that overly the corrugator supercilii (frowning/eyebrow-movement) in both caregiver and infant. Lab based investigation of SM in infants have found evidence of infant SM of eyebrow movement at this age range (De Klerk et al., 2018). The obtained EMG signal is rectified, band-pass filtered and z-scored. Artefacts are rejected by identifying and removing outliers fall outside of one standard deviation above or below the mean. Cross-correlations are carried out to obtain a comprehensive overview of the temporal correspondence between the partners' EMG waveforms. Granger causality analyses are also conducted on the EMG-waveforms of the interacting partners to identify if changes in the facial action of one predicts changes in that of the other. Based on our reading of the literature we had predicted that the cross correlations will be significant when the caregiver's waveform is lagged (mother mimics the infant) but not when the infant's waveform is lagged. Our target sample size is 20 dyads, and we are currently at the centriole. In our preliminary analyses (N - 9 dyads), in contrast to our expectations, the cross correlations were significant when the caregiver's waveform preceded the infant's (infant's waveform is lagged). This was seen at lags between .2 and .6 seconds. Granger causality analyses will be performed to test if each of the waveforms can significantly predict the other. Control analysis will be performed with shuffled datasets to rule out spurious results.

P2-H-324 - Young infants' social bidding during the Still Face Task: Influences of mothers' and infants' contingent vocal responsiveness (Power)

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Infants' social bids in the still face phase of the Still Face Task demonstrate their emerging sense of agency as these behaviors happen in the absence of the partner's social overtures. Social bids are smiles or non-distress vocalizations while looking at the partner. By these attempts to elicit interaction from the unresponsive partner, infants show their developing awareness that they can affect others' behavior with their own actions. Previous studies indicate maternal contingent vocal responsiveness in the initial interactive phase predicts infants' social bids in the still face phase. Infants may easily perceive the effect of their vocalizations because mothers tend to stop talking when infants vocalize and resume when infant vocalization ends. Yet infants also tend to become more vocally responsive when mothers talk. The role of infants' own vocal responsiveness on their social bidding has not been investigated. The present study longitudinally examined infants' social bidding in the Still Face Task over infants' first three months and the influence of maternal and infant vocal contingent responsiveness to the partner on this behavior. Infants (N=54) and their mothers engaged in a Still Face Task when infants were 1, 2, and 3 months. In the initial interactive phase, both partners were scored for duration of non-distress vocalizations, and vocal contingency (vocalization following a partner's vocalization within 1 second) was assessed. Vocal contingency scores (phi scores) control for the base rate of each partner's vocalizations. Additionally, infants were scored for frequency of social bids (smiles or non-distress vocalizations while

looking at mother) during the still face phase. Table 1 shows the mothers' and infants' duration of non-distress vocalizations and their vocal contingency scores during the initial interactive phase, and infants frequency of social bids during the still face phase. Infants' social bids significantly increased at 2 months, when infants become more engaged social partners. Likewise, maternal and infant vocalizations and vocal contingency scores increased when infants were 2 months. Mothers' and infants' vocal contingency scores were correlated at each age. Figure 1 shows the significant correlations among infants' social bids and maternal and infant vocal contingency scores across the visits. At 2 and 3 months, maternal and infant vocal contingency in the initial interactive phase predicted infants' social bids in the still face phase. Moreover, maternal vocal contingency in the previous months (months 1 and 2) predicted infant social bids at 2 and 3 months and infant vocal contingency at 2 months predicted infant social bids at 3 months. Regression analyses were conducted on infants' social bids at 2 and 3 months (predictor variables: maternal and infant vocal contingency in the current visit, maternal and infant vocal contingency in the previous visit, mothers' and infants' non-distress vocalizations in the current visit). At both ages, the sole predictor was maternal vocal contingency in the current visit. Although infants' vocal responsiveness is associated with their increased social bidding, maternal vocal responsiveness is the strongest predictor of infant's emerging sense of agency, as evidenced by social bidding.

P2-H-325 - Investigating infants' gaze following ability over video chat (Capparini)

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Towards the end of the first postnatal year, infants start to understand the function of the eyes in the looking behaviour of others. In fact, they look more often at a target object when the experimenter turns towards it with open rather than closed eyes (Brooks & Meltzoff, 2002, 2005). To date, gaze following development has been mostly investigated in controlled laboratory paradigms. In reality, social interactions take place in less controlled situations. In addition, as a result of the pandemic, it is typical for interactions to increasingly happen virtually. For this reason, understanding if infants treat a virtual social agent in a manner similar to a physically present person is a very relevant and contemporary issue. We investigated early gaze following abilities outside the laboratory, adopting a remote live testing procedure to test infants in their home environment. This study aimed to: (a) understand if early social interactive skills can be investigated using online methods, without the participants physically coming to the laboratory, and (b) investigate whether and how past lab-based findings generalise to a noisier home environment and to a virtual social partner. Thirty-two 11- to 12-month-old infants (16 females, Mage = 342 days) were tested remotely using a synchronous testing procedure. Elements of a video-based presentation were combined with a fully live and contingent social interaction, whilst manipulating whether the experimenter can or cannot see some peripheral targets (Open Eyes vs. Closed Eyes) in a between-subject design. We measured infants' looking behaviour in response to the experimenter who silently turned towards a predetermined target on screen. Survey data showed that 87.5% of our infant sample had been exposed to video calls in the months prior to their participation in this study. Looking score results demonstrated that infants can successfully follow the gaze of a virtual social partner. Infants in the Open Eyes group obtained a higher looking score (Mdn = 1, IQR = 1) compared to infants assigned to the Closed Eyes group (Mdn = 0, IQR = 1, $U = 46$, $p < 0.001$). Overall, the infants also oriented more times towards the correct target in the

Open Eyes group (Mdn = 1.5, IQR = 2) compared to the Closed Eyes group (Mdn = 1, IQR = 1.25, U = 79, p = 0.027), irrespective of which target they fixated upon first. These results generalise past lab findings to a noisier, more ecologically valid, home environment and demonstrate gaze following skills of infants to a socially contingent virtual partner who responded in a timely relevant manner to infants' behaviours. The current findings show that infants can use interactive and contingent online systems for social learning, as if they were physically present with their social partner.

P2-H-327 - Does perceived autonomy support predict mother subjective well-being when transitioning back to work following the birth of a first child? (Bélanger-Trudelle)

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Many primiparous mothers returning to work after parental leave are struggling to adapt, affecting their well-being (Alstveit & al., 2011). This study assesses the link between new mothers' perceived autonomy support from their romantic partner during their parental leave (T1: 6 months postpartum, collected during Quebec's 1-year parental leave) and their subjective well-being when returning to work (T2: within one month of returning to work; 12 months postpartum). We hypothesized that perceived autonomy support from a partner will positively predict the longitudinal subjective well-being of mothers when returning to work, i.e., ↑ positive affect and life satisfaction & ↓ negative affect. A total of 151 primiparous mothers (Mmother=30.93; SD = 3.76) completed online questionnaires at T1 and T2. Multiple linear regression was conducted in SPSS. Our results partially support our hypotheses beyond child and parent covariates (i.e., mother and child age, child's effortful control and negative affectivity temperament, and mothers' fatigue). First, our model significantly predicted a large amount of variance in new mothers' life satisfaction when returning to work (T2), $R^2 = .298$, $F (7, 143) = 8.693$, $p < .000$. Above and beyond maternal fatigue ($\beta = -.276$, $p < .000$) and other covariates, perceived partner autonomy support positively predicted mother's life satisfaction ($\beta = .271$, $p = .008$) when returning to work following parental leave. Maternal fatigue and partner autonomy support subsumed the predictive links between all other covariates and life satisfaction (ps range: .554 - .839). Results also show that our model significantly predicts a medium amount of variance in negative affect of primiparous mothers when returning to work (T2), $R^2 = .233$, $F (7,143) = 6.209$, $p < .01$. Above and beyond maternal fatigue ($\beta = -.216$, $p < .000$) and other covariates, perceived partner autonomy support negatively predicted mothers' negative affect ($\beta = -.239$, $p = .044$) when she returned to work following her parental leave. Similarly, maternal fatigue and partner autonomy support subsumed the predictive links between other covariates and negative affect (ps range: .197 - .508). Finally, our results suggest that our model significantly predicts a medium amount of variance in positive affect of primiparous mothers when returning to work (T2), $R^2 = .164$, $F (7,143) = 4.022$, $p < .001$. Surprisingly, results show that, above and beyond covariates, perceived partner autonomy support was not significantly related to mothers' positive affect ($\beta = .155$, $p = .215$). It seems that maternal fatigue ($\beta = -.302$, $p < .000$) subsumed the predictive links between all other covariates (ps range: .158 - .965) and partner autonomy support on positive affect. These results clearly show that while mothers' fatigue seems the best deterrent of subjective well-being, autonomy support from a romantic partner is associated with more life satisfaction and less negative affect during the return-to-work transition. Considering that parental well-being is an important predictor of children's well-being and quality parenting (Newland, 2015) it seems important to continue the study of maternal well-being at the time of the transition back to work.

P2-H-328 - Sensitivity to the mother's multimodal attention state: a developmental study on mother-infant dyads in naturalistic settings (Dafreville)

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The study of language origins has always been a complicated puzzle. Regardless of whether language emerged from vocal, gestural or multimodal communication systems, there is no convincing account of the integration of multiple sensory modalities into a single stream. Among the selective forces potentially driving the pre-linguistic to linguistic transition, one is the recipient's attention state. A protolanguage may have emerged from speech, songs or distal communication directed to infants by early hominin mothers as a way to compensate the lack of physical contact caused by bipedalism. Here, we investigate the direct implications of this theory on 7-to-20-month-old infants communicating with their mother. We hypothesized that infants would favour audible communication to address inattentive mothers, i.e., mothers who were not looking, touching or talking to their infant, and this ability would refine with age until speech onset. We studied 30 French mother-infant dyads in naturalistic settings. Infants were sampled according to three developmental periods corresponding to before (7 to 10 months of age), during (11 to 14 months of age) and after (15 to 20 months of age) the emergence of joint visual attention and pointing gestures that merely precede the first spoken words. Infants were observed at home using the focal sampling method. Infant's communicative signals were then coded on ELAN software according to their sensory modality: audible signals are oral (e.g., vocalisations) and gestural signals (e.g., hand clapping), silent-visual signals (e.g., pointing gestures) and contact signals (e.g., grasping mother) are exclusively gestural. Each signal was indexed to maternal attention defined from three variables: maternal visual attention (yes/no), infant-directed speech (IDS)(yes/no) and physical contact (yes/no). We assessed infant's attention-sensitive signalling through unimodal and cross-modal adjustment, defined by the capacity of infants to address visually inattentive mothers by avoiding visual communication mismatches and/or favouring communication matches through audible-or-contact signals. Then, we examined how physical contact and IDS impacted infant's adjustment to their mother's visual attention state. We analysed 8,367 signals addressed by 30 infants to their mother: 6,753 audible signals, 1,422 visual signals and 192 tactile signals. Our results show that infants were capable of unimodal adjustment from 7-10 months of age but were not capable of cross-modal adjustment until 11-14 months of age. IDS facilitated the decrease of communication mismatches: a smaller proportion of silent-visual gestures was addressed to inattentive mothers when they were talking to their infant. IDS also associated with a greater preference for oral signals (both vocal and labial) compared to audible-or-contact gestures by older infants addressing inattentive mothers (i.e., during cross-modal adjustment). In line with evolutionary hypotheses, IDS plays an important role in the mediation of maternal attention to infants. As predicted, infants favoured the audible modality to address inattentive mothers. On the developmental aspects, infant's attention-sensitive signalling appear to be scaffolded on maternal IDS that facilitates the disappearance of communication mismatches and supports the shift from audible gestures to oral signals prior to speech onset.

P2-H-329 - The active infant's developing role in musical interactions (Dou)

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Caregivers often sing and play music for their infants, and generally use a small handful of their infant's "favourite" songs during these interactions (Mendoza & Fausey, 2021; Trehub & Gudmundsdottir, 2015). In laboratory settings, infants' favourite music (as reported by their caregivers) captures their attention, encourages rhythmic movement, and more effectively resolves distress compared to unfamiliar music (Cirelli & Trehub, 2020; Kragness, Johnson, & Cirelli, 2021). Familiar music also guides social interactions - infants prefer strangers who sing familiar compared to unfamiliar songs (Cirelli & Trehub, 2018; Mehr et al., 2016). But how do caregivers select the music to include in their daily repertoires? Here, we will explore how infants play an active role in shaping the songs that will become their caregiver-reported favourites through their attentive, motor, and emotional responses. Canadian primary caregivers of infants aged 0 to 24 months will complete an online questionnaire (target N = 400). Caregivers will identify specific songs that they sang and recorded music that they played to their infants in the past week. Caregivers will then identify how frequently their infants responded to these pieces of music (i.e., with attention, movement, and emotional responses) during the past week and the first time they were introduced. We will also collect information on infants' responses to music that was introduced but then abandoned from the daily repertoire. Finally, we will investigate whether infant responsiveness to music is associated with caregiver musical history and engagement, home musical environment (Politimou et al., 2018), and caregiver-child affective attachment (Condon & Corkindale, 1998), given that responsive and sensitive integration of music may be a key component of these dynamic interactions. We predict that caregivers will cite frequent positive responses (e.g., laughing, dancing) to support why certain music has become fully integrated into daily interactions with their infants. We predict that consistent positive infant responses to music at introduction will increase the likelihood that the piece will be repeated in the future, whereas negative or disengaged responses (e.g., crying, staying silent) will decrease the likelihood. We predict that caregivers with stronger attachment bonds with their infants will report integrating music more often at home (replicating prior findings with an older sample of children, Steinberg et al., 2021), and that these two measures will be associated with the frequency of caregiver-reported positive infant responsiveness to music. Data collection is ongoing and will be complete by April 2022. Our findings will reveal how infant musical engagement develops across infancy, how this differs for sung vs. recorded music, and how this shapes caregiver musical selections.

P2-H-330 - How Parent-Child Food Sharing Emerges in Early Childhood (Skiffington)

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Although recent research has examined the emergence of prosocial behaviours such as instrumental helping and comforting in the first year of life, little is known about sharing. Despite current research depicting sharing as a later appearing form of prosocial behaviour, there are good conceptual and empirical grounds for examining sharing early in the lifespan, emerging alongside other forms of prosocial behaviour. The objective of the present study was to examine the emergence of sharing late in the first year of life, and a secondary objective was to measure the development of sharing, assessing sharing by way of more naturalistic and more structured tasks adapted from research with older children. Parent-infant dyads participated from home by way of videoconference at 10 months of age, a time when helping is known to emerge in some infants. In Study 1 (data collection completed), 41 parents were asked to provide a shareable snack (i.e., small and in pieces) to infants without further

instructions, to examine sharing tendencies in a naturalistic setting. Results of that study show that spontaneous sharing in infants is rare but does occur at 10 months. One target of spontaneous sharing was a family dog. In Study 2 (21 dyads at present, data collection ongoing) parents were asked to give infants a shareable snack and asked to get their infants to share with them without further instructions. As in Study 1, spontaneous sharing in infants is rare, however, parents typically ask infants for food, and then take food, possibly as a form of modelling. Findings from across Study 1 and 2 demonstrate the presence of sharing in infants as young as 10 months of age. Findings will be discussed with reference to the larger developmental literature on prosocial behaviour in the first year of life.

P2-H-331 - Positive affect and its relation to prosociality and joint action in toddlerhood (Becker)

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Children help others in a variety of contexts, e.g., by offering instrumental help to adults at the age of 18-months (Warneken & Tomasello, 2006) or helping peers without obtaining any benefit for themselves (Hepach, Kante et al., 2016). However, the underlying mechanisms of young children's motivation to help have recently been debated (Kuhlmeier & Birch, 2005; Dahl & Brownell, 2019; Dahl & Paulus, 2019; Köster & Kärtner, 2019). It remains unclear whether children's motivation to help others is explained by their motivation to interact with others socially (e.g., Dahl, 2015) or is rather explained by a prosocial motivation to help (Hepach et al., 2012). Here, we investigate whether prosocial (helping) and social interactions result in similar levels of positive affect in 1- and 2-year-old children. Therefore, we measure children's postural elevation to index changes in positive affect using a depth sensor imaging camera (Hepach et al., 2017) both after social and prosocial interactions. In a within-subjects design, children take part in six successive play sequences, after which we measure children's body posture. Using linear mixed models (Bates et al., 2014), we will investigate the effect of social (joint interaction), prosocial (helping interaction), and control (no interaction) conditions on the change in children's positive emotions (Gerdemann et al., 2020). Furthermore, we will examine whether emotions following helping and social interactions are related. We have started data collection in August 2021 and aim to invite 80 children. This sample size is based on a power analysis and mirrors sample sizes in prior work using the same dependent measure of body posture (Hepach, Vaish, and Tomasello, 2017b; Hepach & Tomasello, 2020). As of now 60 children have participated in this study (14-months-olds, N = 23; 24-months-olds, N = 37). Preliminary analyses show that 55% of children helped on the first test trial (35% of 14-months-olds; 65% of 24-months-olds). This pattern was similar on test trial two (overall 57% of children helped; 37% of 14-months-olds; 69% of 24-months-olds). In total, 11 14-months-olds (and 30 24-months-olds) helped at least once, whereas 11 and 7 children did not help respectively. Fisher's test revealed that older children helped more often (p = .0191). Across age groups children interacted with the experimenter in the social condition (97% of children averaged across both trials). All children interacted at least once. Similarly, the majority of children fulfilled the criterion of the control condition (90% averaged across both trials), i.e. they played for themselves while the experimenter completed an action alone. Additionally, we have thus far collected children's body posture data on 262 out of 360 trials. We will conduct our preregistered statistical analyses once data collection is completed (https://osf.io/euq8a/?view_only=eaf09e8887ac441cb21f25ed2c089a6c). The current study is part of a larger multi-method data collection project and all participating children also take part in another study involving a looking time paradigm. The results of this project will contribute to the debate as to whether

the same motivational mechanisms underlie social and helping interactions in toddlers, which will in turn inform our understanding of prosocial development.

P2-H-332 - Infants' Emotions in Instrumental and Empathic Helping During the First Year of Life (Djordjevic)

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Emotions are at the core of social interactions in infancy, including prosocial behaviors (Hammond & Drummond, 2019). It is evident from current literature that infants exhibit emotions during tasks meant to elicit comforting and care (i.e., empathy tasks, e.g., Zahn-Waxler, Radke Yarrow, & Wagner, 1997; Davidov, Roth-Hanania, Orlitsky, Mankuta, & Zahn-Waxler, 2019; Roth-Hanania, Davidov, & Zahn-Waxler, 2011), where infants, even early in the first year, display negatively-valenced emotions such as concern and self-distress (Davidov et al., 2019). However, the link between emotions and another early-appearing form of prosocial behavior, namely instrumental helping, which arises in helping someone complete a goal, remains unknown. Studies of instrumental helping in older children have documented the presence of positive emotions (Rheingold, 1982), however, this phenomenon has never been systematically explored. The present study is the first in the field to investigate infants' emotions during instrumental helping and whether these emotions differ from emotions in empathy tasks. The study examines responses of 10-month-old (N=44) infant-mother dyads drawn from two larger studies on prosocial behavior (data collection completed). Typically developing Canadian infants were met remotely using videoconference software prior to the COVID-19 pandemic (see Libertus & Violi, 2016). A subset of these infants was also observed at 5-months of age (approximately N=16). Each infant-mother dyad participated in an instrumental helping task followed by an empathy task. In the instrumental helping task the mother would pretend to accidentally drop a spoon, whereas in the empathy task she would pretend to injure herself by accident and the baby's reaction would be observed. The coding scheme used for infants' emotions was adapted from Zahn-Waxler et al. (1997) and Davidov et al. (2019) studies of empathy for use with instrumental helping. Mothers' expressed emotions were also coded for the broad presence of positive emotions and negative emotions such as distress. Preliminary data analysis suggests that infants express positive emotions in instrumental helping tasks, and in doing so they are often mirroring the parent's emotions, whereas, in the empathy task, infants' and parents' emotions diverge. The discussion will situate these findings in the larger body of prosocial behavior in infancy, and the role of emotions in prosocial behavior.

P2-H-334 - Social exclusion affects infants' neural processing of emotional faces (Quadrelli)

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Social exclusion is a very aversive feeling that threatens important psychological needs such as self-esteem and belongingness (Williams & Nida, 2011). It has been shown that social exclusion often induces considerable physiological (Bass et al., 2014), cognitive (Kawamoto et al., 2014) and behavioral (Bourgeois & Hess, 2008) changes in adults. Yet, only few studies investigated children and infants' cognitive capacities (Marinović & Träuble, 2018) and behavior (Watson-Jones et al., 2014) after being exposed to third party social ostracism. Moreover, little is known about children and infants' response to

self-experienced social exclusion. The current study investigates the influence of self-experienced social exclusion on 13-month-olds' neural processing of emotional faces. To do so, 28 infants first participated in a live ball-tossing game with two experimenters, named Cyberball (Williams & Sommer, 1997), during which they were either included (N=14) or excluded (N=14) in the game. In the inclusion condition, infants received the ball a third of the time during the whole game, while infants in the exclusion condition only received the ball twice at the beginning and were then ignored for the rest of the game. The Cyberball phase was videorecorded to quantify infants' behavior in response to inclusion or exclusion and assess the degree to which the infant seemed affected by the experimental manipulation. After the exposure to the Cyberball game, event-related potentials (ERPs) were recorded while infants observed dynamic stimuli of faces expressing anger, fear and happiness. Preliminary analyses were performed by conducting a repeated-measures ANOVA on latency and amplitude values of the attentional and perceptual ERP components, with Emotion (happiness, fear and anger) and Hemisphere (left, right) as within-subjects factor and Condition (inclusion, exclusion) as a between-participants factor. Results revealed a significant Emotion*Condition interaction on the P1 latency values, $F(2,23)= 1.82$, $p = .03$. Post-hoc comparisons showed a faster P1 to happy faces in the exclusion ($M = 162$ ms, $SD = 10.2$) vs the inclusion ($M = 175$ ms, $SD = 13.7$) condition, $p = .009$ (Figure 1). In addition, in the inclusion condition angry ($M = 167$ ms, $SD = 19$) and fearful ($M = 167$ ms, $SD = 12.6$) faces elicited faster responses compared to happy expressions ($M = 175$ ms, $SD = 13.7$), $ps < .01$, while no significant differences emerged in the exclusion condition, $ps > .22$ (Figure 1). Furthermore, analyses conducted to explore behavioral reactions during the Cyberball game revealed that included infants appeared to direct their body posture towards the other players more frequently than excluded participants, $p = .01$. While data collection is still ongoing, these preliminary data suggest that self-experienced social exclusion modulates infants' neural processing of facial emotions, and that this modulation varies according to the emotion processed. In addition, as more involvement in the Cyberball game was highlighted for included vs excluded infants, current results suggest that the manipulation successfully induced feelings of social inclusion and exclusion at 13 months of age. Taken together, present findings demonstrate that social exclusion influences infants both at the behavioral and neural levels.

P2-H-335 - Socioeconomic Status and the Emergence of Autistic Traits in Infancy and Early Childhood (Foster)

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Background: Autism spectrum disorders are characterized by impairments in social communication and restricted and repetitive patterns of behavior, interests, or activities. Studies highlight associations between low parental SES and child neurodevelopment, including speech impairment, poor executive function, and delays in socioemotional development that may resemble ASD criteria (Hackman & Farah, 2009; Bradley & Corwyn, 2002). Clarifying the relationship between environmental factors associated with low SES and ASD symptoms will inform more accurate diagnoses and interventions. Objective: The current study uses a prospective longitudinal design to examine the relationship between SES and the emergence of autistic traits among infants and toddlers. Methods: Participants (n = 23; High SES = 14; Low SES = 9) were enrolled in a prospective longitudinal study on early autism symptoms. At 12, 15, 18, and 24 months, clinicians administered the Communication and Symbolic Behavior Scales (CSBS; Wetherby & Prizant, 2003) and later scored the Systematic Observation of Red Flags (SORF; Dow et al.,

2016) from video recordings of the CSBS administration. Mothers with a college degree or higher were considered "high SES" and mothers who had not completed a college degree were considered "low SES". Maternal education has been shown to be strongly correlated with both income and SES (Noble et al. 2007) and other studies investigating similar relationships used maternal education alone to establish SES groups (Clearfield & Jedd, 2012; Stevens et al. 2009). We investigated trajectories of SORF scores between groups with linear mixed-effects models. At each time point, the difference of least square means between high SES and low SES groups was calculated. Results: The low SES group showed increasing SORF scores from 12-24 months while the high SES group showed decreasing SORF scores. Significant interactions between age and SES were found for: social communication domain (SCD) scores ($F(1, 7) = 6.35$, $p = .04$), restrictive and repetitive behavior domain (RRB) scores ($F(1, 7) = 5.75$, $p = .04$), and total SORF scores ($F(1, 7) = 12.23$, $p = .01$). In general, the low SES group showed significantly more ASD features by 24 months compared to the high SES group. By 24 months, significant differences between the low and high SES groups emerged for total SORF scores ($t(7) = -3.73$, $p = .007$) and SCD scores ($t(7) = -2.50$, $p = .04$). RRB score differences between SES groups approached significance at 24 months ($t(7) = -2.36$, $p = .05$). Conclusion: These results suggest that infants from families with lower maternal education show increased autistic traits over time, such that significant differences emerge at 24 months. It is important to note that these results do not indicate a relationship between SES and ASD diagnosis, such that those with low SES are more likely to be diagnosed with ASD. Rather, these findings reveal greater functional impairments in children from lower SES backgrounds that increases over time. This finding points to the possibility that children in lower resourced families may present with more ASD features, regardless of ASD diagnosis, and highlights the importance of treatments tailored for low SES families.

P2-H-336 - Infants' moral trait inferences in protective third party intervention (Zeng)

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The ability to infer traits from behavior is an essential social skill, especially in domains where moral learning is involved. There is some indication that humans gain this ability as early as infancy; infants suspend expectations that an agent will follow fairness norms for hindering agents but not for helping agents (Surian et al., 2018). Real life situations, however, go beyond just helping and hindering or fair and unfair. One paradigm that aims to tackle these complexities is the protective third party intervention (PTPI) paradigm, in which an aggressor repeatedly hits a victim before a third agent intervenes to protect the victim (figure 1A). Kanakogi et al. (2013, 2017) find that infants (a) prefer victims over aggressors and (b) prefer interveners over non-interveners. There are multiple plausible explanations for these findings. An observer could feel sympathy for the victim and detest the non-intervener's cowardice. They could also judge the aggressor's actions as morally reprehensible, and the intervener's actions laudable. The reasons behind these preferences, however, have not been directly tested. In the present research, we hope to investigate whether moral trait inferences underlie these preferences. We predict that infants will make moral evaluations of aggressors and interveners, but no moral evaluations of victims and non-interveners. Using a violation-of-expectation paradigm, infants ($N = 22$) aged 12 to 24 months participating in an aggressor condition were familiarized to four repetitions of a PTPI paradigm (figure 1A), followed by two test trials showing the aggressor making either a fair or an unfair resource distribution (figure 1B). In support of our predictions, participants looked significantly

longer at fair than unfair test trials (t(21) = 2.12, p = .046; figure 2). Additionally, 17 out of 22 participants looked at fair test trials longer than unfair test trials by at least one second, a proportion that significantly differs from chance (p = .008). These results demonstrate that infants were more surprised when the aggressor behaved morally by making a fair resource distribution. In ongoing work, we are testing infants in an intervener condition which uses the same PTPI familiarization trials, but the two test trials will show the intervener making resource distributions. A baseline condition showing a random movement control will also be conducted. We predict that in the baseline condition infants will look longer at the unfair than the fair test trials; this same pattern of results is predicted in the intervener condition, although it is anticipated that the effect size will be larger in this condition, indicating that infants are surprised when an intervener commits an immoral action. The results of this research would place moral evaluations at the root of infants' understanding of PTPI situations. We also provide more definitive evidence of infants' moral trait inferences by demonstrating that infants' do not just suspend expectations of fairness norms for bad actors as previous work on hindering agents has shown, they actively expect aggressive agents to act unfairly.

P2-H-337 - Construction and factorial validation of a novel short version of the IBQ-R in German (Feyerabend)

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The Infant Behavior Questionnaire-Revised (IBQ-R) is a well-established tool that has been widely used to assess dimensions of infant temperament over the first year of life. The instrument was developed to assess temperament along 14 scales which were suggested to fit the three overarching dimensions of Surgency/Extraversion, Negative Affectivity, and Orientation/Regulation (Gartstein & Rothbart, 2003). However, replication attempts in samples with different cultural backgrounds have reported some similarities but also notable differences in factor structure compared to the original validation (e.g. Enlow et al. 2016, Dragan et al., 2011, Gartstein et al., 2005). This includes studies using the German version of the IBQ-R, which found support for two of the proposed higher-order factors but could not replicate the Orienting/Regulation factor (Mink et al., 2013, Vonderlin et al., 2012). The current paper reports the construction and validity of an abbreviated version of the German translation of the IBQ-R, with the primary objective to increase fit to the proposed 3-factor structure of the original version. Analyses were conducted on data from 340 six months-olds and 148 twelve months old infants provided by two labs in Germany. Separate principal component analyses were conducted for each of the three overarching dimensions for both age groups. The included items and the number of extracted factors for each analysis were chosen after the established factor structure of the original IBQ-R. Items with at least moderate loadings (>0.3) on the first unrotated component, as well as on the factor that best reflected their respective scale in the pattern matrix after oblique rotation, were retained for the further selection process. This step was conducted to only retain items that most adequately reflect the primary- and secondary factor structure of the IBQ-R. Selections for both age groups were compared and items with high factor loadings in both groups were selected for the final instrument. The abbreviated scales were further manually inspected for the breadth of item content and specific items were exchanged if necessary. The abbreviated scales of the final instrument contain 4-5 items each for a total of 69 items. Internal consistencies were acceptable to excellent for all scales for both age groups (Cronbach's alpha > 0.70, only Activity >0.60, Table 1). Correlations between the abbreviated- and standard form scales

indicated acceptable to high correspondence between the scales (correlations with Levy's (1967) correction, Table 1). The structure of primary factors within the three higher-order domains was well supported for both age groups, as well as for a combined data set of all infants. Divergent loadings of specific scales compared to other validation studies are discussed. Factor analyses suggested a two-factor solution at ages 6 and 12 months, which is consistent with previous findings in German populations (Table 2). The three-factor model could only be replicated in the mixed data set that contained both age groups (6+12 months). In line with our objective, the abbreviated scales provided a better model fit for the three-factor solution compared to the standard scales (Table 2).

P2-H-338 - Impact of PrePregnancy Maternal Trauma on Perceived Infant Temperament & Verbal Responsivity: Experience of the Flint Water Crisis (Canfield)

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Exposure to specific trauma during pregnancy may impact maternal perceptions of infant temperament, potentially through impacts on stress and mental health (Zhang et al., 2018). For instance, among women who experienced Hurricane Katrina during pregnancy, increased PTSD and depressive symptoms, regardless of level of exposure, were related to perception of difficult infant temperament (Tees et al., 2010). Mental health symptoms and perceptions of temperament together may lead to less responsive parent-child interactions (Newland et al., 2016). However, although some studies have examined the role of mothers' lifetime stress (Bosquet et al., 2017; Lang et al., 2010), no studies have examined the role of experiencing a traumatic event prior to pregnancy in infant development and responsive parenting. This study will examine the impact of pre-pregnancy stress experienced during the Flint Water Crisis (FWC) on maternal perceptions of infant temperament and verbal responsivity at infant age 9m. Mother-infant dyads in Flint, MI were enrolled in 2020-21 at their first newborn pediatric visit in a randomized controlled trial (RCT) of a preventive parent-child program aimed at reducing disparities in school readiness. Experience of stress, mental health, and water quality during the FWC--the period from 2014 when Flint's water supply source was switched to 2015 when lead contamination was widely reported (5-6 years earlier)--were measured at enrollment using a life-history calendar method. At 9m visits, mothers reported on stress, parenting, and infant temperament, including temperamental approach (positive behaviors/excitement regarding new experiences). Analyses controlled for sociodemographics. Enrollment is ongoing; the current analytic sample includes 56 dyads for whom complete data was available. Linear regression analysis indicated that maternal stress experienced during the FWC predicted lower temperamental approach when controlling for child gender, birth order, maternal education, perceptions of water quality, and concurrent maternal stress at infant age 9m (Table 1). Further, both FWC-related stress and infant temperamental approach predicted maternal verbal responsivity at 9m, though in opposite directions. Structural equation modeling indicated that the indirect effect of FWC-related stress on maternal verbal responsivity through perceptions of infant temperament was marginally significant ($p<.07$; Figure 1). This study provides evidence for the importance of maternal stress and experience of trauma on infant development, even when that stress occurs before pregnancy. Mothers' experience of stress during the FWC predicted more negative perceptions of infant temperament. This has important clinical implications, as infants who show lower temperamental approach may be viewed as more difficult. This in turn may trigger negative caregiving behaviors, particularly in mothers who have increased stress, disrupting maternal-

infant synchrony. Interestingly, FWC-related stress predicted increased verbal responsivity, perhaps due to increased fears and public health messaging regarding impacts of the FWC on children's development. However, mediation analyses indicated that negative impacts on temperament perceptions may in turn lead to lower responsivity. Thus, preventive interventions aimed at promoting responsive parenting may be particularly relevant for mothers who have experienced a natural or disaster or other traumatic event.

P2-H-339 - Two-Year-Olds' Understanding of Their Need for Help in the Context of Problem-Solving (Raport)

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Traditionally, children's help-seeking behavior was viewed as an expression of their lack of competence. Today, help-seeking is recognized as an intelligent and adaptive strategy deployed by learners who realize that others' assistance is key for their progress on a problem (Nelson-LeGall, 1981, 1985). By requesting others' help, children express awareness that social learning is crucial for their cognitive growth. Previous research found that infants as young as twelve months old orient preferably towards informed, over uninformed, adults to seek information about novel objects (Bazhydai, 2020). By age 2, infants selectively seek help based on the helper's demonstrated competence (Cluver, Heyman, & Carver, 2013). What has, however, to our knowledge, not been studied is how help-seeking varies with infants' familiarity of a given problem, and whether infants consider the addressee's level of maturity (e.g., infant vs. adult) when eliciting help from someone. We investigated these issues in an online study with 2-year-olds. In Experiment 1 (N = 56 total), for which data collection is ongoing, we examine whether infants seek help at different rates depending on their familiarity with a problem-solving task. There are two experimental conditions, with infants randomly assigned to either condition. In the Familiar Condition, infants are trained with puzzles similar to a target puzzle they will receive at test. These infants will thus be familiar with the problem they will confront at test. In the Unfamiliar Condition, infants are trained with games that are unrelated to the target puzzles; they will thus be unfamiliar with the problem they face at test. Infants from both conditions have the opportunity to request help by pressing a button shown on the screen while working on the target task. If they press the button, they are presented with a choice between two kinds of helpers: an infant or an adult. Preliminary analyses from infants tested so far (n = 7), pooled with pilot data collected prior to the study (n = 10), indicate that infants seek help more often when completing an unfamiliar task than when completing a familiar task, p = .012. Furthermore, a trend is emerging that infants prefer to seek help from an adult over an infant (64% over 36%). In Experiment 2, in addition to varying helpers' maturity level, we plan to independently manipulate the helpers' own familiarity with the problem, which will allow us to test whether infants prefer help from those who are familiar with the given problem. This empirical study will advance our understanding of infants' help-seeking and its variation with task familiarity. Identifying when and how infants seek help from others has implications for theories of social learning and for practices of assisting infants in learning contexts.

P2-H-340 - Exploring the effects of repeated exposure on infant and toddler vegetable consumption over a two-week period (Kielb)

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Infants and toddlers in the United States are not meeting dietary recommendations; consumption of vegetables is particularly poor in toddlerhood (Roess et al., 2018). Repeated exposure to the taste of novel or disliked foods consistently results in increased liking and consumption of foods in early childhood (Birch et al., 1990; Johnson, Shapiro, et al., 2021). Prior studies on repeated exposure typically prescribe a rigid number of offers (often 8-10; for a review, see Spill et al. 2019), as opposed to exploring naturalistic parent offering behaviors. The purpose of this study is to explore: 1) changes in infant and toddler consumption of a novel vegetable across four time points, and 2) whether the number of offers during a home exposure period predicted consumption. Infant-caregiver dyads (n=57, 71% Non-Hispanic White) completed two laboratory visits two weeks apart when the infants were between 6-24 months of age (average age = 53.58 weeks, SD = 21.82 at baseline). At each visit, caregivers offered infants the target vegetable (golden beets) in either pureed or diced form. Caregivers selected the texture most appropriate for their child. Between visits, caregivers received 12 samples of beets to offer their child as often or as little as they liked at home (average offers = 6.84, range: 2-12). All samples were pre- and post-weighed on SECA scales and vegetable consumption (in grams) was calculated as the difference between pre- and post-weights. Food texture and child age were highly associated, with infants <9 months more likely to receive the puree, X 2 (df) =30.77, p<0.0001; thus, food texture was included as a covariate to control for both food texture and child age. Number of home offers and food texture were included as predictors in analyses. To explore infant vegetable consumption over time (see Figure 1), we estimated a linear multilevel model of change (MLMC). The unconditional model revealed that 34.7% of variance in vegetable consumption was due to between-participant differences, and in the MLMC, the random intercept suggested significant variation between participants in consumption (σ 2 μ 0=242.10, SE=111.33, p<0.05). In the unadjusted model (no covariates), there was a significant main effect of home offers (β=1.79, SE=0.89, p<0.05) on vegetable consumption. However, when controlling for food texture, this effect disappeared (p=0.11), leaving only food texture (and by proxy child age) as a key predictor of lower consumption (β =-13.74, SE=4.90, p <0.01; See Table 1). These findings are consistent with prior literature indicating that age is a critical driver of food acceptance, with younger infants (6-9 months) consuming more of the novel vegetable than older toddlers (Johnson, Moding, et al., 2021). Despite prior research suggesting 8-10 exposures are considered ideal for increased liking and consumption in early childhood, several studies have suggested as few as 4-5 exposures may be adequate for certain children (Spill et al., 2019). However, less research has explored when and for whom fewer exposures are needed. Future studies should explore individual differences in response to repeated exposures to inform more individualized best practices for increasing vegetable consumption in early childhood.

P2-H-341 - Exploring young infants' selective empathic concern towards other-race recipients (Drew)

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Prosocial behaviors are a key to successful social interactions and social acceptance (Eisenberg et al., 1996). As such, prosocial motivations seem to be rooted early in ontogeny, evidenced by infants' displays of other-oriented concern. By 3 months of age, infants show overt signs of empathic concern when someone is injured, and their individual responses to distress remain largely stable across infancy

(Davidov et al., 2020). By 14 - 18 months of age, toddlers spontaneously help, share, and comfort those in need (Dunfield et al., 2011; Warneken & Tomasello, 2009). Like adults, however, young children can be selective when engaging in prosocial behaviors, and toddlers readily attend to characteristics of the beneficiary of their actions (Kuhlmeier et al., 2014, for review). For example, they prefer to help an experimenter who has demonstrated prosocial intentions and actions, rather than helping a previously antisocial individual (Dahl et al., 2013; Dunfield & Kuhlmeier, 2010). A recent study indicates that toddlers also attend to the race of the recipient when exhibiting prosocial behaviors (Laible et al., 2021). 24-month-olds preferred to help an own-race (ie., White) versus other-race (ie., Black) individual; however, the same infants unexpectedly showed greater empathic concern for an other-race (ie.,Black) versus own-race (ie, White) experimenter during a feigned injury task. Although this research did not find an effect among 18-month-olds, previous work has shown that 15-month-olds do attend to an actor's race when forming morally relevant evaluations (Burns & Sommerville, 2014). The extent to which infants' other-oriented concern is informed by the race of the recipient, however, remains largely unexplored. Here, we examine 10-month-olds' empathic concern towards own- versus other- race experimenters with a sample of White and Asian infants. While prior research has predominantly used WEIRD samples to investigate selective prosocial behavior, our sample will also allow us to explore whether Asian and White infants respond differentially to an ethnic outgroup member in distress. Children from non-White minority groups seem to hold different implicit race-based preferences than White children (Dunham, Chen, & Banaji, 2013); thus, their selective empathic concern for other-race individuals might also vary. This substudy is part of an ongoing longitudinal research project that follows infants' social and moral development from birth to age 3. At 10 months old, infants sit across from an own-race (Asian/White) or other-race (Asian/White) experimenter who "injures" her finger with a toy hammer and subsequently shows signs of distress (as in Davidov et al., 2020). During this episode, infants' facial expressions and vocalizations are coded for intensity of concerned affect and inquiry behavior (range:0-4). These scores are then summed to create an overall empathic concern score. Data collection is ongoing (target N ~100, based on an a-priori analysis); however, a preliminary analysis (N = 40; M age = 9.78 months; 48% Female; 28% Asian) indicates that 10-month-olds exhibit marginally increased inquiry behavior ($t = 1.92$ (38), $p = .06$), and significantly greater empathic concern toward an other- versus own-race experimenter ($t = 2.35$ (38), $p = .02$). This preliminary finding is in line with recent work showing that toddlers have greater empathic concern for ethnic outgroup members (Laible et al., 2021) and contributes to the discussion on the altruistic versus affiliative motivation behind infants' empathic concern.

P2-H-342 - Understanding Low Vision Infants Socio-cognitive Skills Emergence: the ULISSE project (Guida)

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Social cognition is a set of mental abilities that enable us to understand and interact with others (Alaerts et al., 2011; Beaudoin et al., 2020). A fundamental milestone for adequate social cognition development is joint attention, that is the coordination of attention between a social partner and an external focus of shared interest, and it is known to be associated with positive developmental outcomes such as better language, socio-emotional, and theory of mind skills in typical development infants (Carpendale & Lewis, 2006; Tomasello et al., 2007). Despite joint attention can be elicited by nonvisual cues, to date research

on this competence hardly considered the role of senses other than vision, making it difficult to study developmental trajectories of joint attention in infants that are visually impaired (Bakerman et al., 1984; Adamson et al., 2004; Rossano et al., 2012). Considering the lack of scientific literature referring to visually impaired infants' socio-cognitive skills, it appears fundamental to develop new procedures able to assess joint attention without the role of visual cues in order to comprehend its developmental trajectory and to assess potential risk and protective factors (Pérez-Pereira et alt., 2005; Morelli et al., 2020; Loots et al., 2003). The objective of this study is to explore joint attention competencies through the ear channel in both typical development (TD) and visually impaired (VI) infants. To this aim, an innovative procedure (the EASY-1 procedure) has been developed. The EASY-1 procedure consists of videotaped sessions during which play episodes with the mother are alternated to episodes in which sound stimuli (i.e., human and non-human sounds) are presented. During the sound episodes, the mother is asked to stay still, so that infant behavior in response to sounds could be recorded without any interference. Each sound episode is followed by a reunion episode during which mother and infant can play again. The EASY-1 procedure has been proved reliable to detect joint attention behaviors through preliminary results on 14 TD infants longitudinally tested at 9 and 12 months (Figure 1). The total sample will be constituted of 60 infants (30 TD and 30 VI). Data collection is ongoing and both TD and VI infants are being tested at 9 and 12 months of age to understand whether the developmental trajectories of the two samples are comparable in terms of timing and features. Particularly, we expect that both groups increase joint attention behaviors (i.e., pointing, looking at the mother, looking to the sound source, vocalizations) from 9 to 12 months and that VI infants show generally less joint attention behaviors than TD infants of the same age. To test this hypothesis a repeated-measures Analysis of Variance (rmANOVA) will be conducted with Age (9 months and 12 months) as within-subjects factor and Group (TD vs VI) as between-subjects factor. We hypothesize that fewer possibilities for VI infants to make the experience of joint attention contexts, due to their limited access to visual cues, may determine a delay in the development of this competence. Thus, the possibility of understanding and assessing social cognition precursors also in VI infants could allow the implementation of interventions focusing on the enhancement of this important skill (Pérez-Pereira & Conti-Ramsden, 2005).

P2-H-343 - Synchrony and mutual responsiveness in mother-preterm infant interactions and child socioemotional development until 6 months CA (Grochowska)

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The way mothers and infants interact from the very beginning is crucial for child socioemotional development. Many theoretical models explain, how reciprocity and physiological synchrony in relationship with a caregiver can modify infant's neuronal pathways and contribute to child's individual set of behavioral abilities (Feldman, 2012, Porges & Furman, 2011). Earliest social stimuli may modulate production of neurohormones and launch a descending chain reaction, starting with mesocortical and dopaminergic pathways, that communicate with hypothalamic-pituitary-adrenal axis and sympathetic-adrenal-medullary stress response system, ending with vagal autoregulation of parasympathetic nervous system (PSN), that diminishes increasing arousal (Weber, Harrison, & Steward, 2012). Infant vagal PSN activity can create child's effective stress response system and increase adaptive socioemotional competences. These processes might be of particular importance in the case of preterm infants due to increased neurodevelopmental risks and exposure to early environmental challenges.

Objectives: Our aim is to examine interdependence of postnatal interactional synchrony and PNS activity of mother and her preterm infant, and of socioemotional development up to 6 mos of infant's age. We hypothesize, that there is a correlation between: a) behavioral synchrony in mother-infant interaction, level of PNS synchrony, and infant's recovery time after distress, b) the level of biobehavioral synchrony in mother-infant early interactions and later socioemotional developmental competencies. Method: 30 mother-preterm infant dyads will be enrolled in the NICU. Inclusion criteria: maternal age >19 years, infants with gestational age between 28 and 36 weeks with stable vital signs and without congenital anomalies or severe insult to CNS. Three meetings with participating families are planned: during the NICU stay, at 3 and 6 months CA. First, biobehavioral synchrony and mutual responsiveness in mother-preterm infant dyads will be assessed. In order to measure the real time parasympathetic activity, we will use NIPE - Newborn Infant Parasympathetic Evaluation for infants and ANI- the Analgesia Nociception Index for mothers. Both technologies register heart rate variability (HRV), of which high frequencies oscillation represents PNS activation. We will also video-record 20 min of free interaction after the exposure to routine painful NICU procedure (vaccination) and evaluate infant's ability to calm down after distress. Attachment during stress scale (ADS) and Preterm Mother-infant Interactive Scale (PREMIS) will be used to measure responsiveness, soothability and overall synchrony. In the follow-up part at 3 and 6 mos of CA we will measure infants' temperament with the Infant Behavior Questionnaire−Revised (IBQ-R). At 6 mos we will also assess social competences using the Communication and Symbolic Behavior Scales-Developmental Profile Infant/Toddler Checklist (CSBS-DP), recording mother-infant 10 minutes' free play and coding frequencies and duration of socially directed behaviors, as well as, mother-infant co-regulation with Fogel's global Relational Coding System. Expected results and implications: By identifying early biobehavioral factors, that saliently promote infant brain circuit adaptation via specific neurophysiological pathways, we hope to better understand processes contributing to infant's socioemotional competence in the context of prematurity related risks.

P2-H-344 - Interpersonal coordination in early interactions: Comparisons of infant-directed singing and speech (Flaten)

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Across cultures, mothers interact with their infants through infant-directed (ID) singing and ID speech. Compared to adult-directed singing, ID singing is highly repetitive and conversational, and infants prefer it (Trainor, 1996). Although studies are investigating the coordination of behaviour and/or physiology during caregiver-infant interactions, few have investigated musical interactions. Thus, the current study compares interpersonal coordination between mothers and their infants during naturalistic ID singing and ID speech. Specifically, we are collecting time series data for movement, gaze, and physiological signals (heart rate [HR]; skin conductance [SC]) simultaneously from mothers and infants during these interactions. This study compares two forms of coordination: synchrony (similarity of the time series) and bidirectional information flow (how much each time series predicts the other). Moving synchronously is associated with concurrent physiological synchrony and social bonding in adults (e.g., Gordon et al., 2020), and with increasing helpful behaviours in 14-month-olds (Cirelli, Einarson, & Trainor, 2014). Information flow has been related to social communication (Shockley, Santana, & Fowler, 2003) and leader-follower dynamics in performing musicians (Chang et al., 2017). Thus, we

hypothesize that mother-infant synchrony may relate to social bonding and social development, while information flow may relate to sensitivity to each other's cues in a bidirectional manner. Previous studies show that matched gaze and vocalizations between caregivers and infants are associated with increased coordination of their heart rhythms, which together associated with better infant affect (e.g., Feldman et al., 2011). Further, one study found mother-infant SC decreased when mothers sing lullabies, but stabilized during playsongs, suggesting that mothers use singing to help infants regulate their arousal (Cirelli, Jurewicz, & Trehub, 2019). We expect coordination of movement between mothers and infants to associate with concurrent coordination of arousal, which will be reflected in SC and HR. Mother-infant dyads (full data in N = 3 dyads; 5 months; data collection is ongoing) were recruited. In the LIVELab at McMaster University, reflective markers were placed on each dyad member's head, wrist and torso, and movements were recorded by motion capture (Qualisys). To measure HR and SC, triple point sensors (Thought Technology Ltd.) were worn on the mother's left index finger, and the infant's right foot. To measure gaze, tablets were set up to simultaneously record each dyad member's face. Mothers sat facing their infant. After a baseline, in 3 conditions mothers sang songs familiar to their infant (1) as a lullaby, (2) as a playsong, and (3) told the story of the song(s) they sung in infant-directed speech. We are analyzing synchrony and information flow using mathematical analyses. We predict that: (1) ID singing will be more associated with movement synchrony, and ID speech with information flow compared to each other. (2) ID singing will synchronize arousal (HR & SC) between caregivers and infants more than ID speech. (3) Moment-to-moment changes in synchrony and information flow in movement, HR and SC will be related to each other and modulated by gaze. We expect this project will significantly advance our understanding of how ID singing affects caregiver-infant interactions.

P2-H-345 - Quality of father-infant interactions as an antecedent of children's friendship quality: Family alliance as a mediating factor (Marquis-Brideau)

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The quality of parent-infant relationships is a well-documented predictor of child subsequent social functioning (Bornstein, 2019). Meta-analytic data shows reliable associations between parent-infant interactions and the quality of children's interpersonal relationships over years of development (Pallini et al., 2014). Although this body of literature has long focused on mothers, studies increasingly suggest that fathers also do play a central role in supporting their infants' social development (Deneault et al., 2021; Rodrigues et al., 2021). Theoretically, it is expected that dyadic parent-child interactions contribute to shape relational processes that take place at the higher-order, triadic mother-father-child level, with some indication that fathers may play an especially salient role in shaping triadic mother-father-child process (Brown et al., 2010). In turn, such triadic processes may support children's relational skills (e.g., conflict resolution, compromise) and thus, their capacity to establish high-quality friendships. Very little research, however, has addressed such relational developmental cascades. Accordingly, this study aimed to examine a 9-year developmental cascade model linking the quality of father-infant interactions at age 18 months to child friendship quality at age 10 through the mediating role of family alliance (the degree of mother-father-child engagement and coordination in joint activities) at age 6. We controlled for the quality of mother-infant interactions to reach conservative, father-specific conclusions. The quality of interactions of 136 father-infant dyads was assessed during 10-minute play sequences when infants were aged 18 months. The videotaped interactions were rated with the

Mutually Responsive Orientation scale (MRO; Aksan et al., 2006), which assesses harmonious communication, mutual cooperation and emotional ambiance. 25% of videos were rated independently by two research assistants. Inter-rater reliability was excellent, intra-class correlation (ICC) =.86. When children were in kindergarten, their family alliance with their father and mother was assessed based on the 15-minute Lausanne Trilogic Play (Fivaz-Depeursinge & Corboz-Warnery, 1999), rated using the Family Alliance Assessment Scales (Favez et al., 2011). Interrater reliability on 25% of double-coded interactions was excellent, ICC = .91. The quality of children's relationship with their best friend was self-reported by children with the Friendship Quality Questionnaire (Parker & Asher, 1993) at age 10 years. Mediation analysis was conducted using the PROCESS macro in SPSS. We controlled for family SES, child sex, and the quality of mother-child interactions (also assessed with the MRO at 18 months). Results show that above and beyond the effects of family SES, child sex, and the quality of mother-infant interactions, the quality of father-infant interactions predicted family alliance (β = .31, p = .02), which in turn predicted the quality of children's friendship (ß = .40, p = .002). The overall indirect effect linking the quality of father-infant interactions to friendship quality via family alliance, after adjusting for covariates, was significant (estimate = 1.16, bias-corrected bootstrapped confidence interval = 0.1508 - 2.3215). These results suggest that fathers may play a central role in shaping the developing family alliance, with implications for child subsequent social functioning.

P2-H-346 - Facial emotion processing development amid the COVID-19 pandemic (Dautrich)

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The Covid-19 pandemic significantly impacted children's social worlds, as children were prevented from interacting with others during crucial periods of development (Williams et. al., 2010), or interacted with others who were consistently masked, something found to disrupt face perception in adults and older children (Ruba & Pollak, 2020). The current study explores how exposure to masked faces in infants born during the Covid-19 pandemic (now 18-24-mos old) influences their tendency to prefer masked or unmasked faces. It also examines whether mask exposure and parental mask attitudes influence early abilities to perceive emotions in unmasked faces. Utilizing a moderated online data collection method, infants will proceed through two looking-time tasks, a facial preference task and an emotion recognition task. Looking-times will be coded offline from webcam video footage. In the facial preference task, two neutral faces will be presented side-by-side, one masked and one unmasked, across four trials (see Figure 1). In the emotion recognition task (adapted from Montague & Walker-Andrews, 2001), infants will proceed through four blocks, each containing four trials. Infants will first be familiarized to one facial emotion (happy or sad) over three trials. A fourth test trial will portray either the same emotion ("same trial") or a different emotion ("switch trial", see Figure 2 for an example). Half of the blocks will contain masked faces, and half will contain unmasked faces. In addition to these looking time measures, parents will provide information on their attitudes towards masking via the Mask Anxiety Questionnaire (MAQ, adapted from Xu & Cheng, 2021 and Nikčević & Spada, 2020), and data on infants exposure to masked vs. unmasked faces during the first year of the pandemic via the Mask Exposure Questionnaire (MEQ, an exposure diary adapted from DeAnda et al., 2016). Growing up in a masked world could present an advantage for these infants, since experience detecting emotion from only the top half of the face could improve their ability to recognize emotions with only limited facial information (Barrick et al., 2021). It may also present a hindrance, as studies show that early facial input is crucial for children to be able to

develop normal facial processing abilities (Geldart et. al., 2002). To explore these competing hypotheses, we will first create a looking time ratio for the face preference task (looking time to masked faces / looking time to unmasked faces) and compare this score to an average of one (two-tailed t-test). To analyze the emotion recognition data, we will create a difference score between the 3rd and 4th trial in each block and categorize them as "same" or "switch trials". We will run a 2 (faces: masked, unmasked) X 2 (emotion: same or switch) ANCOVA with baseline emotion (happy or sad) as a covariate. We will also run a stepwise regression on all data collected from the parent measures (MAQ and MEQ) to help us choose which independent variable most influences infant looking time scores. In this way, we will be able to explore the nuanced ways in which "pandemic babies" grow up experiencing and perceiving the social information around them.

P2-H-347 - Sharing Cultural Experiences over Video Chat: Grandparents and Grandchildren Navigate Disconnection at a Distance (Piper)

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Caregivers and grandparents share traditions and family stories with young children through teaching, imitation, and learning (Legare, 2017). Cultural transmissions are facilitated by contingent interactions, typically occurring in-person. However, families turned to video chat to share their cultures at a distance throughout COVID-19 (Brown & Greenfield, 2021). While previous work supports using video chat for sharing family traditions (Tarasuik & Kaufman, 2016), disruptions in communication caused by technology may introduce challenges for cultural transmission. For instance, unequal access to high-speed internet may disrupt interaction quality between infants and their distant relatives (McClure & Barr, 2017), and it is currently unknown 1) how and if technology disruptions occur during video chat, and 2) how cultural transmission takes place in the context of tech disruptions. Between October 2020 and August 2021, we conducted a naturalistic, longitudinal observational study of 49 families, recording three video chats between grandparents (all grandmothers, M=62 years), infants (M=11.6 months, range: 6-25 months), and parents (2 fathers), supplemented by surveys. Forty-one families also submitted a recorded in-person visit. Adults were highly-educated and mostly Caucasian; geographic distance between them ranged from 1-2700 miles. Occurrences, sources, and resolution of technical problems leading to significant visual/audio/visual-audio delay were coded across video chats (Table 1). To assess cultural transmission, we coded cultural markers (Table 1) directed toward the target child during shared experience. We plan to look at rates of cultural expression per minute in each recording. We will examine frequencies of tech disruptions across sessions to address our first question. A mixed methods approach will be used to examine cultural transmissions before and after tech disruptions, looking at both frequency of cultural transmission and themes that arise in the interactions and transmissions surrounding the disruptions. The project is pre-registered on OSF. Data have been coded using Datayvu, with high levels of interrater reliability. Challenges posed by using video chat to communicate included instances where grandparents or children unintentionally muted themselves or ended the call. Regarding cultural transmission frequency (Table 2), the most common cultural marker was gestures (M=0.139 per minute, SD=0.129). Future work involves qualitative analysis of tech disruptions and cultural exchanges. For example, parents and grandparents involved the baby in

imitative games and nursery rhymes. The grandparent played patty cake on their end of the call, while the parent held the baby's hands to imitate and follow the grandparent's vocalization. Studying cultural exchanges in a digital age requires including virtual, real-time formats (e.g., video chat). We predict frequent virtual cultural exchanges that will increase as a function of the age of the baby and frequency of family video chat. We predict that technology disruptions will take place (McClure & Barr, 2017) and that chats where tech disruptions occur will be associated with reduced cultural expression.

P2-H-348 - Cultural contributions to parental psychology: A multilevel analysis from the joint effort toddler temperament consortium (Sehic)

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The present study aims to develop a greater understanding of the manner in which culture may impact parenting, and thus child development, by examining the relationship between cultural values/orientation, socialization goals and parental ethnotheories. Specifically, this study will examine ways in which the cultural values/orientation dimensions provided by Hofstede et al. (2010) (i.e. individualism/collectivism, power distance, masculinity/femininity, uncertainty avoidance, indulgence/restraint, and long-/short-term orientation) shape autonomous and relational socialization goals and parental ethnotheories. Using data collected via the Early Child Behavior Questionnaire (ECBQ) of toddlers from 14 nations represented in the Joint Effort Toddler Temperament Consortium (JETTC), we hypothesize the following: 1) Cultural value dimensions consistent with independent cultural ideals will be associated with socialization goals and parental ethnotheories representative of a greater emphasis on autonomy and independence; 2) Cultural value dimensions consistent with interdependent cultural ideals will be associated with socialization goals and parental ethnotheories representative of greater interrelatedness; and 3) Cultural values/orientation variables are not expected to significantly impact within-culture variance and are associated primarily with between-culture effects, as these are culture-level variables. The following countries were included in the JETTC: the United States (US), Brazil, Spain, Mexico, Italy, Russia, Finland, Romania, Belgium, the Netherlands, China, South Korea, Turkey, and Chile. Each of the country sites recruited an average of 61 families. Samples from each country ranged from 49 (Chile) to 112 (the Netherlands) for a total sample of N = 865. Children ranged between 17 and 40 months of age (M = 26.88 months, SD = 5.65 months), with approximately equal distribution of ages across this developmental period, as well as approximately equal representation of genders (52% male). Socialization Goals and Parental Ethnotheories questionnaires provided autonomy and relational orientation indicators. Caregivers indicated their agreement to 10 statements concerning qualities a child should learn or develop in early childhood, using a 5-point Likert-type scale. Multilevel modeling (MLM) will be used to regress parental psychology (Socialization Goals and Parental Ethnotheories) on Hofstede's cultural values, controlling for potentially relevant covariates: child age and gender. Analyses were conducted in STATA version 17. Data were analyzed using a linear multilevel modeling approach, grand-mean centering cultural orientation values to facilitate interpretation. Models were constructed in three phases for each of the 4 dependent parental psychology variables (i.e., relational and autonomous socializations goals; relational and autonomous parental ethnotheories). Models were compared using a variety of fit indices, including reduction of the intraclass correlation (ICC), Akaike's Information Criterion (AIC), Bayesian Information Criterion (BIC), and chi-square difference tests. The proposed study furthers our understanding of the manner in which culture-

level factors impact child development via parental perspectives and approaches. This understanding has the potential to further our insight into culturally-influenced variability of socialization goals and parental ethnotheories that may inform clinical practice.

P2-H-349 - Autocatalytic ontogeny of maternal depression and externalizing behavior in infancy and early childhood (Everhart)

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A myriad of studies suggest variability in the epigenetic expression of the oxytocin receptor gene OXTR_rs53576 with regard to social / emotional sensitivity and diathesis for psychopathology. One recent study (Asherin, Everhart, Stophaeros, Vogeli, Fowler, Phiel & Kaplan, 2019) has linked differential susceptibility to depression for mothers of GG infants in comparison to AG/AA infants, suggesting that an enhanced capacity of GG infants to process positive and negative socially meaningful contextual information, serves to amplify and perpetuating negative affectivity in mothers with depressive characteristics. This study examines the hypothesis that desynchronization of maternal and infant affective cues stemming from heretofore described epigenetic process between mothers and GG infants, in turn, leads to the canalization of cycles of coercion and the development of oppositional defiant behavior in early childhood (Scaramella & Leve 2004). This model is described as autocatalytic in that the interface of maternal negative affect and GG infant sensitivity is thought to produce a desynchronization that in-turn serves as a catalyst for the coupled emergence of dual psychopathological trajectories. In this prospective longitudinal study, 100 to 150 former infant lab participant mothers and their 4- to 14-month old infants (originally recruited through a Facebook advertisement for a larger study on maternal depression and child development) will be re-contacted between the age 4-6 years old in order to examine the relationship between mother and infant OXTR receptor type, intrusive interactions and negative affectivity in infant-mother dyadic interaction, and externalizing behavior in early childhood. The Beck Depression Inventory (BDI-II) is used to assess depression symptomatology in mothers of infants. Dyadic interaction variables are assessed via Coding of Interactive Behavior (CIB; Feldman, 1998) from a recorded 10-minute free play observation. Externalizing behavior, including deficits in executive functions (Zelazo, 2020) will be measured using the Behavior Assessment System for Children-Third Edition (BASC-3) Parent Rating Scales (PRS) and Teacher Rating Scales (TRS) (Reynolds & Kamphaus, 2015). Analysis of covariance is will be used to test the main and interaction effects of OXTR receptor on externalizing behavior, with dyadic interaction covariates.

P2-H-350 - Intersensory Integration in Infants with ASD (Rao)

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Purpose
Intersensory integration is a process that may be critical in infants for developing social cues and adaptive behavior. Studies have shown how children and adolescents with neurodevelopmental conditions such as Autism Spectrum disorder (ASD) are associated with socio-emotional and cognitive deficits that could hinder their intersensory integration abilities and, subsequently, their language and social development. We believe that children learn intersensory integration of sound lip movement by

looking at the mother's face when talking to them. This study examined two groups of infants', Typically Developing (TD) and At-Risk for Autism, sensitivity to audiovisual synchrony when presented with social stimuli of a speaking face and the amount of time spent looking at the mother's face during a Freeplay interaction. Additionally, we studied whether an infant's ability to integrate visual lip movement with sound is related to the infant's social behavior of attending to its mother's face. We expect children at risk for autism to show differences in intersensory integration and the amount of time looking at the mother.

Methods

To measure infants' sensitivity to audiovisual synchrony, subjects around 4-5 months of age sat in front of two screens playing a video of a woman articulating the syllable /ba/. On the matching screen, the audio matched the women's lip movement. On the other discrepant screen, the same events were presented at increasing levels of temporal discrepancies (333 ms, 500 ms, 666 ms, 833 ms, and 1000 ms). This temporal discrepancy reflects the infant's ability to integrate intersensory information. The measure of looking at a maternal face consisted of a mother-baby Freeplay interaction for 3 minutes. We tracked and quantified the number of seconds the infant spent looking at each screen and the percentage of Free Play period the baby gazed at the mother to study the relationship between the two variables.

Results

The relationship between looking at the mother and intersensory integration was examined for the TD and At-risk subject groups. No correlation was found for typically developing subjects ($r= -0.0213$, $n=49$). For subjects At-Risk for ASD, a positive correlation was found where greater gaze time at the mother was associated with better intersensory integration perception ($r= 0.49$, $n=18$). Examining the two subject groups' average looking time at the mother during the Freeplay interaction, a statistically significant difference was demonstrated between the TD and At-Risk subjects', where the TD subjects ($M=.502$, $SD = 0.270$) were found to spend a longer time looking at their mother than at-Risk Subjects ($M=0.390$, $SD= 0.230$; $p <0.0001$.

Conclusion

At the developmental stage of 4-5 months, typically developing subjects' intersensory integration abilities did not correlate with the amount of time they gazed at their mother. At-Risk subjects demonstrated a moderate positive correlation between intersensory integration abilities and gazing at their mother.**P2-I-238 - Measuring infants' empathy during covid-19: cross-validating two online empathy tasks in a longitudinal design (Israeli-Ran)**

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Empathy is defined as the ability to understand and share in another's feelings while maintaining other-self distinction (Uzefovsky & Knafo-Noam, 2017). Empathy can be divided into two components; Cognitive empathy refers to the ability to understand the emotion of others (Davis, 1980) and emotional empathy refers to the ability to share in those emotions (Baron-cohen & Wheelwright, 2004). Empathy in infants is typically measured as the child's response to an adult simulating distress (Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992). A video of a peer expressing distress has also been used with similar findings (Roth-Hanania, Davidov & Zahn-Waxler, 2011). Yet, during the COVID-19 pandemic in-person testing became unfeasible, which required the development of additional methods to test empathy remotely. Therefore, the goal of the current study was to examine the validity of two empathy

tasks conducted online during the first and second waves of COVID-19. Data was collected for 199 participants mother-infant dyads who participated in an online Zoom session. 61 participants were removed from the analysis (52 due to technical problems, 6 were distracted, and 3 had developmental problems), resulting in a final sample of 138 infants (age: M=13.6±2.4 months, 47% female). Data was collected May-August 2020. A follow-up online session was conducted with 118 infants (age: M=18.8 ±2.6 months, 51% female) October 2020-January 2021. The two empathy tasks were as follows. First, we used the peer-distress task in which a video of a peer expressing distress (crying) is shown for 26 seconds (Time 1) or 40 seconds (Time 2). Infants were recorded using Zoom and their responses were coded for two main measures - Empathic concern (a measure of emotional empathy) is expressed through facial expressions, body posture, and vocalizations showing concern for the other. Inquiring behavior (a measure of cognitive empathy), is coded based on the child's attempts to understand the situation as reflected in facial expressions, vocalization, and social referencing (Davidov et al., 2021). Second, a cross-modal emotion recognition (cognitive empathy) task was presented (based on Walker-Andrews, 1986; currently only data for Time 1 is available. Time 2 data is currently being coded). In the task, the infant is presented with two images (left and right side of the screen) of a woman expressing an emotion (happy/sad/neutral). The image is presented with a vocal emotion expression (laughing / crying), corresponding to one of the facial expressions for 10 seconds. Preferential looking at the congruent image denotes emotion recognition. Spearman correlations appear in Table 1 (attached). Performance in the cross-modal task correlated with inquiry concurrently (rs=0.42,p= .0000) but not longitudinally (rs=0.19,p= .08). As expected, it did not correlate with empathic concern at both time points. Our findings show that while online testing is challenging, it can be a valid and reliable way to measure empathy. Our findings are especially important in light of the young age of our participants.

P2-I-239 - Importance of Patient-Provider Racial Minority Concordance in Postpartum Depression Screening (Prevatt)

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It is essential to identify pregnant women who are at greatest risk of developing pre and postnatal depression in order to best target screening and preventive strategies. Understanding the role of race and mental health in individual functioning is important, especially identifying barriers to seeking and receiving mental health care intervention. Prevalence of prenatal and postpartum depression has shown to be higher in racial minority mothers (e.g., non-Hispanic black and/or Hispanic mothers; Mukheerje, et. al, 2016) and often goes undiagnosed (Shen, et. al, 2010), compared to mothers who are not racial minorities (e.g., white). Untreated depression adversely affects maternal health outcomes, infants, and relationships with family members. Overall rates of depression screening for pregnant women is low, but is especially low for mothers who are racial minorities. Mothers who are racial minorities may feel more comfortable discussing mental health symptoms with prenatal care providers of the same race, therefore, matching mothers with care providers of the same race may be important. Little research has examined how patient-provider racial concordance may affect patient trust and mental health screening rates. This study examined patient-provider racial concordance and mental health screening during the postpartum period of mothers who are racial minorities. A secondary data analysis was performed on de-identified medical records from a multisite obstetrics practice in the southeastern U.S. for patients between May 7, 2015 and December 31, 2020 (N=3120; n=2354 white; n=766 racial minorities, e.g.,

Black, Asian, American Indian or Alaskan native, Native Hawaiian, Hispanic). Demographic variables, such as patient minority status, provider minority status, maternal age, relationship status, insurance type, and depression scores were included in the analysis. The Edinburgh Postnatal Depression Scale was used during the postpartum period to determine depression scores, where mothers rated cognitions, mood, and emotions they experienced from the past week. A logistic regression examined effects of racial minority status of mothers and their providers on likelihood of receiving postpartum screening. Additionally, a t-test examined differences in depression scores based on patient-provider racial minority concordance. Results suggest that patients were more likely to receive a postpartum depression screening if their care providers were of the same minority status (OR=1.44; 95% CI=1.05-1.95; p=.022). Importantly, there was a significant difference in depression during the postpartum year (t(396.55)=2.68, p=.008, 95% CI=0.28-1.83, Cohen's d=0.14), with racial minority mothers reporting greater symptomatology when screened by a provider who was also a racial minority (M=5.66, SD=5.24), compared to those who did not share their provider's minority status (M=4.60, SD=4.31); however, the effect was small. Results indicate that racial minority concordance with health providers may be a key factor in developing patient trust, increased engagement with care providers, honest reporting of depressive symptoms, as well as being a key component to effective screening and treatment of postpartum mood disorders for racial minority mothers. Further research is necessary to better understand these relationships and how to best meet needs of mothers belonging to racial minority groups.

P2-I-240 - Understanding the relation of maternal sensitivity, toddler temperament and language ability with daily mother-toddler communication patterns (Thinzar)

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Although language and emotions are critical components of early parent-child communication, they are often studied separately (Cole et al., 2010) within brief, semi-structured tasks. While these tasks provide insight into family communication, they do not capture communication patterns as they occur in everyday life (Buhler-Wassmann & Hibel, 2021). To address these gaps, we used Language Environment Analysis (LENA; Xu et al., 2009), a wearable audio-recording technology that automatically quantifies daylong samples of parent-child communication. In our previous work (BLINDED FOR REVIEW), capitalizing on LENA's ability to identify communication sequences involving negative emotion, we found that, although parents were less likely to respond to toddler cries compared to (pre)verbal vocalizations, when parents responded to toddler cries, toddlers were most likely to vocalize next (CRY->PARENT->VOC). These findings imply that parents are more responsive to toddler verbal cues than to distress cues and suggest possible co-regulatory processes in which parents help their toddler shift from negative to verbal expression. Yet, it is unknown how sequential patterns identified by LENA relate to traditional measures of parenting. To address this gap, 25 one-year-olds (Mean=16.60 months; 92% White) wore the LENA recorder for a full day and participated in semi-structured tasks with their mothers. Maternal sensitivity to distress and non-distress was coded (NICHD ECCRN, 1999) from these tasks. Mothers reported on child language ability and temperament. We found no main effects of global ratings of maternal sensitivity to distress on any sequences involving toddler cries (Table 1a). However, maternal sensitivity to distress interacted with toddler temperament to predict the probability that mothers responded to toddler cries (CRY->MOM), and that toddlers continued crying following mothers'

response (CRY->MOM->CRY). Specifically, mothers low in sensitivity to distress were less likely to respond to the cries of toddlers high in negative affectivity (Figure 1). When mothers responded to toddler cries, highly surgent toddlers with less sensitive mothers were more likely to continue crying. Toddlers high in effortful control were more likely to vocalize following mothers' response to their cries (CRY->MOM->VOC). As expected, global ratings of maternal sensitivity to non-distress predicted the probability that mothers responded to toddlers' (pre)verbal vocalizations (VOC->MOM; Table 1b). Maternal sensitivity to non-distress also interacted with toddler effortful control and language ability to predict this sequence. Highly sensitive mothers were more likely to respond to vocalizations of toddlers with higher effortful control or lower language ability. Maternal sensitivity to non-distress was unrelated to the effect of maternal responses to vocalizations on toddlers' subsequent communication (VOC->MOM->VOC, VOC->MOM->CRY); these sequences were predicted by toddler effortful control and language ability. Thus, although there were few main effects of global ratings of maternal sensitivity on communication sequences identified by LENA, maternal sensitivity to distress and non-distress interacted with toddler characteristics to predict sequential patterns. Methodological implications, strengths and limitations of automated processing technology, and the importance of considering the transactions between child characteristics and parenting quality in predicting moment-to-moment communication will be discussed.

P2-I-241 - The impact of remembered childhood non-supportive emotion socialization experiences on mothers' non-responsiveness to infant distress (Lutolli)

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The way mothers respond to infant and toddler distress impacts numerous facets of their children's development (McElwain & Booth-LaForce, 2006; Spinrad et al., 2007). Specifically, children whose mothers respond sensitively to their distress have better emotion regulation and fewer behavior problems compared with other children (Leerkes et al., 2009). Thus, it is essential to identify mothers at high risk for engaging in non-supportive response to negative emotions. Thus far, only one study to our knowledge has explored the intergenerational transmission of emotion socialization (Leerkes et al., 2020). Therefore, we extend prior literature by examining the association between mothers remembered non-supportive emotion socialization in childhood and their non-responsiveness to their own infants' distress at both 6 months and 1 year of life and possible indirect effects via mothers' beliefs about crying. The sample included 259 primiparous mothers (128 European American, 131 African America) and their infants (52% female). Expectant mothers completed a demographic questionnaire, which assessed mother's age, education level, family income and depressive symptoms. Also, mothers reported remembered emotion socialization experiences from childhood using the Coping with Children's Negative Emotions Scale (Fabes et al., 1990) and Parental Bonding Instrument (Parker et al., 1979); the non-supportive and emotion minimizing scales were standardized and combined to create a measure of non-supportive emotion socialization. When infants were 6 months, mothers reported their beliefs about infant crying via the Infant Crying Questionnaire (ICQ) (Haltigan et al., 2012) yielding two scores: infant oriented (IO; e.g., crying is how babies communicate, responses build trust) and mother oriented (MO; e.g., crying is a nuisance to mother and others) beliefs. When infants were 6 and 14 months, mothers completed the non-responsiveness subscale of the Maternal Responsiveness Questionnaire (Leerkes & Qu, 2016). Data were analyzed via path analysis (Figure 1). There were no

direct effects between remembered childhood non-supportive emotion socialization and non-responsiveness at 6 months or 1 year. Bootstrapped confidence intervals demonstrated two significant indirect pathways. Mothers higher in remembered childhood non-supportive emotion socialization had more mother orientated cry beliefs which in turn predicted higher non-responsiveness at 6 months (b = .075, 95% CI [.025, .168]), and this chain in turn predicted higher non-responsiveness at 6 months and at 1 year (b = .030, 95%CI [.009,.078]). Although, non-supportive emotion socialization in childhood predicted lower infant-oriented cry beliefs as predicted, infant-oriented cry beliefs did not predict non-responsiveness. Results demonstrated that non-supportive emotion socialization experiences in childhood were associated with more mother-oriented negative beliefs about crying ultimately predicting mothers to be non-responsive to infant distress at 6 months and this effect was carried forward to 14 months via the stability in maternal non-responsiveness. Thus, identifying mothers who experienced non-supportive emotion socialization in childhood and providing preventative interventions to reduce their mother-oriented cry beliefs may promote more adaptive parenting in infancy.

P2-I-242 - Motherhood constellation and maternal resiliency in mothers with newborns (van Bakel)

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Objective The transition to motherhood is a major life event for most mothers. Daniel Stern (1995) described the maternal transition phase as "motherhood constellation", a unique mindset held by the mother prior to the infant's arrival and sustained after birth. This unique mindset places the mother's main focus on her new identity as a mother. The constellation consists of four main themes that preoccupy the mother's thoughts: 1) the life growth theme entailing thoughts of the mother's ability to provide her infant with life and the sustenance it needs to grow; 2) the primary relatedness theme, which concerns cognitions about the emotional connection the mother develops with her infant; 3) the supporting matrix theme, which is the mother's need for a support system to ensure the emotional functioning of the infant and 4) identity reorganization theme, which involves the mother transforming her identity to one that can fulfill all of her duties. Although all mothers experience this constellation to some extent, we expect the presence of these themes to be related to mother's resiliency traits. Resilient mothers might adapt more easily to the challenges of motherhood. The main objective of this study is to explore the association between maternal resiliency and the four motherhood constellation themes. Methods Participants were 997 mothers (mean age 30.2) of newborns (mean age 11 weeks) that participated in the 'Baby 2020 Cohort Study' that was set up in June 2020 in the Netherlands and included mothers of infants born during the first peak and lockdown of the COVID-19 pandemic. Mothers filled in an online survey including several questionnaires. To assess mother's resiliency we included the Brief Resiliency Scale (Smith et al., 2008) and to measure the extent to which a mother deals with the 'motherhood constellation' we asked to report to what extent they agree or disagree (on a 7 point Likert scale) with the four themes, e.g. 'I am worried if I can love my child(ren) unconditionally' and 'I am worried whether I will be able to fulfil and integrate my other roles and/or identity (e.g. as a partner, son/daughter, friend, professional) in addition to parenthood' (Van Bakel & Rexwinkel, 2020). Results Correlational analyses indicated significant positive correlations between maternal resiliency and the four themes of motherhood constellation, i.e., Worries about life / growth ($r=-.17$, $p<.001$); relatedness ($r=-.13$, $p<.001$), support ($r=-.30$, $p<.001$), and identity , ($r=-.34$, $p<.001$), indicating that mothers who reported higher levels of resilience also reported to be less preoccupied with the specific

themes and their transitional experience as a new mom. Conclusion This study is among the first to assess Stern's (1995) motherhood constellation themes in mothers of newborns in a community based sample. Motherhood constellation is found to be related to maternal resiliency, even after controlling for confounding factors. Implications for further research and to prevention and psychological intervention in relation to new motherhood will be presented.

P2-I-351 - Examining the bi-directional relations between attention and temperament across the first two years of life (Bierstedt)

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Quickly recognizing and responding appropriately to potential threats in our environment is an adaptive mechanism for survival. While research suggests that attention to threat in infancy is normative (Yrttiaho et al., 2014; Peltola et al., 2009), a separate, but equally large literature suggests that biased attention to threat, as evidenced by rapid detection to threat and slower disengagement from threat, is linked to the development of anxiety-related behaviors later in life (Bar-Haim et al., 2007; Nozadi et al., 2016; Fu et al., 2019). Specifically, attention to threat moderates the relation between infant temperament and social withdrawal at 5 years of age (Pérez-Edgar et al., 2010). Further, attention biases 7 months predict social developmental outcomes at 24 months (Peltola et al., 2018). Despite evidence of these relations, it remains unclear when and how attention patterns first develop, and how they are shaped by other influences such as temperament. Here our goal was to examine the patterns of attention bias to threat across the first two years of life and whether patterns of temperamental social fear are associated with the development of those biases over time. We collected data from infants (N = 357) longitudinally at 4, 8, 12, 18, and 24 months of age. At all 5 time-points the infants participated in 2 eye-tracking tasks (vigilance and overlap) which measured different components of attention bias, and parents completed questionnaires assessing infant temperament. The vigilance task examined engagement with threat by measuring how quickly infants detected the presence of angry (threat), happy, or neutral facial configurations (Vallorani et al., 2021). Conversely, the overlap task measured infants' disengagement from threat by presenting infants with one of three emotional facial configurations (angry, happy, or neutral), immediately followed by a checkerboard probe that simultaneously appeared beside the face. For the first three time points, social fear was measured using the Infant Behavioral Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003), and for the final two time points, we used the Toddler Behavior Assessment Questionnaire (TBAQ; Goldsmith, 1996). Based on Goldsmith's recommendations and other work for measurement equivalence, we used 5 items that specifically measured infants' responses to strangers on the IBQ, and the social fear subscale on the TBAQ (r = .68; Goldsmith, 1996; Brooker et al., 2013). We will use a random intercepts cross-lagged panel model to analyze the data. We predict that measures of both attention bias and social fear will reflect a reciprocal relationship over time, such that greater attention bias at 4 months will predict greater social fear, which will in turn predict greater affect biased attention. Our goal is to examine stability within attention and temperament and estimate prospective prediction across constructs. In doing so, we hope to better understand the prospective and bidirectional relations between attention biases and temperament.

P2-I-352 - Longitudinal measurement invariance of caregiver depressive symptoms across the postpartum period and across race, education, income, and state (Padrutt)

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Depressive symptoms affect up to 19% of postpartum women (O'Hara, 2009). These symptoms are associated with infant development across key domains such as affect and behavior (Goodman et al., 2011). Thus, research examining caregiver depressive symptoms during the postpartum period has important implications for infant development. This research often involves examining longitudinal changes in symptoms. However, evidence of changes in symptoms over time has two potential interpretations. It may indicate true changes in depression levels across the postpartum period. Alternatively, it may reflect participants answering questions differently at different times, irrespective of depression level. The latter possibility is called differential item functioning (DIF) and creates bias by altering scores as a function of time, rather than true differences in depression. DIF results in scores with different meanings across time. DIF can also occur across sociodemographic groups, meaning that sociodemographic factors--not just depression--may influence how participants respond to questions and produce symptom scores with different meanings across groups. There is some evidence measures of depressive symptoms show DIF across time postpartum (Cunningham et al., 2015) or sociodemographic groups (Breslau et al., 2008; Di Florio et al., 2017). However, to our knowledge no studies have included more than two postpartum time points or simultaneously tested DIF across sociodemographic variables. Our study aimed to address this gap by examining DIF in the Brief Symptom Inventory-18 Depressive Symptoms scale (Derogatis, 2000)--a well-established measure of depressive symptoms--across four postpartum timepoints (2, 6, 15, and 24 months) and multiple sociodemographic variables. Specifically, after establishing consistent factor structure across time and groups, we fit moderated non-linear factor analytic models (MNLFA; Bauer, 2017) using longitudinal caregiver depression data from the Family Life Project (N = 1,292)--a prospective study of low-income rural families in North Carolina and Pennsylvania. MNLFA leverages advantages of multiple common methods for testing DIF into a single approach appropriate for continuous, categorical, time-varying, and time-invariant moderators. Our moderators were time postpartum, race, education, income, and state. Results (Figure 1) suggested DIF for three items. Specifically, controlling for latent depression, odds of endorsing item 2 (feeling no interest in things) increased across time postpartum and were higher for caregivers who were African American, had less education, and were from Pennsylvania. More affluent caregivers were less likely to endorse item 11 (feelings of worthlessness), and this item became more strongly associated with latent depression as income increased. Finally, caregivers with more education were more likely to endorse item 14 (feeling hopeless about the future). After adjusting for DIF associated with time postpartum, race, education, income, and state in these three items, only income was associated with latent depression. On average, less affluent caregivers reported more depressive symptoms. Our findings highlight the importance of examining DIF across time and across sociodemographic moderators to ensure valid measurement of depressive symptoms during the postpartum period. Doing so ensures that observed differences in depressive symptoms reflect substantive differences rather than measurement artifacts and will afford clearer interpretations of associations between caregiver depression and infant functioning.

P2-I-353 - The significance of mothers' neural responding to infant cues for caregiving behavior (Patrick)

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Sensitive responding to infant needs has enduring significance for children's socioemotional development (Raby et al., 2015), and mothers' cognitive processing of infant cues is thought to organize mothers' sensitivity (Fuths et al., 2017). Event-related potentials (ERPs) index specific stages of cognitive processing, and thus, are a useful tool for examining mothers' cognitive processing of infant cues in relation to parenting behavior. ERPs reflective of perception (N170) and attention (P300, LPP) have been implicated in parenting-related outcomes. However, findings across the literature have not been consistent. Specifically, meta-analytic evidence indicates that factors that pose risk for insensitive caregiving are linked with early perception (N170) of infant emotional expressions, but not later attentional biases (P3, LPP) (Bernard et al., 2018). One reason for the lack of consistent findings regarding the link between later attentional biases and caregiving might be that few studies in the literature have included observational assessments of caregiving behavior. Thus, we examined the significance of mothers' P300 - reflective of allocation of attentional resources - to their infants' emotional expressions (distress, happy, neutral) for direct observations of caregiving behavior. 140 mothers of 6-month-old infants attended two laboratory visits. Images of the mother's own infant displaying distress, happy, and neutral facial expressions were acquired during the first visit. During the second visit, mothers completed an infant emotion oddball task while brain activity was measured. Mothers viewed images of their own baby displaying distressed (25% of images), happy (25% of images), and neutral (50% of images) facial expressions. During one block of this oddball task, distress facial expressions served as the target stimulus and happy expressions served as the emotional distractor, and for the other block, happy facial expressions served as the target stimulus and distress served as the emotional distractor (counter-balanced). Maternal parenting behaviors were observed during a free play context (i.e., play with no toys). Interactions were coded for sensitivity, intrusiveness, detachment, positive regard, negative regard, and dyadic mutuality using scales adapted from the NICHD Study of Early Child Care (Frosch & Owen, 2016). The P300 to infant emotional expressions was extracted for analyses. Findings indicated that heightened P300 amplitude reactivity when viewing the distracting emotional expressions (i.e., distress and happy distractors vs. neutral) is associated with poorer parenting behavior, including less sensitivity ($r = -.25$), less positive regard ($r = -.26$; i.e., positive emotion, affection toward the infant), and less dyadic mutuality ($r = -.26$; i.e., synchrony). Such evidence suggests that heightened attention to all infant emotional cues does not necessarily support parenting behavior. Instead, these results indicated that mothers who are distracted by extraneous emotional information display lower quality parenting toward their infant. This study also extends prior research (Bernard et al., 2018) by demonstrating that mothers' ERPs reflective of late-stage attentional biases in the processing of infant emotional cues is associated with direct observations of parenting behavior.

P2-I-354 - Prenatal Group Care as a Facilitator of Maternal Mental Health Screening (Norcross)

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Group-based prenatal care is associated with many health benefits; however, little research has examined the impact of group-based care on maternal mental health. Further, little is known under which conditions social support programs during pregnancy, such as CenteringPregnancy, may affect depressive symptoms during the postpartum period. CenteringPregnancy is a group-based prenatal care model in which pregnant women are grouped by gestational age with other pregnant cohorts, and meet their provider and peers for 10 prenatal appointments, and 1 six-week postpartum appointment. Despite the common prevalence of depressive symptoms throughout pregnancy, research indicates that women are not consistently screened for symptoms during the postpartum period (Gjerdingen&Yawn,2007). Group-based prenatal care may be an essential intervention for improving maternal mental health outcomes by providing consistent support throughout pregnancy and a systematic approach for mental health screening after birth. Thus, the present study examined the effects of group-based prenatal care on postpartum depression scores, and receipt of postpartum screening. A secondary data analysis was performed on de-identified medical records from a multisite obstetrics practice in the southeastern US. for patients between May 7, 2015 and December 31, 2020 (N = 3095). Demographic variables included maternal age, race (White=0, racial minority=1), partner status (partnered=0, single=1), prenatal care type (care-as-usual=0, CenteringPregnancy=1), and insurance type (private=0, Medicaid=1). The Edinburgh Postnatal Depression Scale was utilized to collect depressive scores at 6 weeks postpartum. First, a linear regression (N= 2138) model examining the effects of demographics and type of prenatal care on postpartum depression scores at 6 weeks postpartum revealed that group-based prenatal care predicted postpartum depression scores (B= 0.65, SE =.21, p= .002; See Table1). Results indicated that CenteringPregnancy patients had a significantly higher postpartum depression scores (M= 4.66, SD= 3.69) at 6 weeks compared to patients who received prenatal care as usual (M= 4.09, SD= 3.71); t(2422)= 2.83, p= .005, 95% CI = 0.18-0.98; suggesting that developing patient trust in providers is a key component to effective screening and treatment of postpartum mood disorders. A logistic regression examining factors associated with receipt of a postpartum mental health screening (N=3096) included demographic variables, such as maternal age, race, partner status, insurance type, and prenatal care type (see Table2). The resulting model was significant, $\chi 2(5) = 34.05$, $p < .001$, Nagelkerke R2 = .015. Factors associated with receipt of postpartum screening were group-based prenatal care (OR= 1.56; 95% CI = 1.24-1.97; p= .001), and partnered relationship status (OR= 0.72; 95% CI = 0.59-.088; p= .002). Results indicated that mothers who participated in CenteringPregnancy were more likely to receive a mental health screening and report depressive symptoms, compared to mothers receiving prenatal care as usual. Findings also suggested that it was more likely for mothers to receive mental health screening if they were partnered rather than being single. Thus, social support is important during pregnancy, and increases the likelihood of receiving a mental health screening postpartum, as well as creating strong, collaborative relationships between patient and providers.

P2-I-355 - The role of mother-infant emotional synchrony in speech processing in 9-month-old infants (Vanoncini)

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Interactions between mothers and their infants are characterized by regular and recurring cycles of behavior and affective expressions. These rhythmic patterns might elicit the temporal alignment of

behavioral states (i.e., interpersonal synchrony), such as the matching of affective expressions (Feldman et al., 2011). Similarly, language is rhythmic. Infants are sensitive to speech rhythm, which helps them to segment words from fluent speech (Jusczyk et al., 1999). Moreover, infants' ability to perceive rhythm (Höhle et al., 2014) and their word segmentation ability (Junge et al., 2012) predict later language outcomes. The present study aimed at investigating whether and how mother-infant emotional synchrony contributes to infant language development (for the preregistration, see https://aspredicted.org/LDZ_8NT). We hypothesized that more frequent and longer episodes of emotional synchrony are linked to better word segmentation at 9 months of age. Data of twenty-six 9-month-old infants (M=298.23 days, SD=11.57, 12 females) and their German-speaking mothers (M=32.65 years, SD=5.18) were included in this study. To measure behavioral synchrony, we video-recorded 5 minutes of free play interactions between the mothers and their infants, which were then coded for positive, neutral and negative emotional expressions (Feldman et al., 2011). Infants' word segmentation ability was examined with a central fixation paradigm (Cooper & Aslin, 1990) using eye-tracking. We familiarized infants with auditory text passages in German containing two target words. In test trials, we presented infants with both the familiar target words and novel words. We measured infants' looking times (LTs) while listening to novel and familiar words to examine whether they segmented the words from the passages. For statistical analysis, we applied step-wise linear regression modelling to test for effects of emotional synchrony. Log transformed LTs by trial at test were used as dependent variable. Frequency of emotional synchrony (i.e., the number of co-occurrences) and proportion of emotional synchrony (i.e., the total duration of emotional synchrony divided by the total duration of interaction) were included as fixed effects in separate models. Other fixed effects were trial type (novel vs. familiar) and total LT during the familiarization phase. Participant was included as random effect. Results revealed that neither frequency nor proportion of emotional synchrony interacted with trial type. Interestingly, the frequency of emotional synchrony, but not its proportion, interacted with the total LT during familiarization: infants synchronizing more often with their mothers, who also have longer LTs during familiarization, show longer LTs at test (Figure 1). Finally, total LT during familiarization interacted with trial type: infants showing longer LTs during familiarization preferred familiar words at test, while the others preferred novel words, suggesting individual differences in segmentation performance (Figure 2). These findings suggest that getting in emotional synchrony rather than staying in synchrony during interactions might be associated with infants' listening to speech. Our study highlights the relevance of exploring the role of shared emotions in communication and language development.

P2-I-356 - Maternal and paternal parenting stress as predictors of infant internalizing and externalizing behavior problems (Lapolice Thériault)

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For the majority of adults, parenthood brings about great joy. However, being a parent also involves a lot of adaptation (Doss, 2017). Faced with these challenges, the perception of not having enough resources, skills, or knowledge to meet the demands of one's role can lead to a feeling of stress specific to parenting known as parenting stress (Deater-Deckard, 1998). Parenting stress is an important phenomenon, as indicated by its predictive role in a variety of child outcomes (Holly, 2019). In particular, the associations between parenting stress and child socio-emotional functioning, notably the

presence of internalizing and externalizing behavior problems, is robustly supported (e.g., Crnic et al., 2005; Mackler et al., 2015; Stone et al., 2016). However, the vast majority of the literature has focused on mothers? parenting stress. This is an important shortcoming, as it is now well established that both parents experience comparable levels of parenting stress (Deater-Deckard & Scarr, 1996; Solmeyer & Feinberg, 2011) and contribute complementarily to child development (Volling & Cabrera, 2019). Also, to take into account the systemic aspect of the family, one needs to analyze not only the additive but also the interactive effects of both parents on child outcomes (Cabrera et al., 2018). Thus, we aimed to examine both the additive and interactive effects of maternal and paternal parenting stress in the prediction of child internalizing and externalizing behavior problems. The sample consisted of 158 French Canadian children (51.9% boys) and both their parents. Fathers and mothers completed validated questionnaires during two home visits. To assess parenting stress, both parents completed the Parental Stress Index - Short Form (Abidin, 1995) when their child was 18 months old. Internal consistency was adequate for both mothers (α = .88) and fathers (α = .90). To assess child internalizing and externalizing problems, both parents completed the Child Behavior Checklist (Achenbach et al., 1999) when children were aged 4 years. Internal consistency was adequate for internalizing (α mothers = .83; α fathers = .83) and externalizing problems (α mothers = .90; α fathers = .90). Given their inter-correlations (both rs > .49), maternal and paternal reports of child behavior problems were averaged. Two multiple regressions were computed, one for externalizing and one for internalizing problems. These analyses suggested that after accounting for child sex and family SES, paternal (β = .30, p = .030) but not maternal parenting stress (β = .16, p = .203) uniquely predicted child externalizing behaviors. Furthermore, there was a significant interaction between paternal and maternal stress (β = -.17, p = .047), which was broken down with the PROCESS macro. These analyses indicated that paternal parenting stress predicted more child externalizing behaviors at most levels of maternal stress, but this association was no longer significant (p = .279) when maternal stress was very high (at or above the 90th percentile). No significant results emerged with internalizing problems. In sum, the results of this longitudinal multi-informant study suggest that paternal parenting stress may be of salient importance in the development of child externalizing behavior problems.

P2-I-357 - Infant attachment dimensions and behavioral inhibition as predictors of childhood anxiety (Morra)

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Mother-infant attachment style and infant behavioral inhibition have been shown to be related to the development of childhood anxiety (particularly social anxiety and its precursor in early development, separation anxiety), but relations among the three are not always consistent, and more longitudinal work is needed (Manassis & Bradley, 1994; Shamir-Essakow, Ungerer, & Rapee, 2005; Lewis-Morrarty et al, 2015). Growing evidence supports the idea that attachment may be more stable over time when considering the underlying dimensions (i.e. proximity versus avoidance and resistance) rather than categorically (i.e. secure, insecure-avoidant, insecure-ambivalent) (Fraley & Spieker, 2003). To our knowledge, no studies have tested attachment dimensions as longitudinal predictors of childhood anxiety. In the current study, we investigated the moderating effect of infant behavioral inhibition on the relation between mother-infant attachment dimensions and childhood anxiety. Data were collected as part of a longitudinal study investigating maternal and infant emotional development. Participants

were 134 mother and infant dyads (43.3% female infants, 84.3% White). At infant age 12-15 months (M=14.13, SD=1.25) infant attachment style was assessed using the Strange Situation Procedure (Ainsworth et al., 1978), and behavioral inhibition was measured using a well-established standardized protocol (Fox et al., 2001). Standard scoring procedures were completed by trained, reliable coders. Following Fraley and Spieker (2003), an attachment proximity dimension comprised proximity-seeking, contact-maintenance, and reverse-scored avoidance across the two reunions; a resistance dimension represented the average resistance scores across the two reunions. When children were 5-6 years-old (M=64.10 months, SD=4.43), mothers reported their children's social and separation anxiety with the Parent Preschool Anxiety Scale (Spence et al., 2001). Four moderation models (Table 1) were analyzed using the PROCESS macro for SPSS (Hayes, 2013). Participants with complete data (n = 64) were analyzed; multiple imputation will be used to analyze the full sample for conference presentation. The first model revealed a significant interaction between the proximity dimension and behavioral inhibition in relation to separation anxiety (Figure 1): proximity related to anxiety at low (b=0.32, SE=0.11, t=3.08, p=.003) and mean (Table 1), but not high (b=0.02, SE=0.10, t=0.18, p=.861) behavioral inhibition. Second, there was a similar interaction between resistance and behavioral inhibition in relation to separation anxiety. Resistance predicted anxiety at low (b=0.28, SE=0.11, t=2.62, p=.011) and mean (Table 1), but not high (b=-0.07, SE=0.09, t=-0.75, p=.457) behavioral inhibition. In the third and fourth models, which predicted social anxiety, interactions and simple effects were in the same direction but only marginally significant. These findings suggest that for infants with low to moderate behavioral inhibition, the proximity and resistance dimensions of attachment are relevant indicators of risk for separation anxiety. The marginally significant social anxiety models suggest that a similar pattern may emerge with social anxiety, but perhaps more strongly in older children, when social anxiety becomes more prevalent (Stein & Stein, 2008). Taken together, this research stresses the importance of investigating relational and temperamental risk factors for anxiety in infancy.

P2-I-358 - Mothers' Perceptions of Parenting by Their Own Mothers and Fathers: A Pattern-Based Approach to Examining Links with Maternal and Infant Outcomes (Parade)

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The way women remember being cared for by their mothers is an important predictor of the quality of the current mother-infant relationship, which is a cornerstone of healthy infant socioemotional development (Lomanowska et al., 2017; Narayan et al., 2021). Additionally, recollections of parental rearing are associated with relationship satisfaction (e.g., Chen & Busby, 2019) and depressive symptoms (e.g., Kullberg, 2020), two factors that are sensitive to change during the perinatal period and are important for the entire family system and developing infant (Parade et al., 2014). However, most research has focused on recollections of maternal rearing, neglecting the role that fathers play in development across the lifespan (Cabrera et al., 2018). Mothers and fathers affect one another's parenting and together influence the larger family context and child adjustment, underscoring the need for a family network approach when investigating relational and developmental research questions (Dagan & Sagi-Schwartz, 2018). Assessing women's perceptions of the care they received in childhood from both parents may reveal the relative importance of mothers versus fathers as well as the totality of childhood rearing experiences in relation to key outcomes. Thus, this study combined data from two

longitudinal projects of mothers in the perinatal period to identify patterns of recalled parental rearing by both parents (measured using a revised version of the Parental Bonding Instrument [Leerkes & Siepak, 2006; Parker et al., 1979]) and examined how these profiles differentially related to maternal and infant outcomes. The sample consisted of socioeconomically and racially/ethnically diverse mother-infant dyads (N = 466) assessed in pregnancy and at 6 and 12 months postpartum. We conducted a latent profile analysis (LPA) to identify distinct profiles of parental rearing in childhood by both parents (see Tables 1 & 2). Covariates were included while forming the profiles (i.e., sample, maternal age, race/ethnicity, marital status, employment, education, status as a first-time mother). Consistent with the four family network configurations described by Dagan and Sagi-Schwartz (2018), LPA derived four distinct profiles of recalled parental rearing: two supportive parents, two unsupportive parents, a supportive mom but unsupportive dad, and a supportive dad but unsupportive mom. Results showed that mothers who recalled two supportive parents demonstrated higher levels of observed maternal sensitivity and lower levels of self-reported parenting non-responsiveness with their own infants compared to mothers who recalled two unsupportive parents. Further, mothers who recalled two supportive parents had higher levels of relationship satisfaction with a romantic partner, were less likely to have clinically significant depressive symptoms, and had infants with lower levels of socioemotional problems compared to mothers classified into the other three profiles. These findings highlight the importance of assessing mothers' memories of their father's caregiving in addition to their mother's caregiving, as the totality of caregiving experiences was related to a host of outcomes for mothers and their infants. Overall, results suggest that recalling two supportive parents is associated with positive adjustment, and that recalling only one supportive parent largely may not prove beneficial for mothers or their infants over and above recalling no supportive parents.

P2-I-359 - Toddler Impulsivity: Validating Behavioral Markers in a Novel Social Context and Links with Infant Surgency (Kobezak)

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Broadly, impulsivity has been identified as a transdiagnostic risk factor for externalizing psychopathology, and specifically, has been linked to elevated risk for the emergence of ADHD. Validly measuring impulsivity early in life would enhance opportunities to identify young children at risk of externalizing difficulties and provide opportunities to identify even earlier factors associated with toddler impulsivity; however, measuring impulsivity in early childhood is challenging to do at a behavioral level of analysis. This challenge emerges because behavior indicative of impulsivity may alternatively be indicative of poor top-down control - processes that have different neural substrates than impulsivity. In the current study, we aimed to provide evidence that impulsivity can be identified behaviorally in the context of a controlled laboratory situation - the stranger approach task - that typically is utilized to measure inhibited/fearful/shy behavior (i.e., behavior opposite to that which is indicative of impulsivity) from young children. To do so, we added a new behavioral code, communicative approach, to the standard Lab-Tab coding scheme for this task, which already included an "Approach" code, which we termed physical approach because this code only captures behavior involving the child physically moving closer to the stranger. We expected communicative and physical approach to be related, and for these codes to be related to maternal reported toddler impulsivity. Next, we considered links between maternal reported infant surgency and toddler impulsivity, providing

additional evidence of validity of impulsivity and of continuity between infant surgency and toddler impulsivity. Participants consisted of 179 mother-child dyads involved in a longitudinal study. Mothers completed the IBQ-R when children were 12 months of age, from which the subscales of high intensity pleasure, activity level, and approach, loading onto the Surgency factor in factor analytic work, were indicators of a latent variable of Surgency. Mothers completed the ECBQ, which includes an impulsivity subscale, and toddlers participated in a stranger approach task in the laboratory when children were 18 months of age. FIML estimation was used in all analyses to handle missing data. Physical and communicative approach were strongly related, $r = .47$, $p < .001$. Subsequently, a CFA was employed to examine the association between a latent variable of behavioral impulsivity, with behavioral and communicative approach codes used as indicators, and a latent variable of maternal report of impulsivity, developed using three item parcels for indicators. Model fit was adequate (Figure 1) and the association between maternal report of toddler impulsivity and behavioral impulsivity, $b^* = .39$, $p < .01$, supported the validity of the behavioral impulsivity codes. In the final SEM, maternal report of impulsivity and the behavioral impulsivity codes were employed as indicators of a latent variable to examine the association between infant surgency and toddler impulsivity. Model fit was good (Figure 2). There was a strong association between infant Surgency and toddler Impulsivity, $b^* = .55$, $p < .01$, demonstrating continuity between infant surgency and toddler impulsivity, and further supporting the validity of our approach to assessing toddler impulsivity. The implications of these findings, and important future directions, will be discussed.

P2-I-360 - Emotion recognition from mother to child: the impact of a maltreatment history (Noémie)

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Emotion recognition involves both the perception and identification of emotional expressions presented by others (Priel et al., 2020). A multitude of factors can influence the development of these skills. Among others, some studies trace a positive link between the recognition of the parent's emotions and that of their child (Castro et al., 2015). Moreover, childhood maltreatment has important effects on individuals. Notably, maltreatment is related to difficulties in emotion recognition during childhood (Pollak et al., 2000). This effect is long lasting. Parents with a history of maltreatment have more difficulty recognizing emotions in children's faces (Turgeon et al., 2020). Furthermore, for mothers who experienced severe childhood maltreatment, good emotion recognition skills are associated with weaker sensitive behaviors (Bérubé et al., 2020). The present project aims to investigate the transmission of emotion recognition from parent to child while taking into account the parent's history of childhood maltreatment. A sample of 36 mothers and their children aged between 30 and 60 months ($M = 51.22$, $SD = 9.59$) came to the laboratory to participate in a series of activities. Maternal and child emotion recognition tasks were used. Mothers were presented with child's faces displaying two different emotions morphed onto the same image at different percentages of intensity. Mothers had to identify the dominant emotion. Children were presented with adult female faces showing a morphed emotion of joy with a negative emotion. The child had to indicate whether the woman was "happy" or "not happy". The short version, translated and validated in French, of the Childhood Trauma Questionnaire (CTQ; Paquette et al., 2004) was used to verify childhood maltreatment in the mother's history. A moderation analysis was performed to test the moderating effect of childhood maltreatment on the relationship between the emotion recognition abilities of mothers and their child. The model and the interaction between the

mother's recognition of emotions and her experience of abuse is significant. Analysis of simple slopes revealed that contrary to mothers with no or low childhood maltreatment experience, for mothers who experienced severe maltreatment, good emotion recognition is related to poorer emotion recognition in the child. These results are consistent with research indicating that mothers with a traumatic past could react to children signals by disengaging from the relation, thereby diminishing opportunities for children to learn from the dyad. Interventions aimed at supporting these mothers should be considered.

P2-I-361 - Infant Attention to Emotional Faces and Maternal Emotion Recognition Across the First Year of Infancy: An Exploratory Study (Dela Cruz)

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Numerous studies have examined underlying processes that give rise to infants' ability to discern and direct their attention to different emotions (Fu et al., 2019 & Miguel et al., 2019); however, how factors outside the infant, such as their primary caregiver's emotional abilities, may shape their emotional development remains an area that warrants further exploration. The current study examines how mothers' emotion recognition skills may be linked to their infants' attention to emotions across time. One study found a link between parents' emotion recognition skills and their children's (i.e., 8- to 11-year-old) emotion recognition abilities (Castro et al., 2014), which informs our hypothesis of anticipating a relationship between maternal emotion recognition and infants' attention to emotions. Furthermore, according to the transactional model that suggests that development unfolds through continuous dynamic interactions between the child and their environment (Sameroff, 2009), we anticipate a bidirectional reciprocal relationship between maternal emotion recognition and infants' attention to different emotions. Lastly, we hypothesize consistent stability in maternal emotion recognition and infants' attention to emotion across multiple timepoints. This study draws upon a diverse sample and relevant measures from a larger longitudinal study that explores socio-emotional development in infancy (N=107; see Table 1 for sample demographics). We will examine three timepoints when the infant was 5, 7, and 14 months old. The infants completed an eye-tracking preferential looking task, where they were presented with neutral and an emotional face (i.e., angry, fear or happy) side-by-side in an individual trial. We will be using the infants' initial fixation latency to the emotional face. The mothers completed the dynamic emotional expression recognition task (DEER-T) that measured their emotion recognition. Mothers were instructed to identify the emotion quickly and accurately when watching photographic stimuli of actors' faces dynamically morph from neutral into the full emotion. We will be examining the mothers' reaction times of the correct answers only for the angry, fear, and happy emotions to align with the infant emotion task. We used a cross-lagged panel analysis to examine the longitudinal and reciprocal relationships between maternal emotion recognition and infants' attention to emotions across time. We first transformed the reaction times and latency data using the Box-Cox method to correct the positive skewness and normalize the distribution (Box & Cox, 1964). We used the Lavaan package in R (Rosseel, 2012) to execute the cross-lagged panel analysis with full information maximum likelihood estimation (FIML) to account for the attrition across the waves. Figure 1 provide model fit statistics and full results for the cross-lagged models for each emotion. We found that infants' attention for fearful faces at Wave 1 predicted their looking times for the same emotion in Wave 3. However, we observed inconsistent stability in infants' attention to angry and happy faces across the timepoints. We found that mothers had greater stability in emotion recognition for each emotion across

the timepoints. The current study is among the first to incorporate behavioral measures to examine emotional abilities across the first year of life within the infant and mother dyad.

P2-I-362 - Evaluation of a Collective Reflexive Coaching Device to Sustain Early Childhood Education Managers Well-being during COVID-19. (Fortin)

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Background. Work well-being of early childhood education and care (ECEC) managers is essential to provide educational quality services to children (Corr et al., 2017). If some factors are known to influence work well-being, such as job stress, burnout, depressive symptoms, self-compassion, and work engagement (Cumming & Wong, 2019; Rothmann, 2008; Zessin, 2015), COVID-19 pandemic appears to be deleterious (Bigras et al., 2021), particularly because of the frequent adjustments induced by public health measures and staffing shortages. In a previous study, ECEC managers expressed a need for support to face the challenges encountered during the pandemic (Bigras et al., 2021). To meet their need and support their work well-being, a professional coaching process, through a collective reflexive group, had been implemented (Bigras et al., 2021). Coaching modalities involving reflective practice were included to ensure its effectiveness, considering its value for dealing with complex problems, as ECEC managers did since the pandemic (Susman-Stillman et al., 2020). Objective. This study aims to evaluate the effects of a collective reflective coaching device intended for ECEC managers on the factors linked with work well-being (self-compassion, work-related stress, burnout, depressive symptoms, and work engagement) during the pandemic. Methods. This research uses a quasi-experimental design (pre-post) with a control group. Experimental group involves 39 ECEC managers from some regional areas in Quebec (Canada) and was recruited with the help of the regional grouping of ECEC of Monteregie. The experimental group, divided in four subgroups, met for three hours every four weeks between February and June 2021. The meetings focused on topics based on managers' needs to support their work well-being (e.g., stress, self-compassion, self-care). Control group involves 43 ECEC managers from the same regional areas recruited by email. Quantitative data were collected with an online questionnaire (LimeSurvey) completed before the first meeting and after the last one for both experimental and control groups. Social desirability was measured for the two groups, at both pre and post times. Results. ANCOVA analyses controlling for pre-test scores were conducted. Since the control group (M = 0.71, SD = 0.19) had higher pre-test score on social desirability than the experimental group (M = 0.61; SD = 0.16), t(79.115)=-2.561, p=0.012, we controlled for this variable. Preliminary results indicated that each variable is explained by the pre-test scores (p>0.001). Also, the descriptive data at pre-test indicated that participants in experimental group had lower pre-test scores and that they tended to reach the means score of control group on post-test scores for each variable. Conclusion. Preliminary results suggest that reflective support system could be beneficial to improve well-being of ECEC managers through COVID-19 because theirs scores improved between the beginning and the end of the meetings. It is possible that participants in the experimental group joined the program because they needed support for their well-being. Nevertheless, since managers must perform their job with high quality in ECEC, it seems imperative to ensure that they receive all the support and resources they need to mitigate negative influences of the pandemic on their well-being.

P2-J-243 - Pregnant women and their prenatal care in the United States: Associations with adverse infant birth outcomes (Nordgren)

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Infant health continues to be a compelling and urgent topic in the United States with prenatal care at its forefront for prevention of adverse birthing outcomes. In the United States, roughly 10% of infants are born preterm and nearly 13% are born low birthweight (LBW) putting them at a heightened risk for placement in neonatal intensive care units (NICU) and future developmental consequences (Thielen, 2012). Although 95% of pregnant women engage in prenatal care (Currie & Rossin-Slater, 2015), the characteristics of mothers and the quality of their care often vary. This study explored differences in adverse infant birth outcomes related to the sociodemographic backgrounds of mothers and their prenatal care experiences. Data was analyzed from the publicly available Listening to Mothers III dataset. Comprised of 2400 online-survey participants who gave birth in U.S. hospitals between July 2011 and June 2012, the fully female sample is nationally representative. Infants of mothers belonging to various sociodemographic backgrounds were compared on measures of gestational age, birthweight, and NICU admittance. Structural equation modeling was employed with full information maximum likelihood to account for missing data. The model examined mediators of structural conditions of prenatal care (i.e., week of first visit, duration of visits, group prenatal care) and the quality of provider behavior between maternal predictors and infant outcomes. Of infants born to mothers in the sample, 7% were born preterm, 7% were born LBW, and 15% were admitted to the NICU. Significant associations were found between maternal predictors and both the prenatal care experience mediators and infant outcomes (see Figure 1 for significant associations at $p < 0.01$; see Table 1 for direct, indirect, and total effects). Unexpectedly, mothers involved with group prenatal care had a 5% and 18% increase in likelihood of their infant being born LBW and spending time in the NICU, respectively. Income below 200% of the poverty line was the only variable that positively predicted preterm births ($p < 0.05$). Maternal race/ethnicity, primiparous status, and perceived depression had the strongest total effects for infants spending time in the NICU, while income, marital status, and education showed no significant total associations for the same outcome. This finding runs contrary to the emphasis that is often placed on socioeconomic indicators in developmental and child health research. Given the detrimental developmental effects of poor birthing outcomes, mothers and prenatal care providers need to be aware of factors that can put infants at risk. This study indicated that several racial/ethnic disparities still exist within prenatal care, even when controlling for key socioeconomic indicators as most evidenced by the effects between the race/ethnicity groups and NICU admittance. Additionally, involvement in group prenatal care had robust negative associations with LBW and NICU admittance, even when controlling for sociodemographic characteristics and maternal depression. Our results indicate a need to address persistent racial/ethnic disparities beyond the socioeconomic, and further examine why group prenatal care was associated with poorer infant health outcomes despite the extensive list of controls.

P2-J-244 - Cultural Relevance of a Parent-Mediated Intervention for Infants at High Likelihood of Neurodevelopmental Disabilities (DuBay)

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Infants and toddlers with significant developmental needs may best be served in their own natural environments to maximize intervention quality and relevance. Parent-mediated intervention (PMI) is a common format for intervention in this population, where parents are taught therapeutic strategies to use at home to support their child's development (NRC, 2001). Most research developing early PMIs was conducted with white, mid-high SES, monolingual English-speaking families (Trembath et al., 2019), with few studies examining diverse populations. If parents are expected to incorporate therapeutic strategies within their parenting routines that are not aligned with families' cultures, there is potential for cultural incongruence and reduced participation or engagement (Parra Cardona et al., 2009). The central purpose of this study is to examine how elements of a PMI for autism align with the range of cultures of Latin American Spanish-speaking families in the US. Our research questions included: What aspects or topics of the intervention foster the most engagement and learning among Latin American families? What barriers or facilitators to attendance and participation do Latin American families experience? and How do Latin American families perceive the relevance of a PMI for infants and toddlers at high likelihood of neurodevelopmental disorders? Seven Spanish-speaking families with 10-18-month-old children at medium or high likelihood for a neurodevelopmental disorder according to a community screen participated in a virtual, short-term, waitlist-style intervention. CITAS (Communication Interaction Training on Autism for Spanish-speaking caregivers) was implemented as a four-session PMI designed to increase caregiver knowledge and social support, and to improve the quality of parent child interaction (Guerra et al., 2019). CITAS incorporates many elements designed to align with this cultural group, including a group-based format, dedicated social time, and a culturally matched interventionist. Qualitative examination of how families perceive these features and others will help determine which elements align with cultural patterns, strengths, and resources, which are most valuable to families, and which require further adaptation. Data was collected via focus groups, individual interviews, attendance rates, qualitative engagement, and live reactions to materials and delivery methods. Preliminary findings revealed that topics related to bilingualism, behavioral characteristics and needs of the infant and older siblings, access to services, and family stressors prompted the most engagement among attendees. Families identified several aspects of the intervention that fostered participation and learning, including the group format of the intervention and video models to present specific strategies to use with children. Significant barriers to both active participation and attendance were also noted, including family and childcare duties and technical difficulties. The features that facilitated attendance, participation, and engagement in the intervention should be considered as ways to potentially modify existing PMIs for Latin American families. Fully powered randomized controlled trials could then examine what benefit these modifications may add to the effectiveness and experience of parent-mediated intervention, as compared to original un-adapted intervention content. These and other specific clinical implications will be discussed.

P2-J-245 - Risk of Prenatal Depression and Anxiety Symptoms on Birth Outcomes: Role of Maternal Race and SES (Marroquin Aparicio)

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There are various physiological and psychosocial changes that occur during pregnancy. Therefore, the prenatal period is one of increased vulnerability to psychiatric mood disorders such as maternal anxiety and depression (Smith et al.,2011). Perinatal mood disorders are characterized by psychological symptoms (e.g.,excessive worry, hopelessness) that significantly interfere with functioning during pregnancy. Prenatal mood disorder symptoms affect approximately 20-25% of new mothers and are associated with adverse birth outcomes, including low birth weight and preterm birth (NationalPerinatalAssociation,2018). We extend prior literature by examining how prenatal mental health symptoms, specifically those of anxiety and depression, impact the risk of developing labor and birth complications. This study consisted of a secondary data analysis on de-identified medical records (N=3609) from a multisite obstetrician-gynecologist practice in urban NC. The records contained demographics information including maternal age, minority status, and insurance type (0=Medicaid, 1= private). Medical information such as mental health screening data and birth information, including complications, were also included. Prenatal mental health consisted of anxiety and depression symptoms assessed at 28 and 36 weeks using the following measures: Generalized Anxiety Disorder 7(GAD-7), Patient Health Questionnaire(PHQ), Edinburgh Postnatal Depression Scale(EPDS). Analysis consisted of two multistep logistic regression models to estimate the odds of labor and birth complications (e.g., preeclampsia, placenta previa). Demographic information (e.g., maternal age, race, and insurance type) was included as the first step in each model. The second step included prenatal depression(model 1) or anxiety(model2) scores. Out of 3,609 participants, n=347 participants for depression and n=51 participants for anxiety met inclusion criteria and were included in each of the analysis. SPSS software was used to determine descriptive statistics of the study participants(see Table1). Results indicated elevated anxiety symptoms to be to be a predictor of labor complications (OR=1.523{95% CI=1.055, 2.197}p=.025), but not depression symptoms (OR=1.024{95% CI=.974, 1.078}p=.349). Additionally, the likelihood of labor complications increased for each additional point on the GAD-7 score. It was also found that racial minority mothers (N=13) are more likely to experience labor complications (OR=7.74,{95% CI=1.482, 1498.606},p=.029). Lastly, patient's health insurance, a proxy for financial resources, was also a significant predictor of labor complications (OR=.027,{95% CI=.001, .804}p=.037). In sum, these findings help clarify the connection between prenatal mental health and birth outcomes. Currently many prenatal mental health assessments only screen for depression and not anxiety symptoms; however, this study found depression to not be a significant predictor of birth complications. Typically, prenatal assessments only include measures such as the EPDS and PHQ, neither of which detect anxiety symptoms. This study found that anxiety is a significant predictor of labor complications especially for racial minority mothers, and mothers with low financial resources, therefore, prenatal screenings should include an anxiety scale such as the GAD-7. Doing so could potentially allow for early intervention of anxiety symptoms, leading to earlier treatment, thus, improve adverse birth outcomes.

P2-J-246 - Comparison of Gut Microbiota Diversity in Breastfed, Formula-fed, and Mixed-fed Infants at 3 and 9 Months (Salahin)

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The gut microbiome plays a crucial role in human health, and begins its dramatic and dynamic development from the moment we are born. Some evidence suggests the gut microbiome influences

neurodevelopment and could be linked to cognitive outcomes during infancy (Carlson et al., 2018). Various environmental factors influence the initial colonization of gut microbes during this period, including feeding methods. Some research has been done to understand how breastfeeding, formula-feeding, and mixed-feeding (breastfeeding and formula-feeding) impact the composition of the gut flora in infants. Such research has demonstrated gut bacterial diversity is higher among babies who are formula-fed and mixed-fed than babies who are breastfed (Moore & Townsend, 2019; Ma et al., 2020). However, these early processes are still not well documented, especially with regard to how changes in environmental factors can impact microbial development across infancy. Given the existing research, we hypothesized that infants who are primarily formula-fed or mixed-fed would have greater gut microbial diversity compared to infants who are primarily breastfed, and that infants who increase their formula intake over-time will have greater gut microbial diversity than infants who are breastfed or increase their breastfeeding over-time. Families (n = 62) were recruited from the New York City Metropolitan area and reflect a wide range of economic backgrounds (annual household income: $13k - $350k). Mothers completed a survey on infant feeding at 3 and 9 months of age. We asked mothers, "To what extent do you breastfeed or use formula for your baby?" Our participants could then answer "I only breastfeed," "I mostly breastfeed," "I breastfeed half the time and use formula half the time," "I mostly use formula," or "I only use formula." We collected stool samples when infants were 12-months to assess gut bacterial diversity. The Chao1 index estimates total richness or abundance of bacteria, whereas the Shannon index reflects both richness and evenness or the distribution of bacteria. First, we grouped infants based on survey responses at both time-points. Group 1 included mothers who only or mostly breastfed; Group 2 included mothers who only or mostly used formula; and Group 3 included mothers who breastfed half the time and used formula half the time. Replicating past studies, at both time-points babies who had some exposure to formula were more likely to have higher microbial diversity (Shannon: p's < 0.022, Chao1: p = 0.022). There were significant differences between groups across time [Shannon index: $F(4, 44) = 4.791$, $p = 0.0027$], with infants who were only or mostly formula-fed having higher gut bacterial diversity than infants who were only or mostly breastfed at both 3 and 9 months of age (p = 0.011). Infants whose mothers did half and half at 3 months and then used mostly or only formula at 9 months also had higher gut microbial diversity than infants whose mothers breastfed at both time-points (p = 0.047). Altogether, these findings suggest that infants who are more formula-fed have higher gut bacterial variability than infants who are mostly breastfed, and infants with increased formula feeding over-time may have an increase in gut microbial diversity.

P2-J-363 - Innovative Improvements in Home Visiting: Promoting Father Engagement and Enriched Literacy Environments (Treat)

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Introduction Positive father involvement early in life influences children's developmental outcomes and well-being. These contributions may be especially important when children face additional risk factors such as academic and social risk or maternal depression (Gutterman et al., 2018; Henry et al., 2020). Historically, parenting programs have overlooked fathers in the development of program content and delivery of services designed to support high-risk families with young children (Rostad et al., 2017). Evidence-based home visiting is a parenting intervention focused broadly on child development and

school readiness for families whose children are at higher risk for poor health and development outcomes. Language skills upon school entry are one of the most robust predictors of academic trajectories (Durham et al., 2007; Pace et al., 2019; Tamis-LeMonda et al., 2017). While substantial socioeconomic disparities exist in children's early language environments (Suskind et al., 2020), reading daily to young children is one way to significantly increase exposure to language, increase vocabulary, comprehension, and support cognitive development (Raikes et al., 2016). The objective of the current project was to design, implement, and evaluate innovative father engagement interventions while also promoting enriched literacy environments. Method In the present report, implementing agencies (n = 4) participated in a larger learning collaborative targeting the shared aim of father engagement in a diverse, high-risk sample of families (N = 465) enrolled in evidence-based home visiting in the Midwest. Activities within the collaborative were tailored to the makeup of the agencies involved to promote sustainable implementation and collaborative sharing of testable improvements in service delivery. Agencies developed SMART aims (Specific, Measurable, Achievable, Realistic, Time-bound) to provide structure and organization to their intervention and create a clear picture of the activities needed to reach a specific goal in a relatively short amount of time. During intervention design, agencies identified process and disruptor measures that may impact the implementation process and overall success of the intervention. Data monitoring for the outcome, process, and disruptor measures was ongoing during each six-month cycle. To promote father engagement, agencies created welcome letters written specifically for and addressed to fathers introducing them to the project. At subsequent home visits, providers shared additional father-specific materials about the benefits of reading to children, provided additional resources such as ways to access free books, apps or links to online content, library card applications, and age-appropriate books. Result and Conclusion The interventions were well-received by families and the proportion of fathers reading to their children increased approximately 20% across programs. Reading frequency also increased, with percentage increases ranging from 20 to 53% in the frequency fathers read to their children each week. Outcome measures for one of the four implementing agencies are presented in Figures 1 and 2. The final presentation will include program SMART aims and outcomes, as well as process and disruptor measures monitored during implementation. Lessons learned and strategies worth repeating will be highlighted. These findings demonstrate the success of collaborative learning environments to achieve large-scale change for vulnerable families and children in addition to informing policy and practices to support father engagement.

P2-J-364 - Longitudinal study of the effects of early life parenting intervention on enrolled children and their siblings in Rwanda (Jensen)

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Background: Sugira Muryango (Strengthen the Family) is a lay-workers delivered father-engaged home-visiting intervention for families living in severe poverty with infants and children aged 6-36 months in Rwanda. An initial cluster randomized trial (CRT) found that Sugira Muryango families showed significant improvement in father engagement and responsive and playful interactions, and decreased harsh discipline and intimate partner violence. Moreover, a 12-months post-intervention assessment found that children in Sugira Muryango families improved more on child development outcomes than control children. Importantly, early childhood development interventions have effects not only immediately

after implementation, but for many years after, as children grow into adults. We are therefore now, four years after the initial CRT, conducting a new follow-up study learn how families have sustained and built upon previously impacts of the Sugira Muryango intervention. Study Hypotheses: 1) Sugira Muryango will have positive effects among eligible caregivers and children compared to controls on a range of outcomes assessed at previous waves of data collection and on new outcomes that have become relevant as the children have aged, including aspects of school readiness. 2) Sugira Muryango will have positive effects among younger and older siblings of children who were eligible for and participated in the intervention compared to siblings in control households Study design: The study will seek to re-enroll 1049 families (children and caregivers) from the original CRT for Sugira Muryango. We will also sample 250 younger and 250 older siblings to participate in the positive spillover study. We will sample one sibling per household to minimize nesting of data within households. We will seek to enroll an equal representation of male and female siblings. Data collection will take place in June-July 2022. Main study outcomes by respondent are shown in Table 1. Analysis plan: Subjects in the CRT were randomized into a treatment group or control. For repeated measures, intervention effects will be determined if the slope of the response variable for the Sugira Muryango group is significantly different than the slope of the control group using linear mixed effect model with a continuous outcome variable as the response variable. The primary predictors are treatment status (Sugira Muryango vs control), time, and their two-way interaction included as fixed effects. New outcomes (marked in Table 1) will be examined using statistical methods for test linking techniques. Since we also only have one timepoint for the assessments of siblings, effects on siblings will be analyzed using two-level linear mixed models, controlling for covariates that are expected to have an influence in the outcome Implications: Intervening in early childhood has been demonstrated to be highly cost-effective for improving child development and life outcomes, yet interventions in low-resource settings are limited and not always well-evaluated. Moreover, understanding possible spillover effects on siblings will help us evaluate the true impact of early child development programs and their true benefit to society. Results will help to strengthen the Sugira Muryango intervention to seek greater and broader impact in future iterations of the program.

P2-J-365 - Parenting and Prevention of Violence against Children Project: From evidence-based to sustainable large scale (Linhares)

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Violence against children is a huge worldwide problem, that impact negatively on child development, especially in Low-and Middle-Income countries (LMIC). According to the World Health Organization (2020), nearly three in four children frequently suffer physical punishment and/or psychological violence from their parents. Exposure to maltreatment in childhood is a toxic stressful experience that could provokes an intergenerational cycle of violence. Prevention of violence against children requires strengthening of positive parenting. Then, parenting programs constitute a good strategy to promote positive interactions and parental practices, and prevent violence against children. The implementation of evidence-based parenting programs at large scale with sustainability and fidelity in public systems is a great challenge. The purpose of the present project is to evaluate the effectiveness of the implementation at a large scale of a universal parenting program to prevent violence against children in psychosocial vulnerable families. This project is the first large study that evaluate the ACT - Raising Safe

Kids Program (American Psychological Association) implemented in the context of public system of 24 municipalities in the Ceará state, Northeast of Brazil (LMIC). The ACT is a low-cost, well-stablished, and scientific evidence-based program. The project comprises the following steps: (i) Training the ACT-facilitators to work with families, including theoretical and practical activities, and supervision and monitoring with psychologists' specialists; (ii) Nucleation of the minimum local ACT-team linked with the Social Protection Services, in each city (coordinator, supervisor, and at least 5 facilitators).; (iii) Implementation the ACT in the routine of the social assistance of the psychosocial vulnerable families; (iv) Randomized controlled trial (RCT), large study with waiting-list control group and pre-and post-intervention assessments. To date, 190 ACT facilitators was trained and the nucleation was created in the cities with professionals of the public services of social protection area. The data collection was in progress. The family-caregivers are participating in the ACT Program, that includes 8 dynamic- and interactive- sessions described in the ACT Implementation Guide. The pre- and post-intervention assessments included the parental practices and child behaviors measures. Also, the parents` depression symptoms, history of childhood adversities, and parental sense of competence were also evaluated. The register of participants, randomization strategy, and records of the responses in the questionnaires and scales were performed in an App developed customized for the project. Finally, we expected to reach around 1,800 families and the following results: demonstrate the effectiveness of the ACT Program to improve positive parenting program and to reduce the child behavior problems; to better understand for whom the ACT Program functioning and for whom not functioning, and why; obtain the implementation of the ACT Program in a sustainable large scale with good quality and fidelity; obtain data of acceptability and usability for users and providers. The practical implications of the project were the implementation of an evidence-based and low-cost program of violence prevention at a sustainable large-scale, that is a valuable approach for LIMCs. Funding: Maria Cecília Souto Vidigal Porticus, and Bernard vanLeer Foundations

Poster Session 03

P3-A-366 - Role of Perceptual Feedback in Learning the Designed Actions of Everyday Objects (Kaplan)

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Understanding and implementing the designed actions of common artifacts is integral to navigating everyday life. However, many everyday objects entail hidden affordances, where the designed action is non-obvious. For adults, zipping up a jacket and twisting open a water bottle are second nature. But from visual information alone, the required zipping and twisting actions are not obvious--that the user must hold the zipper tab and edge of the coat to apply opposing forces parallel to the zipper teeth; that the user must stabilize the bottle in one hand while using the other hand to twist the lid to the left, repeatedly lifting and replacing the moving hand. Previous work shows that children demonstrate a reliable developmental progression in learning the designed actions of everyday objects (e.g., Rachwani, et al., 2020)--from non-designed exploratory actions (e.g., banging bottle), to the basics of the designed action (twisting back and forth), to successful implementation (opening lid). Knowing the designed action and success do not occur concurrently because each object has specific perceptual-motor requirements that children must learn and possess the motor skill to implement. In particular, prior work with twist-off containers showed that toddler-aged children know to twist the lid to open a screwtop container, but they repeatedly twist back and forth instead of continuously to the left.

Bidirectional twisting suggests that perceptual feedback from the moving lid keeps children on task, but it does not help them learn to implement the action. To further test the role of perceptual feedback on children's learning of designed actions, we encouraged 72 20- to 60-month-old children to open two types of containers that provided perceptual feedback (lids that twisted and opened normally or lids that twisted endlessly but never opened) and one container that did not provide perceptual feedback (lids did not twist). To test the generalizability of children's knowledge, half of the children received containers that twisted conventionally to the left, and the other half received containers that twisted to the right. Preliminary results from a subset of 28 children show that both older and younger children successfully opened the left-twist container (M = 82%; see top row of orange dots spread across age in Figure 1A), but only older children successfully opened the unconventional right-twist container (M = 53%; see blue dots clustered at older ages in third row of Figure 1A). Children persisted longer with twistable lids than stuck lids (four left-most columns of dots compared to right-most column of dots), $t(27)=2.21$, $p=.04$, and quickly switched to alternative strategies (e.g., shaking, banging) with stuck lids. Findings suggest that older children can use perceptual feedback from the container (i.e., lid tightened to the left and loosened to the right) to overcome the typical "lefty-loosey, righty-tighty" rule and that perceptual feedback keeps children on task, making it more likely that they will perform the designed action. Next, we will examine children's twisting actions in real time across each trial.

P3-A-367 - A longitudinal study of infant motor development using an automated pose estimation technique: The grasp-transport-release movement (Hakuno)

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Introduction: There is growing evidence that motor skills have an impact on other areas of development, such as social cognition and language and that atypical motor development is an early sign of autism spectrum disorders (Leonard & Hill, 2014). However, there is a lack of quantitative research on the development of motor skills during infancy and toddlerhood particularly using longitudinal study designs. Recent advancement of pose estimation technology has enabled us to easily quantify motor skills also for infant populations. In this study, we explored an objective approach to quantify infants' fine and gross motor movements using OpenPose, an open-source pose-estimation software (Cao et al., 2017, 2019). In addition to quantitative assessment, we also applied the observation coding method to assess the grasp-transport-release movements qualitatively. Our research goal was to advance our understanding of developmental changes in motor skills during infancy and toddlerhood using quantitative and qualitative assessments. Methods: Fifty-two healthy full-term infants (31 females) participated in the study. Of the 52 enrolled infants, 21 were included in the analysis at 12 months, 40 at 15 months, 42 at 18 months, 35 at 24 months, and 27 at 36 months. In the grasp-transport-release task, infants were encouraged to grab a block and put it in a hole 7cm distant from where the block was first placed for at least three trials. The grasp-transport-release motions were recorded with a single camera and tracked 2D coordinates of joint positions automatically from image frames using OpenPose (Figure 1). As the quantitative variables, the spatial variability, the durations, and the velocities of the grasp-transport-release movements were calculated. In addition, trained video-coders scored each grasp-transport-release movement for the qualitative assessments. A generalized linear model (GLM) including quantitative and qualitative measurements as explanatory variables was used to explore age-related

changes in the grasp-transport-release movements. Results and Conclusion: The qualitative scores of grasping and releasing abilities were found to be a significant predictor of age, indicating that the grasping and releasing abilities improve as infants get older. Additionally, the duration of the movements and the spatial variability in elbow position decrease while the uniformity of hand trajectories increases as the infants grow. Furthermore, the spatial variability in shoulder position increases as a function of age, suggesting the wider range of movement of the shoulder joint in older infants. Our findings revealed the typical developmental trajectories of fine and gross motor abilities. Future work should assess high-risk infants to better understand both typical and atypical motor development.

P3-A-368 - Developmental Cascades in Neurogenetic Conditions (Will)

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Background: Early motor experiences facilitate important learning opportunities critical for cognitive development (Bornstein et al., 2013). Moreover, achievement of motor skills initiates a developmental cascade that has downstream influences on cognitive skills, among other domains (Iverson, 2021). Characterizing developmental cascades initiated from early motor skills in developmentally delayed populations can inform our understanding of atypical developmental processes and targeted intervention. Down syndrome (DS) and fragile X syndrome (FXS) are two neurogenetic conditions associated intellectual disability and early motor delays that emerge in the first year of life (Will et al., 2018). Little is known regarding the cascading effects of early motor impairments on cognitive outcomes for infants with DS or FXS. Objectives: The present study aimed to investigate the longitudinal effects of infant motor abilities on cognitive outcomes at 36-months in DS and FXS. Methods: Participants included 15 infants with DS (mean chronological age (mean CA)= 12.1 months at initial enrollment) and 27 infants with FXS (mean CA = 13.04 months at initial enrollment). The Mullen Scales of Early Learning (MSEL; Mullen, 1995) visual reception domain provided a measure of cognitive ability at 36-months. The Vineland Adaptive Behavior Scales-2nd Edition (VABS-II; Sparrow et al., 2005) was used as a measure of motor abilities to avoid issues with measurement impurity. Raw scores were used in all analyses due to frequent floor effects with standard scores in populations with intellectual disability. Moderated regression model was used to determine whether composite motor skills at 12-months predicted 36-month cognitive outcomes, and whether this cascade differed between children with DS or those with FXS. Within group correlations were then tested to further examine the effects of 12-month fine motor versus gross motor on 36-month cognitive outcomes. Results: Regression model results indicated that 12-month composite motor abilities indeed significantly predicted 36-month cognitive outcomes for the FXS group (b=0.32; p=.001), and there was no difference in this effect for the DS group (b=-0.22; p=.280), indicating significant effects in that group as well (see Figure 1). Within group correlations revealed a moderate association between 12-month Gross Motor and 36-month cognition (r=0.34), but a negligible association between 12-month fine motor and cognitive outcomes for children with DS. Likewise, growth in gross motor skills between 12 and 24-months was strongly associated with 36-month cognition for children with DS (r=0.54). A different pattern emerged for infants with FXS in that 12-month gross motor and fine motor were both strongly associated with 36-month cognitive outcomes (r=0.53 and r=0.42 respectively), whereas there was no substantial association between change in these skills between 12 - 24-months and cognitive outcomes. Conclusions: Findings highlight the role of early

motor skills for cognitive outcomes in infants with neurogenetic conditions. Our results also suggest etiologically distinct developmental cascades for children with DS versus those with FXS. Collectively, these findings provide preliminary evidence for targeted motor interventions in infancy to boost cognitive outcomes for children with neurogenetic conditions and that timing of motor interventions may have a differential impact on cognitive outcomes across infants with DS or FXS.

P3-A-369 - Body Reaching: Vibrotactile Localization during the Second Year (Patton)

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Introduction Infants develop the capacity to reach to tactile stimuli on the face during the first year. They reach to lateralized face targets with the ipsilateral hand, but reach equally with each hand (left/right) to midline face targets (Chinn et al., 2021). However, less is known about hand selection during facial localization after 12 months. Here we investigate whether similar patterns of lateralization are evident in the second year. Ipsilateral reaching to lateralized targets may decrease in the second year, since during this period, hand dominance strengthens and midline-crossing during reaching becomes more frequent. Method In a larger longitudinal study on self-recognition, 19 toddlers (8 female) participated in a tactile localization task beginning around 14 months and returned monthly up to 20 months. During each visit, a vibrating disc was applied to the cheek and center of the forehead on separate trials (laterality and order counterbalanced). The disc was first placed while toddlers faced away from a mirror and again while facing the mirror. Toddlers were then encouraged to find the disc. To date, 12 toddlers have been coded with 149 total eligible trials (M = 12.4 trials per toddler). The hand used by the toddler to touch the disc was recorded as ipsilateral/contralateral for cheek trials and left/right for forehead trials (Cohen's Kappa = 0.8 for 20% of trials). Trials in which localization did not occur were excluded from analyses. Preliminary analyses indicated no effects associated with age. Because the number of testing sessions varied, each toddler's proportion of ipsilateral reaches among cheek trials and right-hand reaches among forehead trials was calculated. Proportions were then averaged across infants and compared to 0.5 using a two-tailed one-proportion z-test. Results For cheek trials, ipsilateral reaching dominated. Ipsilateral localization was observed in an average proportion of 0.87 among cheek trials conducted away from the mirror, $Z12 = 2.56$, $p < .05$, and an average proportion of 0.79 among cheek trials conducted in the mirror, $Z12 = 2.01$, $p < .05$. Across non-mirror and mirror trials, ipsilateral localization was observed in an average proportion of 0.81 among all cheek trials, $Z12 = 2.15$, $p < .05$. By contrast, forehead trials were not strongly lateralized. Right-hand localization was observed in an average proportion of 0.77 among forehead trials conducted away from the mirror, $Z11 = 1.79$, $p = .073$, and an average proportion of 0.58 among forehead trials conducted in the mirror, $Z12 = 0.55$, $p = .579$. Across non-mirror and mirror trials, right-hand localization was observed in an average proportion of 0.66 among all forehead trials, $Z12 = 1.11$, $p = .268$. Conclusions Reaching strategies were not random but varied according to target location. Toddlers demonstrated an ipsilateral hand preference when reaching to either cheek but no left/right hand preference to the central forehead location. In the second year, toddlers show a similar pattern of lateralization when reaching to face targets as do infants in the first year. Collectively, findings highlight how body structure organizes early self-reaching patterns.

P3-A-370 - Is barefoot really best? Infants walking barefoot, in bendy shoes, and in stiff shoes (Cole)

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Parents, doctors, and shoe manufacturers currently believe that "barefoot is best" when it comes to infants learning to walk, and that when shoes are required, they should be as thin and bendy as possible. But a generation ago, a sturdy, supportive shoe was believed best for infant walking. In the current study, we tested whether different footwear affects infant walking--specifically, how well and how much infants walk. Twelve- to 20- month-old infants (current N=46, planned N=60) walked for 10 minutes in each of three footwear conditions: barefoot, wearing a bendy-soled shoe, and wearing the same shoe modified to have a stiff, unbending sole. Infants played with their caregivers in a laboratory playroom with six foam elevations and six toys. We recorded the timing and distance of each footstep on a pressure-sensitive mat and video-coded spontaneous activity in the playroom. From videos, we scored time walking and climbing, steps taken, and falls. In addition, parents reported in a structured interview their beliefs about the effects of footwear. (Note, an earlier version of this work was submitted to ICIS 2020; we withdrew the abstract when the conference went remote, and have since added additional participants and analyses). The belief that "barefoot is best" was common: 86% of parents reported that barefoot was best for infants learning to walk. Shoes did affect infants' highest possible walking skill as measured by the standard gait test: Preliminary data showed effects of footwear on speed, cadence, and step width, Wald Xs ≤ 11.48, ps < .003, but not step length Wald X = 4.34, p = .11. Infants walked faster and took narrower steps when barefoot compared to stiff shoes, ps < .02. In contrast, only cadence was affected by shoes during spontaneous play, Wald Xs ≤ 4.38, ps ≥ .11. Likewise, preliminary results showed that shoes did not affect how much infants walked and played. Infants spent similar proportions of time walking in each condition, took similar numbers of steps, and spent similar proportions of time climbing on elevations, Wald Xs ≤ 4.3, ps ≥ .12. Finally, falls occurred equally often in the three conditions, Wald X = 2.02, p = .36. In summary, although footwear affected infants' peak performance as measured in the standard gait task, it had little effect on their walking skill during natural, everyday walking--the actual input for learning to walk. Likewise, infants accumulated similar amounts of total activity regardless of footwear. Parents can be reassured that putting shoes on their infants is unlikely to hinder their babies' developing walking skill.

P3-A-371 - "Universal" developmental sequences may hide big surprises: The case of the sit-crawl-point sequence (Lall)

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Campos et al., (2000) proposed that the development of joint attention, for example, gaze following and the ability to understand referential pointing, may be supported by prior locomotor experience. The literature suggests a clear preprogrammed developmental sequence for infant milestones, with sitting preceding crawling, and crawling preceding pointing. Campos et al., favored crawling as the main predictor of joint attention based on cross-sectional comparisons of age-matched crawlers versus non-crawlers. We tested the crawling hypothesis using a large longitudinal sample of 184 infants. In addition to measuring crawling and pointing, we included sitting as a control for prior non-locomotor development. Our measure of joint attention ability was the protodeclarative point. Although it seemed unlikely that some infants could point before sitting or crawling, we tested our sit-crawl-point sequence

assumption for unexpected patterns (e.g., crawl before sit; point before sit; or point before crawl). Method New mothers and their infants were recruited by distributing brochures in two hospital obstetric units. Moms completed and returned daily checklist reports about the absence or presence of these and other milestones monthly. From their daily observational checklists, we could calculate when, to the day, that a baby first sat unsupported, crawled more than 10 feet, or pointed to share attention. Previous research has found such parent checklist reports to be highly valid. In our study, split-half reliability, based on odd vs even days of recordings, was also very good and ranged from .96 to .99. Milestones Our key checklist items were the following: Proto-declarative Pointing. "Baby points or reaches towards an object or event they're interested in and wants you to notice. Baby wants to share interest and enjoyment with you." Crawling. We included 6 styles of crawling, not just the classic hands-and-knees crawl. The age of first crawl was described to parents as "when the baby moved more than 10 ft." Sit Unsupported. "Baby sits up alone without using hands for support for at least 30 seconds (is not propped with pillows or other supports). Back is straight. Baby often uses hands to play with a toy." Results 184 infants had data on the specific days when they first sat unsupported, crawled more than 10 feet in any style, and pointed to share attention. From these checklist data we calculated the age when each milestone first appeared. With three milestones there are 6 possible sequences of attainment. For example, the assumed sequence is sit-crawl-point. We used our longitudinal data to consider five other possible sequences, such as crawl-sit-point. Our cross-sectional analysis confirmed the expected order of milestone appearance: sitting at 25.5 weeks, followed by crawling at 35.7 weeks, and pointing at 39.9 weeks. However, the longitudinal data uncovered a surprise: 24.5% of babies did NOT follow the assumed sit-crawl-point sequence. These babies, who did not follow the expected sequence, did so by pointing before they crawled. Conclusion The field's knowledge about developmental sequences and cascades comes largely from inferences based on cross-sectional data. Our longitudinal data uncovered a surprise about the sit-crawl-point assumption that could have important implications for the locomotion-joint attention hypothesis. We should conduct longitudinal studies whenever possible.

P3-A-372 - Oral-motor development and complementary feeding approach in 8-month-old infants (Addessi)

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In recent years there has been a rise in the prevalence of 'baby-led' introduction to solids (baby-led weaning, BLW), where infants independently feed on finger foods from the start of complementary feeding rather than being spoon-fed puréed food by their caregiver (parent-led weaning, PLW). BLW may benefit language development by means of a greater participation in family meals, which provide opportunities for modeling language, or through an earlier practice of complex oral-motor and fine-motor skills by independently choosing, manipulating, and chewing food. There is already evidence for an association between oral-motor development and language ability in toddlers, in which complex oral-motor movement scores are positively correlated with the size of spoken vocabulary and sentence complexity. Additionally, it is well known that difficulties with oral-motor movement often co-occur with language dysfunction. However, there is still a lack of evidence concerning the relationship between

early feeding experiences and developmental outcomes, including oral-motor development. We investigated the relationship between oral-motor functions, complementary feeding approach and developmental outcomes in 72 Italian typically developing 8-month-old infants. Mothers reported the complementary feeding method used (PLW, BLW, or mixed), and completed (i) the short form of the MacArthur-Bates Communicative Development Inventories (CDI, Caselli et al., 2015), (ii) the Developmental Profile 3 (DP-3; Alpern 2007), and (iii) a socio demographic questionnaire. We recorded one meal for each child during a videocall and then coded oral-motor functioning through an adaptation of the Schedule for Oral Motor Assessment (SOMA, Skuse et al., 1995). For the dependent variable, we measured the difference (Delta score) between the SOMA score and the cut-off indicating atypical performance for each type of food (with a higher difference indicating a better performance). Twelve children received two food types (e.g., semisolid and solid, or purée and solid). The Delta score did not differ depending on the complementary feeding approach. However, it significantly differed according to the type of food infants consumed ($H2 = 29.828$, $p < .001$): children eating semisolid food performed better than children eating puréed or solid foods (semisolid vs purée: $U = 85.0$, $p < 0.001$, $n1 = 38$, $n2 = 23$; semisolid vs solid: $U = 92.0$, $p < .001$, $n1 = n2 = 23$). Moreover, the Delta score was higher for children who had already acquired the ability to crawl than for those who were not yet able to crawl ($U = 579.5$, $p = .041$, $n1 = 53$, $n2 = 30$). Finally, the Delta score was positively correlated with (i) the DP-3 Motor subscale ($rs = .323$, $p = .002$, $n = 83$), (ii) the DP-3 Adaptive Behavior subscale ($rs = .220$, $p = .045$, $n = 83$), and (iii) the DP-3 General score ($rs = .225$, $p = .040$, $n = 83$), but not with language measures (CDI). In conclusion, oral-motor functioning in 8-month-old infants did not differ according to the complementary feeding approach; however, children fed semisolid food showed a better oral-motor functioning than those fed either puréed or solid, strengthening previous findings (Delaney & Arvedson, 2008). Moreover, better oral-motor functioning paralleled gross motor and adaptive behavior development, possibly anticipating a future enhanced language development.

P3-A-373 - Developmental cascades, step-by-step: Linking locomotor exploration to joint object play and caregiver language across the transition to walking (Pugeda)

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Learning to walk facilitates advances in domains far afield, enabling infants to engage with objects and people in new ways. Recent research has demonstrated that the transition from crawling to walking reorganizes how infants use locomotion to explore their everyday surroundings and elicit communication from caregivers via advances in social interaction. Specifically, compared to crawling, bouts of walking are more likely to co-occur with and be followed by caregiver language about infants' actions and objects. To date, however, studies have yet to provide an account of the processes connecting infant locomotion to exploration and in turn, caregiver input. Here we document one potential pathway linking these domains. Thirty infant-caregiver dyads were videorecorded during everyday activities at home for 45 minutes. We identified when infants first began to walk (5 steps; $M = 11.98$ months, $SD = 1.31$) and coded the monthly sessions just before and after this midpoint (i.e., pre-walk, walk onset, one month of walking). Coders first identified all bouts of infant locomotion (e.g., crawling, cruising, walking). Then, for each bout, we coded whether infants traveled (i.e., by displacing their bodies significantly through space) and whether caregivers or objects were within infants' reach after they stopped moving. Next, we identified whether dyads engaged in joint object play (i.e., actively

manipulating objects together or one partner manipulating and the other observing) and noted who manipulated objects (infant, caregiver, dyad). Finally, we coded whether caregivers provided language input about infants' actions (using verbs) or objects (using nouns) within 3 seconds of bouts containing joint object play. Preliminary results suggest that infants crawled less and walked more over time (ps < .001). We observed an effect of infants' in-the-moment locomotion type (i.e., how they moved in real time) on patterns of exploration, social interaction, and language input. Compared to bouts of crawling, infants' walking bouts were more likely to result in travel (Figure 1a), and upright bouts (cruising, walking) were more likely to be followed by joint object play (Figure 1b). Objects and caregivers were almost always present in the environment when infants stopped moving, and this did not change over time (ps > .05). When joint object play occurred, infants and caregivers were both more likely to engage in solo manipulations (while the other observed; Figures 1c-d) and play together (Figure 1e) after infants walked. Finally, caregivers were most likely to provide language about objects and actions when joint play occurred after bouts of walking (Figure 2a-b). Thus, as walkers, and when locomoting upright, infants are more likely to travel, engage in joint object play with their caregivers, and as a result, receive language input containing rich information about the objects and actions of dyadic play. Taken together, these findings provide a step-by-step account of how this developmental cascade unfolds both in-the-moment based on infants' locomotor posture and across development as infants transition from crawling to walking.

P3-A-374 - Relating infants? behavioral reach-grasp skill to concurrent neural activity (Fulcher)

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Infants' experience with motor skills influences how they perceive and process these skills when observing others perform them (e.g. van Elk et al., 2008; Yoo et al., 2016). Infants show increased neural motor activity when viewing actions they are skilled at - such as reaching - compared to those they are unskilled at. Interest in this response, often referred to as "neural mirroring", has resulted in a number of studies relating early mirroring to other emerging skills, particularly social cognition (e.g. Meyer, Chung, Debnath, Fox, & Woodward, 2022; see Salo, Ferrari, & Fox, 2019). However, a more basic question remains open: how infants' motor skills relate to their neural activity as they perform actions themselves. First indications come from two papers (Cannon et al., 2015; Yoo et al., 2016) which found that aspects of reaching competency (specifically, latency) significantly related to infants' neural activity as they observed others' actions, but - unexpectedly - not significantly related to their neural activity as they themselves performed actions. In these studies, both neural activity and behavioral measures of grasp competency were averaged across all trials within individuals. To our knowledge, the question of how neural activity relates to the concurrent, trial-by-trial quality of motor behaviors infants produce remains unanswered. 66 9-month-old infants from the Chicago area participated in a study in which EEG data were collected as infants performed reach-grasp actions. We were interested in changes in alpha activity over sensorimotor areas, and thus assessed the 6-9 Hz alpha range over these regions. To evaluate grasp quality, latencies between onset of trial, beginning of movement, timing of first touch, length of successful reach-grasp actions, and timing of beginning and completion of successful grasps were identified. Infants' handedness (left, right, or both) and use of one or two hands (uni- vs. bimanual) during their reach-grasp were scored in each trial. We coded whether their first attempt to grasp the object was successful (or whether they required multiple attempts to successfully grasp), and also

whether successful grasps were low-quality (toy was unintentionally dropped within 1 second of grasping). Qualitatively, infants were variable across measures of reach-grasp competency - latencies ranged from under 1 second to more than 5 seconds. Many infants relied on one or both of their hands flexibly, though others exclusively used their left or right hands, or only reached with both hands (never producing a unimanual grasp). Most failed on their first attempt to grasp on some trials, while others were never successful on their first attempt (or, alternatively, never needed multiple attempts). To investigate potential relations between neural activity during action production and the quality of the produced action, we first conducted a PCA to identify which measures of reach-grasp competency contributed jointly to variance within infants' grasping skill. The PCA revealed four significant PCs (see Figure 1); two significantly related to neural activity. In PC1, latency and poor-quality grasps loaded negatively, while successful grasping on first attempt loaded positively; this PC positively related to neural activity ($t = 2.42$, $p = .016$). In PC4, time between the first touch and the first successful touch covaried in the opposite direction of handedness, toy dropping, and length of the successful grasp movement. This PC negatively related to neural activity; $t = -2.20$, $p = .029$. Further analyses will probe these preliminary findings and contribute to our understanding of real-time relations between infants' motor skills and their neural activity.

P3-A-375 - Sensory Processing Difficulties and Autism-Related Traits in the First Two Years of Life (Soker-Elimaliah)

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Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by social-communication difficulties and restricted and repetitive behaviors (RRB). Sensory processing difficulties are a diagnostic subcriterion of RRB, and retrospective studies of autistic children have found that sensory atypicalities were present in the first year of life (Baranek, 1999). In prospective studies with infants who have a family history of ASD, sensory processing difficulties predict later ASD diagnosis (e.g., Mulligan & White, 2012). The current study expands past work to look at relations between sensory processing and ASD-related traits in the first and second years of life in infants with no family history of ASD. Caregiver questionnaire data was collected for 35 infants at one or more time points between 6 and 18 months. A Sensory-RRB composite score was calculated for infants from select items from the Infant Behavior Questionnaire (IBQ; Rothbart, 1981; 19 items) at 6-12 months, and for toddlers from the Early Childhood Behavior Questionnaire (ECBQ; Putnam et al., 2006; 18 items) at 18 months. Items were selected to correspond with sensory items from the Sensory Experience Questionnaire (SEQ; Baranek et al., 2006; e.g., IBQ item 26 and ECBQ item 27 corresponded to SEQ item 18), and RRB items from the Repetitive Behaviors Scale-Revised (Bodfish et al., 1999), measures traditionally used with older children. ASD-related traits were measured using the Autism Parent Screen for Infants (APSI; Sacrey et al., 2016). For infants with data at multiple time points between 6 and 12 months, average Infant Sensory-RRB and average Infant APSI scores were used. Infant Sensory-RRB score was significantly correlated with 18-month Sensory-RRB score ($r(16) = .67$, $p = .002$), and Infant APSI was significantly correlated with 18-month APSI ($r(16) = .47$, $p = .048$). Infant Sensory-RRB was not associated with Infant APSI ($p = .34$), but 18-month Sensory-RRB was related to 18-month APSI ($r(22) = .46$, $p = .024$; see Figure 1). Longitudinal associations also showed that Infant Sensory-RRB scores predicted 18-month APSI ($r(16) = .53$, $p = .024$; see Figure 2), however, this relationship did not hold when partialling out Infant APSI

score (p = .27). Overall, stability was seen from infancy to toddlerhood for sensory processing difficulties and RRB and for ASD-related traits more broadly. Sensory processing and RRB at 18 months were also correlated with ASD-related traits at the same age, but the predictive association between infant sensory-RRB scores and 18-month ASD-related traits was non-significant once infant ASD-related traits were controlled for. This finding, and the lack of association between concurrent measures of sensory-RRB and ASD-related traits in infancy, could be due to heightened levels of sensory-related and RRB behaviors present in typical development across the first year of life (e.g., Thelen, 1979). Therefore, sensory difficulties and RRB in infancy might not be sensitive enough as predictors of later autistic behaviors. Future work will examine differences in these Sensory-RRB scores and relations with ASD-related traits for infants with a family history of ASD.

P3-A-376 - Statistics in motion: Does the infant motor system predict actions based on their transitional probability? (Ghilardi)

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Motor theories of action prediction propose that our motor system combines prior knowledge about the most likely outcomes of an action with incoming sensory input to predict other people's behavior (Monroy et al., 2019; Kahl & Kopp, 2018; Ondobaka et al., 2015). Recently, it has been shown that the infant motor system also uses knowledge from statistical learning to predict upcoming actions if they follow another action in a deterministic fashion (Monroy et al., 2019). However, in everyday life most actions follow a probabilistic pattern rather than a deterministic one. Here, we build upon prior research by testing the hypothesis that infants can pick up different transitional probabilities between actions through observation and that the activation of their neural motor system, upon seeing an action, is modulated by these transitional probabilities. We hypothesize that the activity over the motor area in the anticipatory time windows during the action observation (see Figure 1) phase is parametrically modulated by the transitional probability of the action pairs. Specifically, we expect maximal activity when predicting deterministic action pairs and minimal activity when predicting actions pairs linked by low levels of probability. 18-month-old infants will be recruited from a database of interested families from the surrounding region of Nijmegen, a middle-sized city in the Netherlands. Our target sample size is 28 infants. We will attempt to recruit up to 60, given the attrition rate of infant EEG studies. Infants view videos of unfamiliar action sequences containing four different levels of transitional probability (25%, 50%, 75%, 100%). The videos feature an adult performing an action sequence with a box-shaped toy which afford six unique object-directed actions. After watching the videos at home, infants participate in an EEG experiment in which they are presented with an action sequence featuring the same statistical structure. After observing the action sequence infants get the chance to play with an infant-sized version of the toy stimulus for several minutes. The purpose of this phase is to identify the sample-specific mu frequency range, as defined by a decrease in power during overt movement relative to baseline (Meyer, Braukmann, Stapel, Bekkering, & Hunnius, 2016; Monroy et al., 2019). Video recordings of the action execution phase will be coded, and epochs will be selected during infant reaching or manipulation of the toy-box. Power will be analyzed in the 2-30 Hz range over central electrodes (C3, C4, Cz) to visually identify the sample-specific mu range. This frequency range will be used to analyze the action observation phase during perceptually identical time windows preceding the actions (see Figure 1). We will analyze the data using a repeated-measures ANOVA with the mu power

as dependent variable and the levels of probability as independent variable. The results will inform us about whether the activity of the motor system reflects the specific statistical likelihood of upcoming actions to generate action predictions. Moreover, this study will provide evidence for a functional role of statistical learning for infants developing action understanding. Preliminary results of 11 infants show mu suppression when comparing action execution relative to baseline, allowing to already define the sample-specific mu frequency range.

P3-A-377 - The role of body movement for the development of visual attention in infancy ? investigation with automatic quantification methods (Lopez Perez)

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In everyday life, we continuously explore the environment around us. During this exploration, we voluntarily move our eyes from one location to another (i.e., saccades) while we process all information present at these locations by keeping our eyes focused there (i.e., fixations). This process of visual orienting involves moving the eyes and the head in response to, or in anticipation of a new sensory stimulus (Johnson & de Haan, 2015), and it appears to play a central role in human learning and development, as it facilitates adaptation to an ever-changing environment (Sokolov, 1963). Initial studies in the area of eye and body movements in infancy have shown that 1-month olds move their body soon after initiating a gaze shift and that these body movements were shorter already at 3 months of age, suggesting a developmental change in the coupling of those movements (Robertson et al., 2011). In a series of follow-up studies, Robertson and colleagues showed compelling evidence that motor development and visual attention are strongly coupled (in time) in the first three months of life (Robertson et al., 2012). However, although the developmental trajectories of eye movements are well documented, little is known about how mastering effective eye movement control relates to (i) movements of other body parts (ii) and the impact it has on later cognitive development. To shed more light into this topic we used a computer vision algorithm to study the coupling between the motor system and visual studies using a series of completed studies with infants ranging from 4.5 months to 14 months (total N~=500). Particularly, we applied Deeplabcut (DLC; Mathis et al., 2018), which is a pose estimation algorithm to precisely track user-defined body parts. For each video in front of the eye-tracker, we extracted four different features (i.e., left and right hand, trunk and head). DLC returns a series of x and y coordinates which were later converted into movement by computing the Euclidean distances between two consecutive frames. Consequently, each Euclidean movement of the labelled body parts was aligned to the onset of each saccade. Finally, the averaged movements time series were later compared to a random model using a bootstrapped significance test. Here, we present the preliminary results of the decoupling of eye movements in different eye-tracking tasks in relation to the rest of the body movements. We then discuss the implications of this relation for the correct function of the attentional networks.

P3-A-378 - Actigraphs: Measuring Infant Laterality in Handedness and Head Orientation (Mercado Ramos)

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Although it is generally agreed that spontaneous movements are important for the development of motor coordination in infants, the specific role of these movements is unclear (Piek, 1996). In order to explore the role of movements, Thelen (1985) explored the synchrony between limb joints through kicking. Accelerometers (actigraphs) in research are mostly used to assess behaviors related to physical activity and sedentary behavior, such as sleep (Hedayatrad et al., 2021). This project extends this line of research by examining the relationship between head orientation and lateralized motor activity, which is observed through the use of actigraphs. The objective of the current study was to examine infants' lateral arm movements while the infant was semi-reclined in an infant seat. Throughout our development, we form lateralized biases (Goodwin & Michel, 1981) in our motor behaviors. Hand preference and head orientation preferences serve as examples of biased lateralized movements. Hand preference biases can be observed during reaching tasks in which infants are presented with objects at the midline. The asymmetric tonic neck reflex (ATNR) is a behavior in which neonates turn and hold their heads to one side. It can be observed repeatedly to gain an approximation of an infant's head orientation preference, which has been related to the development of hand preference for reaching (Goodwin & Michel, 1981). Methods: Six infants were observed at 4, 8, 12, and 16 weeks of age for their arm movement activity. Actigraphs were used to record the motor activity of each arm of the infant while the infant was reclined in an infant seat and wearing the actigraphs on their wrists. After the data was collected, the recordings from the left and right arm were compared across the weeks of observations. A between samples t-test was used to see how whether there were lateral biases present in arm movements between the 4-to-8-week observations and the 12- to-16-week observations. A correlation was also run to see if there was a positive association between arm movements actigraph scores and infant weeks. Results: Results reveal that there is a different in actigraph scores by arm movements, with higher scores seen in right arm actigraph scores in both 4-to-8-week and 12-to-16-week scores. Yet, these results cannot be considered significant due to t test scores not being significant (see Table 1). Additionally, the correlations concluded that there exists a positive association between arm movements actigraph scores and infant weeks (see Table 2). Conclusions: Findings suggest that there is in fact a rightward bias for motor movements, in this case arm movements and that actigraphs can serve to measure said movements. Overall, results do not find a significant difference by arm but do find a positive association between arm movements actigraph scores and infant weeks.

P3-B-379 - Early word learning as a joint action (Goupil)

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How do young children acquire opaque knowledge - such as what things are called - from others? Under pedagogical approaches, what matters the most is young learners' sensitivity to social signals that indicate to them what to attend to (Csibra & Gergely, 2009; Reid & Striano, 2007). By contrast, bottom-up accounts emphasize the role of affordances between the world and learners, and suggest that what matters the most is how information is delivered as a function of the child's (stochastic) actions (Pereira, Smith, & Yu, 2014). Evidence for pedagogical accounts mainly comes from artificial paradigms where infants are passively receiving information from agents whose actions are not contingent to theirs. Conversely, evidence for bottom-up account mostly comes from naturalistic studies that examine how infants' interactions with their environment shapes their learning. A third approach - which can be seen as a way to reconcile the two aforementioned theories - states that what matters is that both learners

and informants be engaged in a form of joint action, where both partners coordinate their actions and attention with respect to one another's in order to achieve a joint outcome: knowledge transmission. Evidence for this third approach is missing at the moment, because we lack data examining bi-directional flows of information between learners and informants. Adopting such a dyadic approach, in this pre-registered study we collect for the first-time audio-visual recordings and dual-EEG data from caregiver-infant dyads while infants (14-mo) are provided with the opportunity to learn novel words (Fig. 1). Based on parental reports, we select objects that are either familiar (e.g., dog) or totally novel (e.g., seal) for the child. Dyads briefly play with the toys, and infants' learning of new object-label mappings is then tested in a looking-while-listening procedure (Fernald & Marchman, 2008). We expect to have collected data for N=60 dyads by July 2022. Preliminary analyses suggest that infants learn what novel words refer to in this context, with some variability. This design will allow us to ask whether: 1) infant-mother dyads' attentional coordination towards objects positively impacts infant word learning (beyond individual factors such as the amount of gaze following, or sustained attention to objects). 2) specific kinds of leader-follower attentional coordination foster infant word learning. This will be assessed both at the behavioral and neural levels. Behaviorally, we will measure the degree to which both partners look at the objects at the same time, and leader-follower dynamics using Granger causality and cross-correlations. At the neural level, we will estimate the degree to which levels of attention reflected in frontal theta power co-vary in both brains, and assess leader-follower dynamics with measures derived from Granger Causality (see Wass, Whitehorn, Marriott Haresign, Phillips, & Leong, 2020). These dyadic measures will provide unprecedented insight into how infants learn words during naturalistic play interactions with their caregivers.

P3-B-380 - Time-resolved multivariate pattern analysis of infant EEG data (Ashton)

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Time-resolved multivariate pattern analysis (MVPA) for analyzing magneto- and electro-encephalography (M/EEG) quantifies the extent and time-course by which neural representations support the discrimination of relevant stimuli (Haynes et. al., 2006). Because MVPA is yet to be widely applied in infant research, there is a need to develop best practices that account for the specific limitations of infant neuroimaging (i.e., limited data, lower signal to noise; Aslin & Fiser, 2005, Bell et. al., 2012). To address this gap, we implemented several different MVPA analysis approaches with infant EEG data, and investigated the effects of different numbers of repetitions for each stimulus due to varying infant cooperation. First, multivariate classification analysis was performed, and we found that the time course of infants' neural representations supported visual image discrimination significantly above chance, as previously found (Bayet et al, 2020; cluster corrected $p<0.05$, chance level of 50%). Classification of the stimulus set also resulted in above-chance decoding accuracy compared to an empirical chance level generated by repeated permutation (cluster corrected $p<0.05$). Second, geometric- and accuracy-based Representational dissimilarity matrices (RDMs) were additionally generated to characterize the space of neural representations (Kriegeskorte et. al., 2013). This was used to assess the structural similarity of the accuracy based and Euclidean distance based decoding results. Significant correlations between inter-stimulus Euclidian distance- and accuracy-based RDMs were found for both infants ($r = 0.85$) and adults ($r = 0.93$; $ps < 0.001$) (Fig 1). Third, because infants often

contribute fewer trials of artifact-free EEG data for each stimulus, we also explored the impact of varying the threshold number of valid trials per condition required for participants to be included in the analysis. Overall, average classification accuracy remained significantly above chance at the group level during the time series, even with as few as 4 trials per stimulus (Fig 2). In adults, split-half reliability of the group-level RDMs increased as more trials were included, even when trial numbers for each participant were matched to those in the infants (Fig 2b). Interestingly, this pattern of improved group-level RDM reliability with increasing numbers of trials was not present in the infant data (Fig 2d). This suggests that optimal methodological choices for multivariate analyses may differ for infant data, perhaps because of their inability to maintain attention across long testing sessions. The use of a nonlinear classification approach was also explored to assess whether a linear decision boundary is actually the most effective for decoding. Classification accuracy was not significantly different when using a nonlinear (i.e., SVM with Gaussian kernel) or linear classification boundary, although it was numerically poorer for the nonlinear classifier. In this work we provide recommendations for best practices in using MVPA techniques with infants and outline potential pitfalls when there are significant deviations from these recommendations.

P3-B-381 - EEG Coherence and Task Performance on Looking Version of the A-Not-B at 8 and 12 Months (Harrison)

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Inhibitory control (IC) is a regulatory process considered to be a fundamental component of the executive functions (Miyake et. al, 2000). IC processes consist of response inhibition and interference control, further divided into attentional control and cognitive inhibition (Diamond, 2013). Both interference control processes can be measured with infant looking tasks. Research suggests that fronto-frontal and fronto-parietal connectivity is associated with performance on the A-not-B task, a measure of cognitive inhibition in infants (Bell, 2012; Cuevas et al., 2012), yet the developmental change of EEG correlates of cognitive inhibition are relatively unknown. The present study examined relations between chance behavioral performance and EEG task coherence in the same infants at 8 and 12 months. Forty-six full-term, healthy infants (24 girls) and their parents were seen monthly in the research lab in a study of brain development. At each lab visit experimenters administered the looking A-not-B task (Bell & Adams, 1999; Cuevas & Bell, 2011) as the cognitive IC task, along with other cognitive tasks not reported here. EEG data were collected during task performance. Infants were classified into one of three categories based on task performance relative to chance accuracy (50%): above chance in both same side trials (A trials) and reversal trials (B trials), above chance in same-side trials only, and below chance in same-side trials. This was done to investigate associations between task performance and EEG beyond a high vs low dichotomy typically used in previous research (i.e. Bell, 2012). Functional EEG coherence, a measure of the phase correlation between two spatial positions (Thatcher, 2012) in the infant alpha frequency band (6-9 Hz) at frontal and parietal electrode sites was analyzed. Repeated measures MANOVA analyzed the effect of group (between-subject factor) on regional and hemispheric coherence (within-subject factors). At 8 months, there was a significant interaction of group, region, and hemisphere indicating greater left frontal-frontal coherence for the group performing below chance on same-side and reversal trials (Figure 1). This was different from previous research where better performance was linked with greater frontal-parietal EEG coherence

(Bell, 2012). At 12 months, there was only a main effect of region, with frontal-frontal coherence greater than frontal-parietal; there were no group effects (Figure 2). Again, this contrasted with previous research reporting greater frontal-parietal coherence with better performance at 12 months (Bell & Fox 1992). Previous research typically based high-low performance on reversal trials only (Cuevas & Bell, 2010) or high-low performance grouping was based on statistical analyses (i.e., cluster analyses; Bell 2012). In this study, grouping was based solely on performance above or below 50%. At 8 months, these data highlight increased frontal-frontal connection for children performing below chance on same side trials. It may be that the task was too difficult for this group, leading to the overreliance on frontal-frontal connection. This group distinction was not replicated at 12 months, perhaps because most infants performed above chance on same side trials. This suggests that above chance performance may not be a sufficiently parsimonious measure to detect group differences in EEG coherence at 12 months.

P3-B-382 - Maternal Deprivation Status Predicts Infant Salivary Alpha Amylase in the Context of Maternal Prenatal Substance Use (Kelm)

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We examined the role of prenatal substance exposure and maternal deprivation index (a measure of the proportional socioeconomic deprivation of an individual relative to others in their state based on Census Block Groups, Kind, 2018; ADI) as predictors of infant baseline salivary alpha amylase (sAA) with maternal sensitivity as a moderator of these associations. Alpha amylase is a measure of physiological regulation and has been identified as a biomarker of chronic stress via autonomic nervous system functioning (Ha et al., 2016; Nater & Rohleder, 2009). We conceptualized our model through a family systems view of biological stress systems (e.g., Ha et al., 2016). Therefore, we included contextual variables (ADI and maternal sensitivity) as well as biological variables (prenatal substance exposure) to account for the array of predictors associated with infant physiological regulation. We hypothesized that prenatal substance exposure and ADI would significantly predict infant pre-stressor sAA. We expected that lower ADI and prenatal substance exposure would be associated with lower levels of pre-stressor sAA. We also hypothesized that maternal sensitivity would moderate this association. Specifically, the relationship between ADI or prenatal substance exposure and sAA would be weaker among infants who experienced higher levels of maternal sensitivity compared to those who experienced lower sensitivity. We also examined maternal income, education, insurance status, and marital status as predictors of ADI in order to understand associations between this larger context variable and individual family level variables. Mother-infant dyads (N = 46) participating in an ongoing longitudinal study were recruited after the first trimester of pregnancy from prenatal clinics, substance-use treatment centers, and the community. During pregnancy, mothers reported their substance use patterns using a validated calendar-based interview (Sobell & Sobell, 1992). A polysubstance exposure risk score was computed based on the number of different substances used in pregnancy with higher scores indicating exposure to more substances. At infant age 6 months, maternal parenting behavior was coded during mother-infant free-play interactions using the Parent Child Early Relational Assessment (Clark, 1999) and infant sAA was collected during a resting baseline period prior to the Still Face Procedure (Tronick, 1980). Hierarchical regression analyses with infant race, ADI, a count variable of the number of substances used during pregnancy, and maternal sensitivity entered in the first step, the interaction term of prenatal substance use and maternal sensitivity in the second step, and the interaction term of ADI and maternal

sensitivity added in the last step. With both interaction terms included, the model was no longer significant, but ADI remained a significant predictor in each step (b = .37, t = 2.49, p = .017). There were no other significant main effects or interaction. Results suggest that context-related deprivation may be predictive of infant physiological regulation by increasing levels of family and maternal stress. This finding contributes to a burgeoning field of studying biological stress through a family systems perspective though the relation between context-related stress and infant physiological regulation requires further study. Overall, findings support the importance of maternal stress-related factors in predicting infant physiological regulation.

P3-B-383 - Exploring the relations between resting-state and task-based connectivity during the first two years of postnatal life (Di Lonardo Burr)

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How do large-scale neural networks, responsible for key cognitive processes in adulthood, emerge in infancy? The Interactive Specialization Theory (IST) of cortical development (Johnson, 2011) predicts that exogenous activation of large-scale neural networks during early cognition (i.e., task-based connectivity) is critical for strengthening both the anatomical and endogenous functional coherence of these networks during rest (i.e., resting-state functional connectivity). Past findings in adults using fMRI have shown a relationship between brain resting-state functional connectivity networks at rest and task-induced activation (Cole et al., 2014; Mennes et al., 2010). In infancy, while predictions of the IST have been investigated regarding the development of individual cortical regions, much remains unknown about the development of large-scale networks comprising multiple cortical regions (Johnson & Munakata, 2005). To investigate the development and relations among and between resting-state and task-based connectivity, we used a longitudinal sample of infants (n = 130) from the Bangladesh Early Adversity Neuroimaging (BEAN) project (see Perdue et al., 2019). Our sample consisted of infants living in a resource-restricted neighbourhood, expanding the reach and diversity of neuroscientific longitudinal samples in infancy. Resting-state and task-based data were collected at 6- and 24-months-of-age. To measure functional connectivity, we used data acquired with fNIRS (Gowerlabs NTS). The headgear/cap was designed to cover fronto-temporal cortices. Resting-state data were collected while infants watched videos of moving toys. To index resting-state connectivity we calculated Pearson correlations between every pair of channels. Task-based data were collected while infants completed a well-established social cognition task (Lloyd-Fox et al., 2009). To index task-based functional connectivity, we used a background connectivity approach which regresses out task-evoked responses, ensuring that connectivity measures are not confounded by the temporal nature of task-evoked responses (Al-Aidroos et al., 2012). This is the first fNIRS study to simultaneously consider resting-state and task-based connectivity both in infancy and longitudinally. Following best practices, we are currently investigating a subset of the data (training set) and will open the test set after exploratory analyses are complete. While the full-dataset will be reported in this poster, here, we report our plans and some preliminary findings. Preliminary findings reveal greater overall connectivity from 6 to 24 months of age with large-scale networks engaged at both ages but more and longer-range connections evident at the older ages. Next, we will test the relations between resting-state and task-based connectivity both

within and across time points. More specifically, we will determine whether greater task-based connectivity at 6 months is correlated with greater resting-state connectivity at 24 months, as predicted by the IST. The simultaneous exploration of task-based and resting-state connectivity further our understanding of how large-scale neural networks develop in infancy. Our work expands on the existing literature that is heavily focused on typically developing infants from high-income populations. With this newfound knowledge, future studies can investigate how these neural networks predict developmental outcomes (i.e., Mullen scores) for diverse populations.

P3-B-384 - Neonatal mimicry of caregivers at home: A feasibility pilot (Casey)

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Large-scale behavioral studies are needed to develop assessments of healthy social development; however, such large-scale behavioral studies are lacking in the neonatal period due to challenges with newborn participation in traditional laboratory settings. To address this gap, we assessed the feasibility of conducting asynchronous behavioral research with newborns online, using the classic behavior of neonatal mimicry as a test case. Caregivers were videotaped on the Lookit platform while engaging in a classic mimicry task where they either modelled mouth opening (MO) or tongue protrusion (TP) to their newborn (randomized between subjects, Figure 1A). Participation was allowed up to once a day while the child was in the age range of the study (0-45 days old). A total of 129 videos from 29 unique participants were collected (Figure 2A). Two independent coders, blind to condition (Figure 1B), coded the videos offline according to laboratory-based criteria to assess the inter-rater reliability for coding usable time and newborn gestures from webcam videos. Coders had high agreement on coding usable time ($r = 0.89$), newborn TP counts ($r = 0.81$), and newborn MO counts ($r = 0.82$). Next, we assessed whether collected data met laboratory-based inclusion standards, including whether the untrained caregivers modelled the correct target gesture as required (i.e., caregiver fidelity; Figure 1A-B). Videos were included if caregiver fidelity criteria were met and at least 10s of the baseline and 80s of the 160s stimulation period were coded as usable (e.g., newborn's face in view and eyes open). Based on these criteria, 66 videos from 16 participants (51.16% of 129 sessions) were included in the analysis. Allowing repeat participation by caregivers modestly increased the participant-level inclusion rates, from 24.14% on the first attempt to 55.17% when considering all attempts (Figure 2B). Finally, we examined preliminary rates of neonatal mimicry of caregiver gestures in this small pilot sample (included N=16), following standard analyses used in laboratory studies. Newborns did not significantly produce higher gesture rates (MO or TP instances per sec of usable time) from baseline to experimental periods (paired Student's t-test; MO rates in MO condition: $t(7) = 0.14$, $p = 0.896$; TP rates in TP condition: $t(7) = 0.92$, $p = 0.386$). Additionally, newborns did not show more MO production from baseline to experimental periods when the caregiver modelled MO (matching) compared to when the caregiver modelled TP (non-matching), and vice versa for TP production (independent Student's t-test; MO rates: $t(11.33) = 0.66$, $p = 0.523$, TP rates: $t(13.44) = -0.33$, $p = 0.748$) (Figure 2C-D). Taken together, the current findings provide a proof of concept for conducting asynchronous online behavioral studies involving newborns and their caregivers. These pilot findings indicate that webcam videos are sufficient for coding neonatal facial gestures to laboratory standards, and that the paradigm is feasible for caregivers to complete

from the comfort of their home. Clear instructions and allowing repeat participation may aid in increasing inclusion rates for asynchronous online paradigms of neonatal mimicry.

P3-B-385 - Exposure to SARS-CoV-2 in pregnancy, family context and child development at six months of age: an exploratory study (Alves)

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Objective: to analyze the association between exposure to SARS-CoV-2 during pregnancy, risk factors in the family context, and the occurrence of suspected developmental and behavioral problems in infants at six months of age. Methods: This is an observational, longitudinal, and exploratory study based on a serological survey for IgG antibodies against SARS-CoV-2 carried out during neonatal screening in five Brazilian municipalities, followed by the screening for developmental and behavioral problems at six months of age. Blood for the serological survey was obtained through a heel puncture when the newborns attended the basic health units for the routine newborn screening. All mothers of neonates under seven days old were invited to participate in the study. The present study sample is compounded by 202 children recruited during April and May/2021. We obtained 1,900 dried blood spots which were tested for SARS-CoV-2 IgG anti-nucleocapsid by ELISA. About 15% of the newborns of asymptomatic mothers were seropositive for IgG anti-N. Mothers were interviewed by telephone during the first month postpartum to characterize their clinical and sociodemographic conditions. When children were six months old, mothers answered the Survey of Wellbeing of Young Children (SWYC) questionnaires to screen for child development and behavior problems, food insecurity, alcohol and drug abuse by family members, maternal depression, and domestic violence against women. The association of the serological results with the family context variables and the results of the SWYC questionnaire was examined by the Chi-square Test. The significance level was set at 5%. This study was approved by the Universidade Federal de Minas Gerais Ethical Committee and corresponds to the preliminary results of a larger research. Results: Table 1 shows the characteristics of the 202 mother-newborn dyads included in the present study. Most mothers studied for less than 12 years and were of low socioeconomic status. Only 30% of the mothers reported COVID-19 symptoms, most of them in the third semester of the pregnancy. Neonates were, in general, born at term and with good birth weight. In the present sample, 47% of the newborns were seropositive for IgG. Graphic 1 shows the comparison between seropositive and seronegative children regarding the SWYC results. Seropositive and seronegative children showed similar results in the developmental (p-value = 0.55) and behavioral (p-value = 0.76) problems screening. We did not also find differences between groups considering alcohol and drug abuse by family members (p-value = 0.84), maternal depression (p-value = 0.12), and domestic violence against women (p-value = 0.34). The proportion of seropositive children exposed to food insecurity was higher than seronegative ones, indicating a trend towards significance (p-value = 0.055). Conclusions: There was no association between exposure to SARS-CoV-2 during pregnancy and suspected developmental and behavioral problems at six months. However, we observed a greater proportion of families with food insecurity in

the seropositive children group, which may represent an obstacle for these children reaching their potential development. Longer follow-up is essential for understanding the effects of exposure to the coronavirus during pregnancy.

P3-B-386 - Decoding functional brain networks through graph measures in infancy: The case of emotional faces. (Polver)

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The human brain can be conceptualized as a set of dynamic networks from which mental states and cognitions emerge. Graph measures represent an optimal way to investigate neural networks' organization, yet their use in the first months of life is limited. The current study aims to disambiguate differential sets of brain activity in response to static and dynamic facial expressions of emotions in 7-months-old infants, applying graph theoretical measures to assess infants' functional topological connectivity. Infants were divided in two groups and presented with either static (N = 21) or dynamic facial emotional expressions (N = 22). We then combined a decoding technique (i.e., the Principal Component Regression - PCR) to graph metrics computation. Nodes' Within Module Degree Z Score (WMDZ) was computed as a measure of modular organization, and we decoded networks' functional organizations across EEG alpha and theta bands. Results of the PCR showed a significant association between experimental condition and PCA WMDZ components in the alpha band, $\chi2(22) = 49.26$, $p < .001$) and in the theta band, $\chi2(22) = 50.14$, $p < .001$). Regarding the alpha band, a component, encompassing right temporal, frontal, central and occipital electrodes, proved to be significant ($b = -1.05$, $z = -3.49$, $p = .01$; dynamic > static). These results highlighted the presence of a specific modular structure indexing activity in response to dynamic emotional faces. Since the alpha band has been implied in perceptual and cross-modal binding in the context of large-scale integration processes (Hummel & Gerloff, 2005), alpha-mediated communication between distant brain areas may provide the basis for integration of complex information, with activity in sensorimotor networks scaffolding more advanced processing, such as those triggered by dynamic facial expressions of emotions (Fransson et al., 2011). For the theta band, three different components showed to be significant: the first one encompassed centro-parietal and temporal electrodes ($b = 0.77$, $z = 3.13$, $p = .01$; static > dynamic), the second one comprised frontal and left temporal electrodes ($b = 0.98$, $z = 3.54$, $p = .009$; static > dynamic), and the third one comprised temporo-parieto-occipital and central electrodes ($b = -0.75$, $z = -2.76$, $p = .04$; dynamic > static). Results for the theta band were coherent with the differentiation between visual streams, as activity in response to static emotional faces was more ventral, while activity in response to dynamic emotional faces was more dorsal. Besides differentiations, we observed invariances in topological organizations across static and dynamic emotional faces presentation: WMDZ components implicated mostly the same topological areas. Such activities may index an invariance of face processing in infants' brains, going beyond presentation modalities. Overall, results for the theta band are in line with the hypothesis of a specific functional role of theta oscillations in the development of brain areas subtending social processing, otherwise known as the social brain network (van der Velde et al., 2021). Current results will be discussed with respect to the use of graph measures as a useful tool for investigating brain networks' organization in early infancy.

P3-B-387 - Brain response to unexpected events underlying babies understanding about physical rules: developmental changes between 9 and 16 months of age. (Conejero)

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Recent research on infant's learning has demonstrated that as early as at 11 months of age babies have a general implicit knowledge about the physical laws that rule the world (Stahl & Feigenson, 2015): they tend to look longer to objects that seem to violate gravity or solidity principles, interacting with these objects in a specific way for testing their properties once they are allowed to manipulate them. Besides, there is a growing body of literature on infants' neural mechanisms related to the detection of errors and unexpected events. EEG studies with infants have found that neural activity over fronto-central sites of the scalp is modulated by unexpected events such as observed arithmetic errors (Berger et al., 2006), impossible ending of actions in a sequence (Reid et al., 2009) or mistakes in animal puzzles formation (Conejero et al., 2018). Both a fronto-central deflection (considered as a precursor of the ERN component) and a burst in theta power has been generally found in response to the violation of expectancies. These are regarded as neural markers of executive attention. In the present study, we investigated functional brain activity in relation to the processing of the violation of physical rules at 9 (n=44) and 16 (n=45) months of age. EEG was registered while infants were presented an ERP-adapted protocol of Stahl and Feigenson (2015) original paradigm. As we expected, we found a greater negativity for the condition of physical rules violation compared to the no-violation condition at both ages. Nevertheless, enhanced ERP amplitude was observed in older infants. Regarding the ERP component location, it was lateralized to the left, similarly to our previous findings (Conejero et al., 2016). At the same time, babies showed increased theta power in response to the violation of physical rules. However, whereas 9-month-olds showed the increment in the 4 Hz frequency band, 16 months-olds presented that increment in the 5 Hz frequency band. Finally, we explored the relationship between neural activation to physical rules violation and the preference behaviour showed by infants to objects that violated the physical laws. With this study we replicated prior results on error detection/expectation violation with a new paradigm, examining age differences. Results are further discussed considering their implication for the understanding of the role of executive attention processes in learning in the first years of life.

P3-B-388 - Neural correlates of the mother's voice recognition in six-month-old infants at high- and low-risk of ASD (Hoshino)

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ver the course of the first year of life, infants develop various cognitive abilities through the interaction with their caregivers. Likewise, they acquire the first language mostly from their caregivers. Recognizing voice identity is one of the important aspects of such interaction between infant and caregivers on the grounds not only for speech perception but also for understanding other social signals. Children with autism spectrum disorder (ASD), however, show impairment in familiar voice recognition compared to typically developing children (Boucher et al., 1998) and show weak functional connectivity between superior temporal gyrus (STG) known as voice-selective area and the reward system including orbitofrontal cortex (Abrams et al., 2013). It is not clear whether this discrepancy emerges during the period of infancy. Here, we focus on the difference in the cerebral base between infants at high- and

low-risk of ASD in terms of familiar voice recognition. We investigated differences in the cerebral activity and connectivity during processing speech spoken by mother and stranger between infants at high- and low-risk for ASD. Our final dataset included data obtained from 21 six-month-old infants at high-risk (HR) for ASD (who have an older sibling with ASD, partly included preterm infants) and age matched 26 full-term infants at low-risk (LR) for ASD. We measured infants' brain activity in the frontal and temporal areas using fNIRS in response to speech. The stimuli were spoken either by their mother or stranger with an infant-directed fashion for 15 s for one trial (more than 6 trials). For analysis, we applied the conservative averaging method with permutation tests and examined functional connectivity using phase locking values from the oxy-hemoglobin changes. When listening to the mother's speech, LR showed significantly increased activation in bilateral cortical regions including the supramarginal gyrus (SMG), STG, the inferior frontal gyrus (IFG) and the dorsolateral prefrontal cortex (dlPFC) whereas HR showed significantly decreased activation in the left STG and right dlPFC. On the other hand, in case of the stranger's speech, LR showed less activated regions than those for mother's speech, while HR showed increased activation in the right SMG. Group analysis revealed that the right STG was significantly more activated in LR than HR when listening to the mother's stimuli and the right dlPFC was significantly less responded in LR than HR to the stranger's stimuli. There were significantly strong connectivities from the right STS as a seed to the bilateral dlPFC and the ipsilateral STS in LR, when listening to their mother's voice. However, HR showed the similar pattern of connectivities in response to the stranger's speech. These results suggest that weaker processing of familiar voice in HR already emerged at 6 months of age and this may lead to impaired development of the language and social skills. We will discuss these results in relation to other behavioral data (e.g. still face paradigm, developmental test) and questionnaires (e.g. CDI, M-CHAT) of our longitudinal study.

P3-B-390 - EEG mu rhythm: Neural reactivity to facial gestures in 6- to 9-week-old infants (Davinson)

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A fundamental aim for developmental social neuroscience is to identify the neural underpinnings of action perception and understanding, and as characterize how these mechanisms emerge in relation to social cognition. The electroencephalogram (EEG) sensorimotor mu rhythm (adult: 8-13 Hz) is one potential candidate, as it exhibits neural mirroring properties. Specifically, mu rhythm desynchronization (MRD; decrease in oscillatory activity relative to baseline) occurs both when performing an action and observing someone else perform the same action (Muthukumaraswamy & Johnson, 2004). There is evidence of neural mirroring in newborn rhesus macaque monkeys (5-6 Hz MRD) and 9-month-old human infants (6-9 Hz MRD) during the observation and execution of facial gestures (Ferrari et al., 2012; Rayson et al., 2017). However, it is unknown when human infants first display MRD or neural mirroring. The present study investigates 6- to 9-week-olds' MRD in response to facial gestures. We hypothesized significant MRD during observation (and execution) of facial gestures but not non-biological movement (spinning disc), our control condition. Forty-seven infants observed a series of 20-s tongue protrusion (TP), mouth opening (MO), spinning disc, and baseline (still face or disc) trials (as per Ferrari et al., 2012; Meltzoff & Moore, 1992). Preliminary analyses are based on usable data 27 infants (14 females; 13 males); EEG processing and spontaneous facial gesture coding are still ongoing. Mu rhythm was defined as 2.5-4.5 Hz based on evidence of ≈3 Hz peak prehension MRD by 11 weeks (Berchicci et al., 2011). MRD was calculated using the equation [(A-R)/R)]*100 (A= observation power; R= baseline power;

Pfurtscheller et al., 1999). Primary analyses focused on central (C3/C4) sites while supplementary analysis of frontal (F7/F3/Fz/F4/F8), parietal (P7/P3/Pz/P4/P8), and occipital (O1/O2) sites characterized scalp topography. One-sample t-tests indicated significant MRD during MO observation localized to central sites ($t(25)= -2.25$, $p= .03$; see Figure 1). However, there was no significant MRD during the observation of TP at central sites ($t(26)= 1.35$, ns) or across the scalp. Importantly, the control disc condition only elicited desynchronization at occipital sites ($t(20)= -3.18$, $p= .005$). In figure 2, MRD values at central sites show the variability in MRD scores based on facial gesture type. Our findings provide preliminary evidence that 6- to 9-week-old human infants exhibit 2.5-4.5 Hz MRD at central scalp sites during the observation of MO, but not non-biological motion. However, unlike evidence from newborn macaques, there was no group-level effect for TP gestures. This unexpected pattern will be explored further, as we will use gesture production data to empirically define the mu frequency range for this developmental period and consider individual differences in mu frequency when examining neural mirroring. At the same time, variability in early MRD is hypothesized to be related to social cognition (Bowman et al., 2017; Tramacere & Ferrari, 2016). Thus, evidence of individual differences in MRD in our longitudinal sample has potential informative value as we consider subsequent indices of social learning. Our findings will be discussed in relation to the active intermodal mapping (AIM) model of early perception-action learning (Meltzoff & Marshall, 2018).

P3-B-391 - Associations between infant amygdala functional connectivity and infant affective engagement following a stressor (Hu)

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The amygdala is a key node in the human brain supporting emotional processing. Among infants, higher levels of amygdala functional connectivity (FC) with the default-mode network (DMN, a neural network supporting self-referential emotional processing) and the salience network (SAL, a network underlying detection of personally relevant stimuli) has been linked to infants' higher negative emotionality and lower positive emotionality (Phillips et al., 2021; Thomas et al., 2019). Further, greater FC within the amygdala has been observed among infants of mothers with higher levels of depression during pregnancy (Rotem-Kohav et al., 2019). Prior studies have typically used caregiver-report measures of infant emotional functioning at a single time point, and less is known about how amygdala FC is related to concurrent and later infant responses to stressors. In this study, we examined the associations between amygdala FC (i.e., within-network connectivity and between-network connectivity with DMN and SAL) at 3 months and observed infant recovery from a social stressor at 3 and 6 months. We hypothesized that greater within-network amygdala FC, as well as greater amygdala-DMN and amygdala-SAL at 3 months, would be related to worse infant stress recovery at 3 and 6 months. Participants were 34 mother-infant dyads (13 girls; mothers were 86% European American). At 3 months, resting-state fMRI data were acquired during natural sleep. After standard data preprocessing, a seed-based approach was used to define key neural networks. Specifically, seeds within the amygdala, the posterior cingulate cortex, and the anterior insula were used to define the amygdala, DMN, and SAL, respectively. Within-amygdala, amygdala-DMN, and amygdala-SAL FCs were calculated (see Figure 1 for the amygdala FC map). At 3 and 6 months, infants were observed during the Still-Face Paradigm, which included three 2-min episodes (play, still-face, and reunion). To capture infant recovery following a stressor, we micro-coded infants' facial expressions, vocalizations, and gaze during the reunion, and

computed the proportion of time infant exhibited social engagement (i.e., infants gazed towards mother's face or interaction-related objects with positive or neutral facial expressions and vocalizations) during the reunion. Consistent with our hypotheses, and corrected for multiple comparisons (i.e., $p < .008$), bivariate correlations (see Figure 2) showed that greater within-network amygdala FC, as well as greater amygdala-SAL FC at 3 months, predicted less infant social engagement during the reunion at 6 months. These associations approached significance at 3 months. Surprisingly, less negative amygdala-DMN FC was associated with more social engagement during the reunion at 6 months, although this association does not survive correction for multiple comparisons. The associations between amygdala FC patterns at 3 months and infant engagement following a stressor suggest that infants' ability to regulate their negative affect with the help of their mothers may benefit from lower levels of functional connectivity within the amygdala and higher levels of functional segregation between the amygdala and the SAL during early infancy. Interestingly, these associations did not emerge until 6 months, indicating that well-organized functional architecture of the infant brain may contribute to a more optimal behavioral stress response over time.

P3-B-392 - Changes in functional connectivity dynamics in full-term and preterm infants (Cai)

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Introduction Earlier exposure to the extrauterine environment has been a leading factor resulting in a higher rate of neurodevelopmental impairment. Accumulating neuroimaging evidences have shown aberrant alterations in static resting-state functional connectivity (FC) in preterm infants (Eyre et al., 2021). However, dynamic FC may be a more sensitive biomarker than static FC (Lurie et al., 2019). Thus, this study adopted functional near-infrared spectroscopy (fNIRS) to investigate how gestational age (GA) and chronological age (CA) of infants modulate dynamic FC. Materials and Methods 27 full-term (GA range: 259-293 days; CA range: 1-5 days) and 36 preterm neonates (GA range: 161-251 days; CA range: 4-136 days) were included in the final analysis. The resting-state data of all neonates were collected with an fNIRS system covering the bilateral temporal and frontal areas (Fig.1A, left). For each neonate, we extracted 3-min artifact-free data from 46-channel time courses of the oxy-Hb concentration to perform further dynamic FC analyses by means of a sliding window correlation approach (Allen et al., 2014). Specifically, a 60-s time window was selected and then slide with 1 s. The time points of all time courses within the window were cross-correlated using the Pearson correlation, yielding 121 dynamic FC matrices. Then, to estimate the variability of each pairwise FC, the standard deviation of each pairwise FC was computed. Associations between FC variability and age (GA, CA) were evaluated by calculating the linear correlation. Moreover, k-means clustering was used on the concatenated dynamic FC matrices across all infants to cluster into 3 FC states. Finally, associations between three predefined metrics and age (GA, CA) were computed to assess changes in FC state expression with age. The three metrics were defined as follows: (1) frequency (F), measured as the proportion of all windows classified as instances of each particular state; (2) mean dwell time (MDT), measured as the average number of consecutive windows classified as instances of the same state; and (3) transition frequency (TF), measured as the number of state transitions from one state to the other state. Results and Discussion We found that variability of across-areas long-range FC (e.g., frontal-left FC and frontal-right FC) showed a negative correlation with CA, whereas that of left-right long-range FC and short-range FC within frontal areas

was positively associated with CA (all ps < 0.05; Fig. 1A, middle). Compared with relations between CA and FC variability, those between GA and FC variability were inversed for FC with similar locations (Fig. 1A, right). Moreover, infants displayed three brain states across all scan time, where state 2 and 3 dominated (Fig. 1B). Notably, F and MDT of state 3, as well as TF between state 2 and state 3, were positively correlated with CA (all rs > 0.29, all ps < 0.05), however, these metrics were negatively correlated with GA (all rs < -0.27, all ps < 0.05). All findings indicate CA and GA modulated the infant brain dynamics and provide a novel insight into the effect of preterm birth on resting-state brain networks.

P3-B-393 - Exploring infants' neural responses to sociomoral scenarios via EEG (Soleimani)

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Studies suggest that even preverbal infants distinguish between prosocial and antisocial individuals (Hamlin, Wynn, & Bloom, 2007; Margoni & Surian, 2018). Over the past two decades, infants' sociomoral evaluations have been studied through different forms of helping/hindering, fair/unfair distributions, and comforting/harming; the majority of these studies showed that infants prefer prosocial to antisocial characters, suggesting that the ability to sociomorally evaluate others is early emerging. However, some propose an alternative interpretation and argue that infants instead prefer agents that are associated with positive perceptual events (e.g., Scarf et al., 2012). Although behavioral research has shed light on the mechanism underlying infants' sociomoral evaluations, behavioral studies are limited because of infants' physical capacities and the inherently multi-determined features of infants' responses. Neuroimaging can help to address this issue by examining specific neural signatures that have been associated with (for instance) social processing and evaluation versus lower-level attentional processing. To date, only three studies have examined infants' neural responses to sociomoral stimuli; each utilized EEG and infants viewed helper and hinderer events in the "hill paradigm" from Kuhlmeier, Wynn, and Bloom (2003; Cowell & Decety, 2015; Gredebäck et al., 2015; Tan & Hamlin, under review). The most recent of these included (relatively) large samples of both 6- and 12-month-olds, and measured brain activity (1) as helping and hindering events unfolded (2) toward still images of helpers and hinderers. Results indicated greater right frontal alpha power (indexing approach motivation) when 6-month-olds (though not 12-month-olds) viewed helping versus hindering. Further, both 6- and 12-month-olds showed significantly greater amplitudes in the P400 (and related N290) ERP components to hinderers versus helpers (indexing social perception); no significant differences were observed for the Nc component (indexing attentional allocation). These findings are broadly consistent with past work and, critically, implicate both social and evaluative processes in infants' responses to sociomoral behaviors and actors. Unfortunately, because to date all work examining infants' neural activity during sociomoral acts has used a single helping/hindering scenario (the hill), observed patterns of neural activity may not reflect responses to helpful/unhelpful actions and individuals more broadly but may be specific to infants' processing of hill events. To explore this possibility, an ongoing and preregistered study in our lab (https://osf.io/v5bjk/) aims to conceptually replicate Tan & Hamlin (under review) using a distinct helping and hindering scenario in which a character tries but fails to open a box (Hamlin & Wynn, 2011). Our preregistered sample includes 32 6- and 32 12-month-olds; data collection began in October 2021 and sufficient data for a poster should be obtained by July 2022. The proposed poster will present results from both Tan & Hamlin (under review) and our new preregistered study,

ultimately assessing to what extent past neuroimaging results reflect neural responses to varied instances of helpful and unhelpful acts.

P3-B-394 - Neonate Voxel-Mirrored Homotopic Connectivity of Resting-state fMRI correlates with reported maternal pandemic-related social disruption (Majbri)

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Background: Prior research has found that maternal stress during early development can result in changes in functional connectivity, which in turn carries an increased risk for the development of psychiatric disorders (Scheinost, 2016; Thomason, 2013). Policies implemented to reduce the spread of SARS-CoV-2 resulted in unprecedented disruptions to social interaction, a potent stressor across multiple species (Venta, 2021). Population surveys conducted during the acute phase of the COVID-19 pandemic have confirmed increases in population-wide stress (Robillard, 2020). Methods: Pregnant mothers were recruited between December 2020 and October 2021 to complete the COPE Survey, which asks about a number of COVID-related experiences. For the present study, mothers rated the extent to which the pandemic disrupted their ability to engage in social and work activities. Resting-state fMRI images were obtained from fourteen neonates following birth, with data collection ongoing (Table 1). A voxel-based approach was used to calculate homotopic connectivity (VMHC) from at least 10 minutes of resting-state fMRI data. Next, voxel-wise partial correlations between VMHC and social disruption were calculated controlling for infant sex and age. Statistical maps were corrected for multiple comparisons by cluster-extent based thresholding at $p < 0.04$ and cluster size > 100. Results and Discussion: 92.9% of participants reported a pandemic related work disruption, with 71.4% reporting either a moderate or an extreme work disruption (n=14). Stronger cross-hemisphere functional connectivity in the medial prefrontal and posterior parietal areas was correlated with higher reporting of pandemic-related social disruption (Fig. 1), which is consistent with mouse studies that show social isolation stress causes changes in neuroplasticity genes within the pre-frontal cortex (Ieraci, 2016). Evaluating the degree of social isolation stress in participants, 71.4% of participants reported not feeling lonely during the pandemic and 92.9% reported feeling not at all tense or a little bit tense, suggesting this sample may be fairly well buffered against the negative social impacts of COVID-19 (n=14). Indeed, given the high socioeconomic status of our sample (Table 1.), social and work disruptions may have enabled new parents to spend more time with their newborn. Interestingly, when participants were asked to rate changes in living environment since the start of the pandemic, out of the 42.9% that did report a change, 83.3% reported a positive change. These findings suggest that the pandemic is not uniformly resulting in increased social isolation, but rather has impacts that are shaped by socio-personal inequalities.

P3-B-395 - Impact of chronic inflammation on fNIRS resting state functional connectivity in Bangladeshi children (Pirazzoli)

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Introduction: Chronic inflammation (CI) can be caused by several early life adversities including infections and psychosocial stressors, and it has been associated with long-term effects on physical and mental health. Children growing up in extreme poverty are at increased risk of CI due to their exposure to both biological and psychosocial adversities. A link between CI and cognitive outcomes was shown in children raised LMIC, however, to date only a few studies have investigated the mechanisms behind this association. Objective: We employed functional Near Infrared Spectroscopy (fNIRS) to examine associations between brain resting state functional connectivity (RSFC) and a measure of CI in children raised in a low resource setting. Methods: Thirty-six months old children (N=95) from an urban impoverished neighborhood in Dhaka, Bangladesh took part in the study. fNIRS resting state data were collected using a Gowerlabs NTS system with 38 channels while children watched a 2-minute video of moving toys. Arrays covered the portion of cortex extending from the inferior frontal gyrus to the posterior temporal cortex. Aiming to measure RSFC over the language network, we calculated two ROIs following anatomical coregistration: the inferior frontal gyrus (IFG) and a posterior portion of the temporal cortex (pMTG/STG)). To index RSFC we calculated Pearson correlations between every pair of channels as well as every pair of ROIs. We also calculated the difference in RSFC between different pairs of ROIs to have a measure of networks functional distinction. We collected serum C-reactive protein (CRP- a marker of systemic inflammation) at six time points during the first 3 years of life. Number of CRP elevations (index of CI) was associated with FC measures using simple correlations. Results: Homologous ROIs (e.g., right and left IFG) showed higher RSFC compared to non-homologous ROIs (e.g., right IFG and left pSTG/MTG) indicating well developed FC (ps<.001). Higher levels of CI (i.e., more prolonged states of inflammation) were associated with decreased connectivity within the left hemisphere (lIFG- lpMTG/STG) (r=.267, p=.034). Higher levels of CI were also associated with reduced discrimination between the left hemisphere network (lIFG- lpMTG/STG) and (1) the right hemisphere network (rIFG-r pMTG/STG) (r=.305, p=.015), and (2) a cross-hemispheric network (lIFG-rpMTG/STG) (r=.361, p=.004). This could suggest that higher CI is associated with a less functionally distinct language network. Conclusions: These preliminary results suggest that the impact of inflammation on brain development can be detected using RSFC measures at 3yo. Specifically, it emerges that RSFC in language networks is negatively associated with this measure of CI. Analyses of 6- and 24-months old infants (longitudinal cohort) raised in the same neighborhood are underway and will complement the present work to yield a better understanding of the development of RSFC and its interaction with inflammation over the first three years of life. The indirect effect of inflammation on cognitive outcomes (measured with the Mullen Scales of Early Learning) via brain FC will also be tested and discussed.

P3-B-396 - White Matter Changes from Infancy to Adulthood (Richards)

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Diffusion MRI is well suited to track the development of white matter (WM) across the lifespan. Diffusion tensor imaging (DTI) provides in vivo indices of WM structure and tractography analyses can help to further investigate the major WM connections. In the current study, we used DTI to investigate developmental trajectories of WM fractional anisotropy (FA) and mean diffusivity (MD) in typically developing subjects across the lifespan. Probabilistic tractography algorithms were applied to reconstruct and analyze 16 major fiber bundles. We compiled a total of 5407 multi-shell diffusion MRI volumes from our scanning acquisitions and open-access sources. Participants included in the final

sample (n = 2864 females, n = 2540 males) ranged from 30 days to 89 years. All diffusion MRI volumes were corrected for susceptibility-induced distortions, Eddy current, and motion artifacts. A diffusion tensor model was fitted at each voxel of the brain to estimate FA and MD parameters. FSL toolboxes were utilized to perform probabilistic tractography and reconstruct 13 association and 3 commissural tracts, listed in Table 1. Linear mixed-effects models were performed to test the effect of age, biological sex, hemisphere (association tracts only), and their interaction, considering the database as a random effect. In a separate set of analyses, we compared the null, linear, quadratic, and cubic fits for all measures. Figure 1 depicts the FA and MD across the lifespan for the whole sample and as a function of the participant's sex. There was a relation between the change in the FA value and age ($F(1,5251) = 226.93$, $p < .001$), regardless of participant's biological sex ($F(1, 5251) = .62$, $p = .433$) and its interaction with age ($F(1, 5251) = 2.67$, $p = .102$). MD values showed to be related to the interaction between age and sex ($F(1,5121) = 62.98$, $p < .001$), and to the effect of sex ($F(1,5121) = 10.66$, $p = .001$) and age ($F(1,5121) = 576.34$, $p < .001$). These results indicate a decrease in the FA values and an increase in the MD values across the lifespan. The MD changes occur at a different rate between male and female participants, with a larger increase in MD for males at older ages. Both FA and MD changes were best described by the cubic model (FA: $F(1,5251) = 18.71$, $p < .0001$; MD: $F(1,5121) = 12.81$, $p = .0003$). The FA change was related to the age factor ($F(1,148579) = 70.29$, $p < .0001$) and the interaction between age and sex ($F(1,148579) = 6.02$, $p = .014$) for all considered tracts. FA values decreased across the lifespan for all tracts, and males had higher FA values than females. For the association tracts, the change in FA values was also related to the interactions between tract and hemisphere ($F(1,132548) = 22.38$, $p < .0001$). The effect of the hemisphere was significant for all tracts except for the uncinate fasciculus, in which the FA change was similar for the left and right hemispheres. Overall, these results suggest that a cubic trend best describes the changes in WM properties. The developmental rate varies between female and male subjects and between WM tracts.

P3-B-397 - Using fNIRS to assess resting-state functional connectivity and its relation to temperament at 5 and 7 months (Chajes)

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Conducting longitudinal assessments that link functional brain connectivity during infancy with behavioral outcomes is an important step towards identifying early biomarkers of later behavioral problems. Previous work (e.g., Kelsey et al., 2021) has shown that variability in cortical connectivity patterns can be associated with differences in temperament, and that these associations can be observed in infants as young as 1 month of age. Specifically, this study found that functional connectivity in the fronto-parietal network was positively correlated with behavioral temperament, while connectivity in the default mode network was negatively correlated. Currently, we aim to test whether these associations are stable over the first 7 months of life by examining the relation between functional connectivity in these networks and infant temperament at 5 and 7 months in the same cohort of infants as Kelsey et al. (2021). We will utilize preexisting data from the 5- and 7-month timepoints of this longitudinal study, including resting-state functional connectivity in the fronto-parietal network and the default mode network obtained using functional near infrared spectroscopy (fNIRS), and infant temperament scores generated from the Infant Behavior Questionnaire Revised Short Form. Using a multiple linear regression with network type as the predictor variables and behavioral regulation as the

outcome, we will assess whether the relation between resting-state functional connectivity in these networks and infant temperament mirrors the previous correlations observed during the 1-month timepoint. These results will contribute to our understanding of the relative stability of the associations between functional brain connectivity and behavioral regulation during early infancy and how we can use early measures of brain connectivity to predict future behavioral outcomes.

P3-B-398 - The impact of socioeconomic status and maternal sensitivity on the development of functional connectivity in infants (Chajes)

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Infancy is a critical period of neurodevelopment that is heavily influenced by the family environment as well as the larger context within which the family resides. It has been well-established that proximal factors, such as sensitive parenting, shape functional brain development during the first years of life (e.g., Perry et al., 2017). Additionally, distal factors, such as socioeconomic status, are known to predict differences in structural and functional brain systems across the lifespan (e.g., Noble & Giebler, 2020). However, questions remain regarding how these familial and contextual factors interact to impact functional brain development during infancy, and particularly how these effects manifest in the infant brain during the first few months of life. Using a variety of neural and behavioral measures collected as part of an ongoing longitudinal study of mother-infant dyads during the first years of life, we aim to examine the interplay between these factors and assess how maternal sensitivity, taken within the broader context of socioeconomic variation, influences the development of long-range functional cortical networks in the infant brain. Socioeconomic status, indexed through family income and maternal education, was collected when infants were 1 month of age, while maternal sensitivity was assessed during a free play interaction when infants were 5 months. Additionally, functional near-infrared spectroscopy (fNIRS) was used to measure infants' resting-state functional connectivity in frontal and temporal-parietal regions of the cortex. Preliminary analyses suggest that 5-month-old infants from high income families whose mothers showed greater levels of sensitivity during the free play interaction exhibited greater functional connectivity overall rather than in a network-specific manner. This suggests that while there may not be network-specific effects at this age, income and maternal sensitivity may be associated with greater long-range functional connectivity in the developing human brain more generally. Furthermore, initial findings also point to the possibility of an interaction between income and sensitivity, specifically when looking at the fronto-parietal network, such that low-income infants with highly sensitive mothers showed enhanced functional connectivity in this network. This may point to the possibility that infants from low-income families 'benefit' most from maternal sensitivity when it comes to the development of the fronto-parietal network. Taken together, this work provides unique insights into the effects of familial and contextual factors and their interactions on the development of infants' functional connectivity networks during the first six months of life.

P3-B-399 - How are infants' attentional behaviours during free play substantiated in their brains during the first year of life? (Perapoch Amadó)

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Infant visual attention has been widely studied with measures of changes in the power spectral density of EEG oscillations in different frequency bands (Xie, Mallin and Richards, 2018). Increased theta (3-6Hz) has been observed during anticipatory and sustained attention (SA) (Stroganova et al.,1998; Orekhova et al., 1999; Berger et al., 2006; Bazhenova et al., 2007, Xie, Mallin and Richards, 2018); other studies have found attenuation in infants' alpha (6-9Hz) activity during SA (Orekhova, Stroganova, & Posikera, 2001). These findings have led several authors to both interpret theta activity as an index of active control of attention and cognitive effort (Begus & Bonawitz, 2020; Orekhova et al., 1999; Xie, Mallin and Richards, 2018; Bosseler et al., 2013), and consider "alpha desychronization" as an electrophysiological sign of increased cortical excitability (Jones et al., 2015; Orekhova, Stroganova, & Posikera, 2001). Although the scope of these findings is vast and well replicated, the statistical models used are primarily concerned with analysing the EEG data during whole episodes of looking but are not linked to any particular event. Thus, little is known on what happens in the brain exactly before and during an attentional episode. The current study aims to explore developmental time-locked changes in brain activity within and prior to individual episodes of attention in a context of free solo play. We are collecting looking behaviour and EEG data from typical 5- and 12-month-olds infants playing alone while seated at a tabletop with 3 toys. This age range was chosen as it represents a key period for both the development of infant theta and alpha activities (Marshall et al., 2002) as well as the ability to allocate and maintain focused attention (Orekhova, Stroganova, & Posikera, 2001). The looking behaviour will be manually coded on a frame-by-frame basis (50fps) to allow the identification of attentional episodes to individual toys. Each infant look onset will be identified in the EEG signal. Artifact rejection will be conducted following Marriott Haresign et al. (2021). We will extract 1000ms immediately before and 3000ms after the onset of each look, across all channels. An additional 200ms will be extracted prior to these segments to serve as baseline. Time-frequency decomposition will be conducted on each look epoch to explore changes in oscillatory activity between 5- and 12-months old infants around these pre-selected attentional moments. We will also examine the relationship between EEG power within the time window preceding the look and look duration using linear mixed effects models. Additionally, we will use auto-correlations on looking behaviour time series data to assess the rate of change of attentiveness. As voluntary control of attention improves over time and brain regions become increasingly specialized, we expect a developmental increase in the strength of the association between the neural correlates of behaviour and attention behaviours. Accordingly, we expect that, over time, we will see 1) increased theta activity prior to look onsets, 2) a strengthened relationship between theta activity prior to the look and the duration of subsequent attentional behaviours, and 3) increased theta synchronisation and alpha desychronization during SA. Behaviourally, we expect 4) increased look durations, and 5) decrease in the rate of change of attentiveness.

P3-B-400 - A Protocol for Neurophysiological Testing of Infants in the First Year of Life During Routine Pediatric Checkups (Phan)

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Background: The autism spectrum disorders (ASD) comprise a heterogeneous set of pathologies which are now believed to occur in 1:54 children or a prevalence approaching 2%. The mean age of diagnosis

of ASD is 4 years and 3 months, with half not diagnosed until after 6 years. Diagnosis and screening instruments for ASD are based on behavioral assessments, and therefore do not become useful clinically until at least 18 months of age when ASD-characteristic behaviors emerge. There is evidence that the earlier the intervention, the better will be the long-term outcome. There is growing consensus that atypical neural development in the first year of life precedes ASD symptoms. The ideal opportunity for personalized intervention may be during this prodromal period, when developmental trajectories might be redirected toward more typical trajectories. But very early intervention, before symptoms appear, requires very early detection based on neurophysiological measurements. Research by our groups and others has shown that two rapidly deployed, easy to use and inexpensive measures of brain development, brainstem auditory evoked response (ABR) and electroencephalography (EEG) together with nonlinear analysis and predictive analytics can be used within the first year of life to predict a later outcome of ASD. Objective: The goal of this feasibility study is to demonstrate that EEG and ABR recordings can be done efficiently by staff in a typical pediatrics office or even in a pediatric community care setting for infants under 12 months. Our hypothesis is that general pediatric office staff can be trained to efficiently take ABR and EEG recordings without significantly disrupting routine checkup workflow. Method: This project will be coordinated through Boston Children's Hospital, in collaboration with the New York State Institute for Basic Research and the Allied Physicians Network of NY. Fifty newborn infants who have pediatric care with Allied Physicians Group of NY ("Allied") will be recruited to this study. Staff in two Allied clinics will be trained to take ABR and EEG recordings and upload the data to project cloud servers. For each ABR and EEG recording, the following data will be collected: ● Total time for the EEG measurement, including preparation, actual recording, cleanup, and data upload. ● Caregivers' evaluation of the procedure (using a Likert scale): 1-no concerns to 5- very stressful ● Staff evaluation of the procedure (using a Likert scale): 1-did not mind at all to 5-very stressful Expected Results: An evaluation of a rapid-use clinical protocol for introducing ABR and EEG measurements into a routine infant well-baby checkup workflow. This information is expected to be useful for taking the results of this entire project to the next step of clinical validation, FDA approval, and clinical implementation. Summary: This project will demonstrate the feasibility of collecting ABR and EEG data in the context of a well-baby checkup in a pediatrics office or other routine clinical care setting. This would be the first step toward a large, prospective clinical research project for testing of very early assessments and interventions, which could potentially serve as prophylaxis against the heterogeneous cascade of atypical developmental trajectories that result in autism.

P3-B-401 - Neuroadaptive Optimisation to Study Individual Differences in ERP Responses to Faces of Mother and Stranger (Throm)

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Objective: Attending to the parent's face in the first year of life is crucial for the development of the social brain. Classic Event-Related Potentials (ERP) studies using the Negative Central (Nc) component as a correlate of social attention engagement found that while six-months-old infants engage more deeply with their mother's face compared to a stranger's face (De Haan & Nelson, 1997; 1999), this pattern changes towards the end of the first year of life (Carver et al., 2013). However, classic infant ERP paradigms examining group-level responses to few pre-selected stimuli are limited in studying individual differences in developmental trajectories. Neuroadaptive Bayesian Optimisation (NBO; Lorenz et al.,

2016) is an artificial intelligence-based individualised approach that efficiently uses brain responses analysed in real time to make predictions about individual preferences. Here NBO is applied to infant ERP data to study how the Nc differentially responds to faces varying along a continuum between mother and a stranger. Methods: 60 infants (30: 5-8 months; 30: 9-12 months) will take part in a closed-loop NBO experiment. The stimulus space is created before each session and consists of 12 face images artificially created such that features linearly change from the face of the infant's mother into a stranger's face (Figure 1). A block is composed of 12 trials x 500 ms-presentations of the same face. EEG data are collected from 6 fronto-central channels using a wireless system (ENOBIO; NE Neuroelectrics). Customised Matlab scripts obtain (with Lab Streaming Layer, LSL), pre-process and analyse the EEG data after each block to calculate the mean amplitude of the negative deflection occurring between 250 and 800 ms post-stimulus (Nc negativity, Figure 2). The Nc negativity value is passed to the BO algorithm which fits a Gaussian process model to the sampled data on which basis it selects the next stimulus, aiming to maximise the Nc negativity. This closed-loop will stop once the optimum stimulus is found, when the child shows distress or after 15 blocks. For each child, the optimum-mother distance in the search space will be calculated. Further, parents will fill out the Vineland Adaptive Behavior Scales (VABS, Sparrow et al., 2005) and Infant Behavior Questionnaire- Revised (IBQ-R, Garstein & Rothbart, 2003). The study has been preregistered on OSF (doi: 10.17605/OSF.IO/CWF96). Analysis plan for each hypothesis: 1. Bayesian Optimisation performance: NBO finds the optimal stimulus for >77% of the infants within the of 15 blocks. 2. Age effect: a. The optimal stimulus is closer to mother's face in 5-8-month-old than in the 9-12-month-old infants (one-way ANOVA). b. Optimum-mother distance increases with age (linear regression). 3. Relationship to behaviour: Smaller optimum-mother distances are related to higher VABS socialization scores and VABS-derived responses to a familiar person and lower scores on the VABS- and IBQ-R-derived reactions to others (linear regressions). General implications: This preregistered study proofs whether NBO with infant EEG can efficiently identify an individual infant's preferred stimulus among a range of stimuli while sampling only a limited number. It can then be applied to studying individual differences in socialisation in infancy and provides infant researchers with a novel method to overcome constrains linked to traditional experimental design.

Thematic Poster - Using fNIRS to study how early social interactions impact social brain development: evidence from different cultural contexts (P3-B-402, P3-B-403, P3-B-404)

P3-B-402 - Maternal sensitivity and infant brain response to emotion (Stern)

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INTRODUCTION: Caregivers are a vital context for the development of the social brain in infancy (Ilyka et al., 2021). Research suggests that maternal sensitivity--mothers' attunement and responsiveness to infant signals--may be especially important for early social development, due to its role in shaping neural circuits underlying emotion processing and self-regulation (Rifkin-Graboi et al., 2015). Thus, the present study uses fNIRS to examine the link between sensitive caregiving and infants' neural processing of emotion in the first months of life. We selected a pre-registered area of interest to begin our investigation--the dorsolateral prefrontal cortex (dlPFC)--given its role in self-regulation and social behavior (Grossmann et al., 2018).

HYPOTHESES: We hypothesized that higher levels of maternal sensitivity would be associated with greater infant dlPFC response to emotion at 5m of age. Because infants' bias to detect negative emotions does not emerge until 7m (Vaish et al., 2008), we hypothesized that effects would be specific to positive emotion (i.e., happiness) during this period.

PARTICIPANTS: Data were drawn from a longitudinal study of mothers (84% White, 9% Black, 3% Asian, 3% multiracial/other) and their full-term infants. When infants were approximately 5m old, mother-infant dyads came to the lab to complete a neuroimaging task and a free-play session; data from these tasks were available for N=77 dyads.

METHODS: Infants' neural responses were recorded as they viewed a series of female faces expressing happiness, fear, and anger, as well as non-social images (i.e., vegetables), following Grossmann et al. (2018). Neural responses were recorded using functional near infrared spectroscopy (fNIRS) from 32 optodes to create 49 channels. Following a pre-registered processing pipeline, we extracted average concentration changes in oxygenated and deoxygenated hemoglobin for each channel for each infant; these values were combined to create areas of interest, including the bilateral dlPFC. At the end of the lab visit, mothers and infants completed a 5-minute free-play; videos were coded by a team of trained, reliable coders using Ainsworth's (1969) gold-standard sensitivity vs. insensitivity scale.

RESULTS: Simple correlations revealed a significant positive association between maternal sensitivity and infant neural activation in the bilateral dlPFC in response to happy faces specifically, r=.24, p=.029 (Figure 1), but not the other emotion conditions. To provide a more powerful test of hypotheses, we performed multilevel repeated measures analyses predicting bilateral dlPFC activity, with emotion condition modeled as the within-subjects factor and maternal sensitivity as a between-subjects predictor; each emotion (happiness, anger, fear) was dummy-coded, with the non-social condition as the reference group. Estimates of fixed effects showed significant interactions between maternal sensitivity and happy faces predicting bilateral dlPFC activation. Specifically, infants showed greater dlPFC response to happy faces compared to the non-social condition if their mothers were highly sensitive, b= .25, p=.048, but not if they were insensitive, b= -.14, p=.251.

These initial findings suggest that parental behaviors in the first months of life shape the development of the social brain in infancy. Further analyses will explore additional cortical areas of interest.

P3-B-403 - Parent-infant interactions and neural responses to social contingency: An fNIRS study (Hakuno)

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Introduction: Live social stimuli are an important aspect of human perception, but it remains poorly understood if brain processing of live interactive social stimuli differs substantially from processing of non-interactive social stimuli. Our previous study revealed that 6- to 8-month-old infants showed increased activation in the right temporoparietal junction (TPJ) region in response to contingent smiles of a social partner (Hakuno et al., 2020). In this study, we examined 6- to 7-month-old infants' brain activity in response to social and non-social contingency during real-life interactions across the frontal and temporal regions using functional near infrared spectroscopy (fNIRS). If activation in the right TPJ region is modulated by the quality of ostensive signals, we expect to find differences in neural activation

between the social and non-social contingent conditions. In addition, we investigated the relationship between condition specific brain responses and the behavioral findings during parent-infant free-play interactions.

Methods: Thirty 6- to 7-month-old healthy infants participated in the study. During the social-contingent condition, the experimenter responded contingently to the infant's behavior by smiling immediately after the infant looked at her face with no temporal delays. During the non-social-contingent condition, the light-emitting device on the experimenter's head emitted visible light contingently when the infant looked at her face. Within the baseline, the experimenter behaved in the same manner except when the responses to the infant's behavior were delayed by 3 s. The two experimental conditions were tested separately, and each condition was presented in between baseline trials. After the fNIRS recordings, a parent-infant free-play session was videotaped for 3 minutes.

Results and Conclusions: the results indicated an early involvement of the right TPJ region in processing both social and non-social contingency during real-life interactions. Since the TPJ is known to form the mentalizing network in human adults, our results suggest that sensitivity to contingency within the brain region during infancy presumably associated with the development of social perception. However, the positive correlation between infant's neural responses to contingent stimuli within the right TPJ and maternal responsiveness during parent-infant interactions was only found for the social-contingent condition, suggesting that the processing of social and non-social contingency may depend on different neural systems (Figure 1). Infant's sensitivity to social cues and its relations to maternal responsiveness will be discussed.

P3-B-404 - The impact of maternal mental health on neural correlates of social discrimination in infants from low-income countries: differences and similarities between Gambian and Bangladeshi cohorts (Pirazzoli)

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Social processing is a fundamental skill for children to effectively interact within the social world. Evidence shows that social cognition skills and socioemotional development are compromised in children

growing up in low- and middle-income countries (LMICs)(1), however the mechanisms underlying this association and the factors contributing to it remain to be explained. Caregiver mental health difficulties, largely untreated in LMICs(2), have been associated with children's socioemotional development(3) and thus could represent a risk factor for atypical social brain development.

Here we present and compare data from two global health projects, which collected longitudinal measures of brain and cognitive development and maternal mental health in The Gambia (Study1) and Bangladesh (Study2).

Our first goal was to characterize neural responses of social discrimination over the temporal and inferior frontal cortex using functional near-infrared spectroscopy (fNIRS) in both countries. Moreover, we aimed to relate these responses with maternal mental health, assessed using the Edinburgh

Postnatal Depression Scale (EPDS- validated in African countries(4)) in Study 1, and the Childhood Psychosocial Adversity Scale (CPAS- devised and validated in Bangladesh(5)) in Study 2.

In the fNIRS paradigm, infants were presented with social and non-social videos and sounds in a block design task extensively used in previous infant studies(6), and culturally adapted for these contexts (Fig.1), at 5 (N = 130), 8 (N = 112), 12 (N = 119), 18 (N = 122) and 24 (N = 118) months in Study 1; and at 6 (N=133), 24 (N=112) and 36 (N=155) months in Study 2. fNIRS data from the two studies were processed similarly, using QT-NIRS for data-quality assessment(7) and spline interpolation + wavelet for motion artefacts correction(8).

Patterns of social discrimination in the visual and auditory domain were overall localised over the inferior frontal and posterior temporal regions, replicating and expanding previous works using the same task. In Study 1, higher levels of maternal depression antenatally, at 1-month and 5-months, negatively impacted the neural response to social stimuli up to 18 months. This association was localised over the frontal cortex for auditory stimuli (ps<0.029) and over the temporal cortex for silent stimuli (ps<0.037). In Study 2, there was no association between CPAS and social discrimination at 6 months. Social discrimination in visual and auditory domains was negatively predicted by three CPAS subscales indicating maternal mental health (family conflict, intimate partner violence, depression) at 24 and 36 months (ps<0.04).

Despite some methodological differences between the two studies, such as the cultural context, age of participants, fNIRS array designs, and mental health questionnaires, our results showed striking converging evidence from the two LMICs. In both studies, maternal mental health difficulties were associated with diminished social discrimination in social brain regions during the early years of life. We advance the hypothesis that this association may be mediated by altered social inputs during early interactions, as caregivers' mental health was associated with reduced supportive and sensitive parenting(9). To test this, analyses of caregiver-infant interactions collected from both studies are underway, and results will be discussed in the symposium.

P3-C-405 - Instance to Category Generalization: A Self-Supervised Model Inspired by Infant Learning (Stojanov)

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A hallmark of an infant's learning ability is their facility to learn with minimal supervision. For example, the fast mapping ability, demonstrated in three and four-year-old children, enables them to learn about novel objects from one exposure and recall their names after a week or month delay (Markson, 1997). Recently, progress in machine learning (ML) has resulted in deep learning architectures which exhibit human-level accuracy in a variety of tasks such as image classification (He, 2015) and eye contact detection (Chong, 2020). However, in contrast to human learning, these methods require millions of manually-labeled examples to achieve good performance. Recently, ML researchers have proposed methods that need less supervision, via paradigms such as low-shot and self-supervised learning. In the past few years, self-supervised methods have out-performed supervised methods for certain tasks (He, 2020). This poster presents recent empirical findings from a developmentally-inspired self-supervised learning approach to object recognition. The predominant self-supervised learning paradigm in ML is

based on learning to discriminate between two images from the same object instance---a positive pair, and two images of different objects---a negative pair. Given a set of images as training data, a positive pair is generated by copying an image of an object and transforming it by slightly blurring it or by altering the color, and a negative pair is formed by randomly choosing images of two different objects from the training data. We have recently developed a new unpublished approach to generating image pairs for self-supervision that leverages the 3D shape of objects by comparing image pairs from different viewpoints of the same object instance. Specifically, the model is trained by making local comparisons between the view pairs: e.g. the image locations corresponding to the same object part (e.g. a chair leg) are positives, and locations corresponding to different parts (e.g. a chair leg vs. a chair seat) are negatives. We use the ABC dataset (Koch, 2019) of unstructured 3D object shapes for training, and the ShapeNet category dataset (Chang, 2015) for testing (see Figure 1). This approach is developmentally more plausible than prior methods because the positive pairs leverage aspects of 3D shape that can be discovered via manual manipulation of an object, as might occur during self-directed play. In Figure 2 we present qualitative evidence of our method's ability to learn object part similarity for multiple views of the same instance, and across different instances of the same category. For a point in the source view, we draw a line to what the model assigns as the most similar point in the target view. We observe that our model can successfully match parts such as the chair legs, the mug handle, and the airplane wings and tail. Our model is the first to achieve such generalization without any category supervision. This work demonstrates that a computational model trained by comparing multiple views of object instances can lead to category recognition. The next step is to investigate to what extent such models exhibit a shape bias, and what are the limits of their generalization ability. Our poster will present our approach and also highlight the connections between self-supervised learning in ML and developmental science.

P3-C-406 - Four-month-old infants' preference for native speakers is challenged by linguistic proximity but modulated by bilingual experience (Marcet)

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Previous research has shown that six-month-old monolingual infants have a visual preference for native speakers, as compared to speakers using an unfamiliar, non-native language (Kinzler, Dupoux, & Spelke, 2007). The distinction between native and non-native speakers is highly relevant during preverbal development, as infants show greater attention to the information provided by native speakers of their language (Marno et al., 2016). Infants' attentional processes to speakers in their environment may promote knowledge acquisition about the properties of their native language. Studies exploring this preference have commonly used distant language pairs (e.g. English-Spanish). It is likely that distant language pairs facilitate the classification of speakers as native or non-native due to their highly significant rhythmic and phonological differences. Importantly, no study to date has investigated a) whether the visual preference for a native speaker can be found when two rhythmically close languages are involved and b) whether infants' regular experience with a pair of close languages (i.e., close-language bilinguals) can modulate this preference. Catalan and Spanish are rhythmically and phonologically close languages. Despite their proximity, Catalan and Spanish monolinguals, as well as Spanish-Catalan bilinguals, can auditorily discriminate these languages already by 4.5 months of age (Bosch & Sebastián-Gallés, 2001). Selecting this pair of languages will enable us to explore the effect of linguistic proximity and linguistic experience on infants' visual preference for native speakers. Although

challenging, the study targeted 4-month-old infants (younger than in previous research), as a first step to explore the effect of bilingual experience in enhancing or compromising infants' visual preference for native speakers. We ran an eye-tracking study with 39 4-month-old infants: 25 Spanish monolinguals and 14 Spanish-Catalan bilinguals. We adapted the paradigm used by Kinzler et al. (2007) in infant looking-time experiments. Infants were familiarized with videos of two female speakers uttering a monologue (one speaker in Catalan and the other in Spanish). After familiarization, infants were presented with side-by-side images of the speakers smiling. To test for a preference, the proportion of looking time to each speaker was computed and compared to chance. Our analysis revealed that 4-month-old monolinguals did not show a significant preference for their native ($t(24)=1.39$, $p=.17$). Interestingly, the 4-month-old bilingual group looked significantly longer to the speaker that used their dominant language ($t(13)=2.22$, $p<.05$). To ensure the lack of visual preference in monolinguals was not simply because of a younger sample, we also tested 25 6-month-old monolinguals. The results revealed again no preference for any speaker ($t(24)=1.45$, $p=0.15$). We can conclude that language similarity hampers the expression of a visual preference for speakers of the native language in 4-month-old infants. Monolinguals seem to face a challenge when discriminating and associating close languages to different speakers, reducing the likelihood of a native speaker preference. In contrast, 4-month-old bilingual infants, who are regularly exposed to different speakers using different languages, are better at successfully forming these associations despite the linguistic proximity, showing a preference towards the speaker that used their dominant language.

P3-C-407 - Newborns' perception of approach and withdrawal from biological movement: a closeness story (Roberti)

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It is well known that infants are attracted by biological motion (BM), which may represent a fundamental signal that guides the early exploration of our social environment. Since birth, newborns discriminate the BM from scrambled motion presented through point-light displays (PLDs, Simion et al., 2008); infants' attention is also driven by biological kinematics when a walker moves in a leftward/rightward direction (Kuhlmeier et al., 2010). Nonetheless, no studies have explored whether newborns present a visual preference for BM that approaches rather than withdraws from them. Yet, approach and withdrawal are two fundamental motivations in the socio-emotional world (Harmon-Jones & Gable, 2018), key in developing empathy and prosocial behavior (Crespo-Llado et al., 2018). Therefore, we investigated whether right after birth we are already attuned to others moving towards us rather than walking away from us. Through a preferential looking paradigm, 24 full-term newborns watched centrally on a screen four videos showing human and scrambled PLDs approaching or withdrawing from them (Figure 1). We ran repeated-measures Analyses of Variance (rmANOVAs) on total looking times and number of orientations, with Type (Human, Scramble) and Direction of movement (Approach, Withdrawal) as within-subjects factors. For looking times, we found a significant Type x Direction interaction, $F(1,23) = 14.09$, $p = 0.001$, $\eta p2 = 0.38$. Newborns looked longer at the Human BM in the Approach condition ($M = 14.46$ s; $SD = 7.59$) than at the Human BM in the Withdrawal condition ($M = 10.05$ s; $SD = 6.13$), $t(23) = 3.03$, $p = 0.006$, $d = 0.62$. Moreover, in the Withdrawal condition the Human BM was looked at less than the Scramble stimulus ($M = 14.49$ s; $SD = 10.15$), $t(23) = -2.36$, $p = 0.027$, $d = -0.48$. As for number of orientations, we found a significant main effect of

Direction, F (1,23) = 4.63, p = 0.042, ηp2 = 0.17. Newborns performed more orientations towards the approaching (M = 4.67; SD = 1.63) compared to the withdrawing stimulus (M = 4.06; SD = 1.75), t (23) =2.15, p = 0.042, d = 0.44, irrespective of its social nature (Figure 2). Overall, our results suggest that newborns are particularly attuned to approaching motion: newborns look longer at human bodies moving towards them rather than walking away. Further, newborns' looking times were also affected by the social nature of the stimulus: in the withdrawal condition, the scrambled motion was more attractive than the human motion. Lastly, newborns oriented their gaze more frequently to approaching stimuli, indexing heightened attention when stimuli follow a trajectory directed toward their body (Orioli et al., 2018). This predisposition converges with the idea that, from the very beginning of life, we are attuned to what is close, and that others play a privileged role in this closeness.

P3-C-408 - The influence of infant locomotor skill on parental attention to environmental threats (Murrugarra)

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Introduction: As infant mobility changes throughout development, so too does the nature of their environment. As infants' locomotor skills mature with the onset of crawling and then walking, they can more rapidly engage with new features of the environment that may be dangerous and outside the parents' reach. How does the maturation of infant locomotor skills shape parents' perception of environmental threats? We hypothesized that parents of infants 0-24 months old would be faster to detect environmental threats to a virtual infant if their own infants had a higher degree of mobility. Method: We developed a game (Figure 1) in which a virtual infant crawls near a busy roadside. Parents (n = 22; of walkers = 8, crawlers = 4, and pre-crawlers = 10) and non-parent controls (n = 28) were given the task of detecting oncoming cars and reporting how quickly they believed the cars were moving. Parents completed the car response task in three phases: before introducing a virtual infant, after the infant was introduced, and after the infant was removed. Participants were asked to keep their virtual infant safe by pressing a button to pick the infant up as needed. We predicted that parents of crawling or walking infants would have a faster reaction time when detecting oncoming cars, as well as rate the cars to be moving faster, when monitoring a virtual infant compared to non-parents and parents of infants who cannot yet crawl or walk. Results: We found a main effect of parent group such that parents of crawlers were significantly slower to detect oncoming cars compared to all other groups. We then assessed whether the presence of the virtual infant influenced reaction time (Figure 2). We found a significant interaction between parent group and infant presence such that parents of crawlers were faster to react to cars when the virtual infant was present. In contrast, parents of walkers slowed in reaction time when the virtual infant was present. The virtual infant did not induce a change in reaction time for either non-parents or parents of pre-crawlers. There were no significant differences in speed estimates between groups or as an effect of the virtual infant. Discussion: This study is the first to use online virtual methods to investigate how parental experience shapes threat perception. We found that parents of crawlers, but not walkers, were quicker to detect environmental threats in the presence of the virtual infant compared to parents of pre-crawlers and non-parents. It is not clear why parents of crawlers were generally slower at detecting threats compared to all other groups. The virtual infant also impacted parents of crawlers and walkers differently. Since the virtual infant in this study could only crawl, it is possible that parents reacted faster to threats when the virtual infant matched the motor

skills of their own infants. We are currently conducting follow-up studies to assess how infant locomotor status shapes physiological and attentional changes in parents. This work will allow us to better understand how parental perception is shaped by their infant's development.

P3-C-409 - Effects of Visual and Haptic Perception of Material Rigidity on Children?s Reaching and Grasping (Preißler)

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The effects of material properties on young children's reaching for objects have been rarely investigated. Although there have been studies examining children's material-dependent object explorations, only few have investigated how visual and haptic object information contribute to children's consideration of an object's material, especially an object's rigidity, for efficient and functional grasping movements. Therefore, the aim of this study was to examine young children's uni-manual reaching kinematics and grasping frequencies for objects of different rigidity following visual and visual-haptic object exploration. 11-months-old infants, 3-year-old children and, for purposes of comparison, adults participated in our study. As stimuli two heavy objects (still liftable for infants) were manufactured, which had two handles made out of different soft and rigid materials. In the visual condition, material rigidity was presented only by tapping and pushing the handles down with a stick (see Figure 1). In the visual-haptic condition, participants manually explored the objects and thereby gained visual and haptic material information. Participants were encouraged to lift the objects by using one of the two handles. Reaching movements were measured using a quantitative motion capture system (Vicon). We expected increased grasping frequencies towards the rigid handle due to its higher functionality for lifting heavy objects. Results showed that adults generally grasped the rigid handle exploiting their knowledge about efficient and functional grasping in both conditions. In contrast, 11-months-olds, after visual object exploration, showed no significant preference for grasping the rigid or soft handles, and thus did not consider the material to facilitate grasping. After visual-haptic object exploration and when grasping the contralateral handles, infants showed a preference for grasping the soft handles, which were harder to use to lift the object. 3-year-olds grasped soft and rigid handles equally often. Participants' reaching trajectories were barely affected by object rigidity. However, reaching kinematics significantly depended on the visual versus visual-haptic condition and age. Visual-haptic object information led to shorter reaching durations and straighter hand movements compared to visual information only. In addition, with increasing age, the number of movement units and the relative hand aperture decreased, whereas movement velocity and straightness increased. In general, 11-month-olds' trajectories still showed a lot of variability, whereas 3-year-olds' trajectories already resembled those of adults a lot (see Figure 2). Our findings provide evidence that infants did not use information about an object's rigidity for efficient reaching and grasping, although they were able to distinguish the handles' materials. Instead, they preferred reaching for soft, pleasant object material. 3-year-olds seem to be on an intermediate level in the development from preferring the soft fabric like the 11-month-olds, to preferring the efficient rigid handle like the adults. Thus, our results suggest that taking rigidity into account when reaching and grasping objects efficiently is subject to a developmental process beyond infancy.

P3-C-410 - Origins of the face-space: influences of parental face features and body odors on face detection in 6- and 9-month-olds (Damon)

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Perceptual experience with faces is largely redundant in infancy, as the primary and secondary caregivers (usually the mother and the father) represent more than 44 and 17% of the infant daily "face time" exposure respectively (Sugden & Moulson, 2018). The overrepresentation of these two individuals may initially tune the basic face representation of infants toward the facial characteristics of these identities. Consequently, whereas adults represent faces in relation to a prototype face (i.e., a "norm-based" representation from the perspective of the multidimensional face-space hypothesis, Valentine, 1991, 2015), infants may process unfamiliar faces in relation to their primary and perhaps secondary caregivers' face. Moreover, in real-world situations, face experience with caregivers is typically embedded in multisensory contexts, notably including olfactory cues such as parents' body odors. Odor information is an integral part of social processing, as suggested by findings showing that (maternal) body odor facilitates face processing in infants (for review see Damon et al., 2021). Thus, these cues could rapidly be associated with face representations, potentially resulting in a new dimension added to the visual face-space, for instance conveying gender information. To investigate these issues, we examined whether parental face features and body odors influenced face detection in 23 6- and 21 9-month-olds. We estimated psychophysical detection thresholds for unfamiliar male and female faces using eye-tracking technology with an automated algorithm determining whether the infant fixated a face or failed to detect it when presented at various locations and visibility conditions (i.e., faces mixed with noise) on a computer screen. During the sessions, infants were exposed to either their mother's or their father's body odor. In both age groups, detection speed was influenced by the perceptual distance between the faces of the parents of the infants and the target faces, showing shorter latencies to detect female faces farther from the mother's face, $r(57) = -.38$, $p = .003$, and shorter latencies to detect male faces farther from the father's face $r(48)= -.31$, $p = .031$ (see Figure 1). These findings support the idea that parents' faces act as primitive templates for gender categories during the processing of unfamiliar faces. We also found an interaction between the odor condition (mother or father) and the age of the infants (6 or 9 months), $F(1,40) = 5.49$, $p = .024$, $\eta 2p = 0.12$, reflecting lower detection thresholds for both male and female faces in 9- compared to 6-month-olds exposed to paternal body odor (see Figure 2). Given the predominance of female caregiving, these findings suggest that infants may need to accrue a certain amount of experience with their father before an influence of body odor be evidenced. Maternal odor also influenced face detection in both age groups, lowering detection thresholds for male compared to female faces. Although unexpected, these latter findings suggest that maternal body odor fostered information acquisition especially for less experienced face categories (i.e., male faces), but without conveying gender information per se. These interpretations are provisional, however, pending the collection of threshold data without exposure to parental body odor (data collection is currently ongoing).

P3-C-411 - Discriminating different states of consciousness exploiting SEPs and Perturbation Complexity Index in newborns (Rossi Sebastiano)

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When we fall asleep, conscious processing of sensory events fades. Hence, the comparison between sleep and wakefulness has largely been employed as a model to investigate unconscious and conscious processing of sensory information. Compelling evidence indicates that the fading of consciousness during certain stages of sleep is related to stronger, but rapidly extinguishing, EEG responses and to a breakdown in cortical effective connectivity (Massimini et al., 2005). Accordingly, while during sleep event-related potentials' amplitude results greater than wakefulness, the response to somatosensory stimulation during sleep may lead to a less widespread response. This fragmentation of brain responses has been proposed as a core mechanism preventing the conscious processing of sensory stimuli to preserve sleep (Gemignani et al., 2015). The Perturbation Complexity Index (PCIst), validated on a large dataset of TMS-EEG recordings, has recently been proposed as an objective measure of the complexity of brain responses. Previous works in adults compellingly demonstrated that different PCIst values are associated with different states of consciousness [i.e., wakefulness and sleep in healthy individuals, sedated subjects and patients affected by disorders of consciousness (Comolatti et al., 2019)]. Previous studies in newborns demonstrated that the sleep stage affects somatosensory-evoked potentials (SEPs), leading to larger SEPs in sleep than in wakefulness (Saby et al., 2016; Pihko et al., 2004); conversely, the effect of the state of consciousness on the complexity of EEG responses in newborns is still elusive. Here, we investigated whether different states of consciousness can be identified in newborns by capitalizing on a recently devised approach based on the computation of PCIst on the responses elicited by peripheral (instead of central) stimulations (Sarasso et al., in preparation). We collected EEG responses to median-nerve stimulation delivered over the right wrist during wakefulness and sleep (6 blocks of 40 trials for each condition) in a preliminary sample of full-term healthy newborns (N=3; age=12-24 hours since birth). The behavioural classification of sleep and wakefulness was confirmed offline by a trained neurologist by analysing the EEG signal before (1-minute) and during the stimulation period. In line with previous studies, SEP amplitude resulted larger in sleep than in wakefulness. Interestingly, by comparing the newborns' PCIst values to those of a sample of healthy adults (N=8), we found that, unlike adults, newborns' values did not differ between sleep and wakefulness. This preliminary result suggests that newborns do not display a different complexity of the EEG response between different states of consciousness. This finding, if confirmed in a larger sample, lays the groundwork for a longitudinal study addressing the emergence of consciousness-related complexity in brain responses to somatosensory stimuli during sleep and wakefulness, in the ontogenetic development.

P3-D-412 - Two-to-one mapping: Testing an alternative model of the mutual exclusivity bias in bilingual infants (Gibson)

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Research has suggested that bilingual infants do not reliably show the word learning heuristic, mutual exclusivity (Byers-Heinlein & Werker, 2009, 2013; Houston-Price, Caloghiris, & Raviglione, 2010). The mutual exclusivity bias refers to the tendency to map novel labels onto novel objects. It has been argued that this tendency may occur due to infants using one-to-one mapping between items and labels (Markman & Wachtel, 1988). However, this approach would not be appropriate for bilingual and multilingual infants as each item can have at least two labels. This study aimed to investigate the effect of language experience on 20-to-26-month-old bilingual infants' performance on mutual exclusivity

tasks by comparing responses when the familiar item is either known in the infant's first, second or both languages. It was hypothesised that bilingual infants may rely upon an alternative model of mutual exclusivity in which two-to-one mapping is utilised, thus, requiring the infant to know the label for the familiar object in both languages before demonstrating mutual exclusivity. To investigate this, 35 20-to-26-month-old bilingual infants were presented with pairs of images. A personalised stimulus set was produced for each participant based on parental reports of vocabulary using the Oxford CDI. Four words were selected for each of the three trial types: (1) words that were only known in English; (2) words that were only known in the infant's other language; and (3) words that were known in both languages. Infants' looking times were recorded using an eye-tracker (Tobii TX300). To examine the mutual exclusivity effect, the proportion of target looking was compared in the pre-naming and post-naming phases using mean difference scores (mutual exclusivity score). Preliminary analyses revealed that bilingual infants' performance on mutual exclusivity trials differs significantly across the three trial types, $F(2,58) = 3.53$, $p = .036$, $\eta 2 = .11$. Post-hoc tests revealed that mean mutual exclusivity scores were significantly greater when the familiar item label was known in both languages than when this was only known in the infants' other language, $t(29) = 2.64$, $p = .035$. Unlike previous research, secondary analyses found that there was no significant correlation between performance on any of the mutual exclusivity tasks and age or proportion of translation equivalents known. This study suggests that bilingual participants demonstrate the mutual exclusivity bias if the familiar item was known in both languages or only in English, but not if this was only known in the infants' other language. This could suggest that two-to-one mapping was advantageous for the ability to use the mutual exclusivity bias or that the testing language provides cues on mutual exclusivity tasks.

P3-D-413 - The vocabulary of infants with an elevated likelihood and diagnosis of autism spectrum disorder: a meta-analysis (Belteki)

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Background: Diagnoses of autism spectrum disorder (ASD) are often accompanied by atypical language development, which can be noticeable even before diagnosis (Iverson et al., 2018; Tenenbaum et al., 2014). Siblings of children with autism are at elevated likelihood (EL) for autism, because they show higher prevalence rates for autism than the general population (Ozonoff et al., 2011). Several studies have looked at how the language abilities of infants with an elevated likelihood or diagnosis of ASD compare to their typical likelihood (TL) or non-ASD peers. Findings have so far been mixed, with studies observing different magnitudes of difference between the ASD and non-ASD groups. This report systematically reviewed the studies comparing EL and TL infant groups pre-diagnostically and/or ASD and non-ASD groups post-diagnostically, in both cases up to 24 months of age. The inclusion criteria was that the studies assessed vocabulary using either the MacArthur-Bates Communicative Developmental Inventory (CDI) or the Mullen Scales of Early Learning (MSEL). We wanted to assess whether effect sizes were modulated by study design (i.e., whether pre or post-diagnostic groups were assessed), by age, and by the language-measure administered. Methods: The systematic search for studies was done in PubMed, PsycInfo and Google Scholar, and yielded 959 records. Of these records, 76 studies met the inclusion criteria and were reviewed. Meta-analyses were performed on the studies that compared the expressive and receptive vocabulary scores of EL and TL infants pre-diagnostically and/or the scores of ASD and non-ASD infants post-diagnostically. Results: Both pre- and post-diagnostically, our meta-

analyses showed that the ASD groups had smaller vocabularies than their non-ASD peers, and effects were more pronounced in the post-diagnostic groups (Cohen's d for expressive vocabulary = 0.89) than the pre-diagnostic groups (Cohen's d for expressive vocabulary = 0.36). Effect sizes across studies were heterogenous, prompting moderator analyses of age and sub-group analyses of language measure as potential moderators of the magnitude of group differences. Age was found to moderate effect size both in the pre- and post-diagnostic groups. In the prediagnostic groups, age moderated the magnitude of difference between EL and TL infants' receptive vocabularies (see Figure 1). Postdiagnostically, age moderated ASD and non-ASD infants' expressive vocabularies (see Figure 2). The language measure used (CDI or MSEL) was not found to moderate effect sizes. Conclusions: Across studies, it was observed that the vocabulary size of EL and ASD infants were smaller than that of TL and non-ASD infants already in the first two years of life. The large heterogeneity observable in effect sizes may warrant further investigation of the factors influencing group differences in the vocabulary sizes of ASD vs. non-ASD infants, e.g., SES. Age was found to moderate vocabulary size in different ways in pre- versus post-diagnostic groups. Whereas in pre-diagnosis samples, age moderated receptive vocabularies, in post-diagnosis samples age moderated expressive vocabularies. This suggests that the EL and ASD infants may have different expressive and receptive vocabulary profiles, and warrants further investigation of how the language profiles differ between infants placed in a pre- versus postdiagnostic classifications.

P3-D-414 - 9-month-old English and French infants' discrimination of complex onsets (Archer)

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Newborns are capable of detecting many speech sound contrasts, but over the first few months, their perception shifts focus to native language contrasts (Polka & Werker 1994; Werker & Tees 1984). Discrimination of contrasts is determined by more factors than simply whether a contrast is native or not. For instance, presentation order influences vowel discrimination (Natural Referent Vowel, Polka & Bohn 2011), and the frequency of occurrence in the language can impact infants' discrimination of speech contrasts (e.g., Narayan et al. 2010). Here, we examine whether acoustic factors also influence how infants' discrimination. We examined 9-month-old English- and French-learning infants' discrimination of English productions of stop-/l/ clusters. Infants of 9 months are sensitive to native-language phonotactics and the /dl/ onset is unattested in both English and French. Acoustic analyses reveal that English productions of /dl/ are more similar to /gl/ than /bl/ (Flemming 2007) and velar stops (g, k) have more acoustic variability than other stops (van der Feest et al. 2010). Moreover, perception studies show that French adults have difficulty perceiving the /gl-dl/ contrast (Halle et al. 1998). With this information, we predicted that 9-month-olds' sensitivity to acoustic information in stop-/l/ contrasts would results in differences in discrimination by place. Since English productions of /gl/ are more variable than /bl/ and acoustically similar to /dl/, we expect that all infants should discriminate the /bl-dl/ contrast and not /gl-dl/. However, if French and English infants discriminate these contrasts differently, this would likely indicate the influence of language experience instead of simply acoustics. Ninety-six 9-month-olds (French (n=49); English (n=47)) were randomly assigned to one of two place groups: labial-coronal (/bla/-/dla/) and velar-coronal (/gla/-dla/). Infants were familiarized to 2 trials of one syllable (e.g., /bla/) followed by 8 test trials, each with 16 tokens: 4 alternating (bla, dla) and 4 non-alternating (bla, bla). Results of an omnibus ANOVA showed a significant interaction between trial (within-subjects: alternating, non-alternating) and place (between-subjects: /bla-dla/, /gla-dla/). Follow-

up comparisons showed a main effect of trial in the labial condition (non-alt p<.01)) but not the velar condition (non-alt n.s.). There was no effect of language in these analyses, suggesting that both language groups of infants discriminated based on acoustic factors. An additional online task was conducted with adults (n = 31). We used jsPsych to create the online AX discrimination task. Participants chose whether the pair was either same (e.g., bla-bla) or different (e.g., bla-dla). Preliminary results show that participants discriminate /bl-dl/ pairs: 160 out of 183 data points, though /gl-dl/ pairs were much less likely to be perceived as contrastive: 61 out of 183 data points. These findings may show that 9-month-olds already detect these contrasts appropriately. These findings suggest that infants' discrimination of stop-/l/ onsets is driven by acoustic factors which, along with frequency and native-language status, influences infants' perception of speech sound contrasts. This has implications for our understanding of early discrimination. Acoustic factors, like variability or similarity, might impact the order in which infants begin to identify their native-language speech sound inventory.

P3-D-415 - The emergence of comprehension in infancy: Is Fido a dog, or just Fido? (St. Pierre)

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Recent studies suggest that word comprehension emerges by 6 months of age - earlier than previously thought (Bergelson & Swingley, 2012). But how mature are infants' early word representations? Some studies suggest they are semantically overly-specific (e.g., Tincoff & Jusczyk, 1990), as when children associate words like 'mommy' and 'daddy' with their caregivers only (and not unfamiliar adults), while others suggest that they are surprisingly abstract (Bergelson & Swingley, 2012). In the current study, we report preliminary results (due to covid) looking at the extent to which 6- to 9-month-olds (n = 68) and 13- to 15-month-olds (n = 28) (1) map either their dog's name (e.g., Fido) and/or the word doggy to images of their own dog, and (2) which dog words (if any) get extended to unfamiliar, perceptually dissimilar dogs. Each child was presented with two types of trials: Familiar trials (12), in which an image of the child's dog and mother appeared side-by-side on the screen, and Unfamiliar trials (12), in which children saw a perceptually dissimilar female and dog. In one condition (Doggy), infants heard the labels they used to refer to their mother and dog (e.g., 'mommy' and 'doggy'); in another condition (Fido) the label for the dog was replaced with the name of their own dog (e.g., 'Fido'). Because infants often have strong baseline looking preferences, our dependent variable consisted of a difference score, whereby children's baseline looks to each target image before the onset of the target word (averaged across trials) were subtracted from their looks to the target image in each trial (starting 300 ms after target onset). Since mom trials were identical across familiar and unfamiliar trials, children's knowledge of their mom's label (e.g., 'mommy') was analyzed across conditions (see Figure 1). Consistent with previous literature, in mom trials, both 7.5-month-olds and 14-month-olds recognize the label for their mom (though the effect is stronger with older kids), and only associate the word with their own mother and not an unfamiliar woman. Surprisingly, younger children appear to recognize neither their dog's name (e.g., 'Fido') nor the word 'doggy', with difference scores hovering around 0 (see Figure 2). In contrast, older children recognize that their own dog can be referred to with either the dog's name or the word 'doggy', demonstrating an early ability for monolingual children to associate 2 labels to the same referent. And while 'doggy' equally applies to unfamiliar dogs for older children, there appears to be decrease in looks to the unfamiliar dog when hearing their dog's name, suggesting that some children are aware that that their dog's name only applies to their dog (though this effect is not significant in the

28/96 children tested so far). Taken together, these findings suggest that infants' understanding of words evolves substantially after their first birthday. Understanding the factors driving these changes will be key to advancing models of early language acquisition. In a follow-up study, we will test infants on trials displaying two dogs or two mothers (one familiar, one not).

P3-D-416 - Infants? Multisensory Integration of Speaker?s Face+Voice is Facilitated by their Native Language (Taylor)

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Recently, we tested 24-mo-olds' (n=32) ability to match a speaker with its concurrent voice track as well as a falling object with its concurrent sound track, both while non-matched speaker and non-matched object appeared on the opposite side of a screen. In the middle of the two events, a rotating geometric distractor was played on half of the trials (this is called high competition) whereas no distractor was present on the other half (this is called low competition). We merged the data from our sample with that of another laboratory using the same protocol who were able to test a considerable number of same-aged toddlers (n= 40) who were more likely exposed to another language (i.e., Spanish) during infancy. This allowed us to test whether performance in the social condition of the multisensory integration task was affected by the language of the speakers (always presented in English) in terms of the percent exposure of that same language in the infants. Data from the English only cohort (all percentages of English spoken to the child were 100%) showed that their ability to attend more to the matched speaker than the non-match during low competition trials was positively correlated with expressive language (r=+.37, p=.04) as well as during high competition trials (r=+.46, p=.01). Moreover, 24-mo-olds' sustained attention to the matched speaker compared to the distractor was also positively correlated with expressive language (r=+.52, p=.002). Interestingly, data from the Mixed-Language cohort (mostly some combination of English and Spanish) showed no significant correlations between attention to the matched speaker compared to the non-match and expressive language, nor attention to the match compared to the distractor (all p's > .05). These findings are intriguing, and suggest that at early ages, the important ability to perceptually select and attend to speakers faces+voices is influenced by the language they are speaking. Even though low level perceptual cues are available even if the language is non-native, 24-month-olds are less likely to use these cues to guide their attention. We will discuss how future studies can be designed to incorporate multiple languages in order to more sensitively assess infants' multisensory processing.

P3-D-417 - How do parents' beliefs about infant-directed speech relate to their children's word learning? (Ramirez)

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Infant-Directed Speech (IDS) refers to how people talk with young children in many societies (Golinkoff et al., 2015). Compared to speaking with an adult (ADS), IDS includes a slower rate of speech, fewer words per utterance, higher-than-average pitch, and elongated vowels (Cristia, 2013). Although there are many benefits associated with using IDS (e.g., Ma et al., 2011; Singh et al., 2009; Thiessen et al.,

2015), there is little information on what parents think about IDS (e.g., Simmons & Johnston, 2007; Rodriguez & Olswang 2003). The limited literature suggests that parents typically do not support the use of baby talk with their infants (Johnston & Wong, 2002; Mancilla-Martinez & Lesaux, 2014). This poster will explore whether parents' beliefs about IDS relate to children's word learning. We ask two questions: 1) How do parents conceptualize Infant-Directed Speech (IDS) and its benefits? and 2) Using the Intermodal Preferential Looking Paradigm (IPLP; Golinkoff, 2013), what is the relation between parents' IDS beliefs and children's ability to learn a novel word? We hypothesize that: 1) Parents will undervalue IDS usage, consistent with previous research (Johnston & Wong, 2002; Mancilla-Martinez & Lesaux, 2014) and 2) Parents' beliefs will relate to children's word learning. Children will be more likely to learn a novel word if their parent supports the use of IDS. This could be because parents who support IDS may be more likely to engage in behaviors associated with IDS. We will also assess the alignment between parents' beliefs and behaviors when asked to teach their child a novel word. Parents and their 15- to 21-month-old monolingual English-reared infants participated in a one-time video chat session in which parents taught their child a novel word. Lastly, parents completed the Parent Belief Questionnaire (PBQ) to assess beliefs about IDS; questions were based on characteristics of IDS reported in the literature. A 4-point Likert scale, ranging from never to always, determined the extent to which the parent supported the use of IDS. Children's proportion of looking time toward the target object and parents' responses to the PBQ were coded offline. To explore how parents conceptualize IDS and its benefits, item-reliability will be assessed using Cronbach's alpha. Next, I will create a mean index by summing parents' positive responses to IDS-items for each parent (i.e., IDS score) with some items reverse-scored. Parents' scores will range from 1 to 4. A score indicates that parents have a positive view of IDS usage. To investigate the relation between parents' IDS beliefs and children's ability to learn a novel word, I will correlate the proportion of children's looking time toward the target object with parents' IDS score. As research has demonstrated the positive benefits of IDS on children's language development (Golinkoff et al., 2015), identifying why parents may not use IDS or think it worthwhile to use with their children is essential.

P3-D-418 - When do infants know a word? Comparing binary and gradient parent reports to infants' online word recognition (López Pérez)

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Measuring children's vocabulary size is important as it has been found to be a good indicator of language ability (Gathercole et al., 2008). A popular children's vocabulary size measure is the MacArthur-Bates Communicative Development Inventories (CDI), a parent report of word comprehension and production for 8-30-month-old children. Generally, CDIs show good reliability and validity in monolinguals (e.g., Fenson et al., 1994) and bilinguals (e.g., Marchman & Martinez-Sussmann, 2002). However, previous research that has evaluated parents' reporting accuracy on the CDIs has predominantly done so by examining the correspondence between CDI reports and direct assessments of children's global (entire) vocabulary (Law & Roy, 2008). Finer-grained aspects of the CDI such as item-level accuracy remain understudied for both monolinguals and bilinguals although they are regularly used in research (e.g., Sidhu et al., 2021). Moreover, it is unclear whether the binary CDI responses dichotomize underlyingly continuous knowledge. Given how widely the CDI is used, more in-depth validation is needed. Thus, we will explore the following research questions (RQs) in a cohort of children with both monolingual and bilingual language backgrounds, which increases the variability of vocabulary

scores in each language, potentially providing a more sensitive test of our RQs. RQ1: What is the validity of the CDI at the item compared to the global level? RQ2: How do the psychometric properties of parent-reported comprehension versus production compare, given that production is more directly observable than comprehension? RQ3. Do the binary response options on the standard CDI reflect underlyingly continuous knowledge? Can word knowledge be better captured via gradient response options? To address these research questions, we will test 60 monolingual and 60 bilingual 8-30-month-old children learning French, English and/or Spanish. Parents will complete the appropriate version of the CDI in each of their child's languages, and will also provide gradient certainty ratings on a subset of words. Then, children will participate in a looking-while-listening (LWL) task to directly measure online comprehension of the same words. We will compare childrens' CDI scores (both binary and gradient) in each language to LWL performance. For RQ1, we expect high global validity, as assessed by correlations between total CDI scores and average LWL performance, and more moderate item-level validity as assessed by intraclass correlations (ICC) between subset items and corresponding LWL trials. To examine RQ2, we will compare correlations and ICCs for CDI-reported production and comprehension. We have no directional hypothesis as production might be a more objective behaviour for parents to report, yet LWL is a comprehension task. As for parents' certainty ratings, we predict higher certainty for production than comprehension. Finally, for RQ3, we will use several statistical techniques to determine whether the gradient CDI captures variance in LWL performance more accurately than the standard binary CDI. This work will impact both research and clinical work as it will more clearly test the validity of global and item-level CDI scores for bilinguals and monolinguals and provide insights on the use of a binary versus continuous scale for parent-reported vocabulary measures.

P3-D-419 - Investigating the Influence of Number of Language Sources on Bilingual Infants' English-Spanish Vocabulary (Martinez)

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Dual language learning is dependent on multiple aspects of a child's language environment, including age of exposure, amount of exposure, and parental characteristics (Place & Hoff, 2016). However, even after considering these factors, there continues to be substantial variability in dual language outcomes across children. One factor that has received limited study is the number of different sources of input (i.e., speakers) in each language. A previous study showed that the number of speakers in each language was positively associated with bilingual children's vocabulary in that language (Place & Hoff, 2011). Specifically, bilingual children who were exposed to more different English speakers had higher English vocabularies, after controlling for the relative amount of exposure to English. The authors suggest that children may need exposure to variability in the signal to learn the speech categories that support word recognition and production. However, because this study did not measure the absolute amount of input in each language, it is possible that the effect of 'number of speakers' is instead explained by amount of input; in other words, children exposed to more different English speakers may have simply heard more speech in English. The current study will provide a more rigorous test of the hypothesis that the number of different speakers in each language influences vocabulary development by using day-long home audio recordings of children in bilingual environments. We draw from a larger study of English-Spanish bilingual children. For the present study (n=25), we will use measures collected at the initial time point (M=24 months). Parents complete an interview about their child's language exposure using the

Language Exposure Analysis Tool (LEAT). They also complete the English and Spanish versions of the MacArthur-Bates CDI to assess their child's vocabulary knowledge. Lastly, families complete a day-long home recording using a LENA digital recorder. The number of different speakers of English/Spanish that children are exposed to will be derived from the LEAT. To estimate the amount of English and Spanish we will perform manual annotation of 1-minute segments sampled from the daylong recordings (see Cychosz et al., 2021). The number of adult words in English/Spanish segments, multiplied by the percentage of English/Spanish exposure, will provide an estimate of amount of English/Spanish exposure. Our primary analysis will consist of two multiple regressions predicting 1) English, and 2) Spanish vocabulary. The predictors will be a) the number of different English/Spanish speakers, and b) the amount of exposure to English/Spanish. We expect to observe a positive relation between the amount of speech and vocabulary scores in each language. We also expect a positive relation between the number of speakers in each language and child vocabulary in that language, after controlling the amount of speech. Alternatively, it is possible that the relation between number of speakers and child vocabulary will be mediated by the amount of speech in each language. Findings from this study will refine our current understanding about factors that influence bilingual children's dual language development, particularly the role of number of speakers. This may inform programs and policies that seek to foster children's bilingualism.

P3-D-420 - The Development of Tone Discrimination in Infancy: An Online Adaptation (Mullins)

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The COVID-19 pandemic has significantly impacted developmental research, forcing experimenters to either halt studies or adapt to a virtual format. However, collecting reliable infant speech perception data online is very challenging, especially using infant-controlled procedures such as habituation paradigms. Nevertheless, with our lab shut down, we were motivated to find a way to continue collecting reliable data remotely. To that end, we created an online adaptation of a habituation-based speech perception project that was just about to get off the ground, i.e., the ManyTones project--a multi-lab study investigating the developmental trajectory of infants' perception of lexical-tones. Like consonants and vowels, lexical-tones are used in tone languages (e.g., Cantonese) to change the meanings of words, yet we know very little about how language experience impacts perception of lexical-tones across development. We used a habituation procedure to test infant lexical-tone discrimination both online via Zoom, and in-person, at 5, 10, and 17 months. Following habituation to a rising lexical-tone, infants were presented with two blocks of test trials in which we measured looking time differences on the control trial (rising tone) versus an alternating trial (alternate rising with either falling or mid-level tone). For the online version, the project was set up on a host computer in our lab, and infants were tested via Zoom using the screen and sound sharing features. In an attempt to control intensity variability across home equipment and environments, participating families were sent a calibration tone and were asked to adjust their computer volume to match a 65dB reading on DecibelX, a downloadable app used to measure sound level intensity. Following calibration, families were asked to seat their infant on their lap facing their computer monitor at which point we ran them through the experimental procedure. In the in-person version, infants came into our lab and were tested in our sound attenuated booth using the same experimental software and design. To test the validity of our

online procedure, we will compare attrition rate, number of trials and time to habituate, and looking-time differences across trial types between our online and in-person participants. Online data will be considered valid if it falls within a 95% confidence interval as established by the data collected in-person. Preregistration of this project can be found at https://osf.io/us8fn. Results of this work may have implications for the efficacy of synchronous, infant-controlled, Zoom-based data collection.

P3-D-421 - The Development of Semantic Integration in Bilingual Toddlers Measured by N400 (Lozano Sánchez)

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Semantic integration (i.e., the ability to integrate concepts with words-- henceforth, SI) is one of the main mechanisms supporting lexical-semantic acquisition (Friedrich & Friederici, 2004). In monolinguals, semantic priming effects at a neuronal level (indexed by N400) emerge between 18 and 24 months (Junge et al., 2021). This timing of onset is key because it overlaps with vocabulary spurt, suggesting that its emergence might be tightly coupled with vocabulary development. Yet longitudinal evidence supports this (Arias-Trejo et al., 2021), the extent to which brain maturation and language experience contribute to the development of SI is unclear. Bilingual toddlers split their time between two language inputs. Crucially, yet monolinguals and bilinguals experience similar concepts, bilinguals are less exposed to the words of each language (Jardak & Byers-Heinlein, 2019). This makes bilinguals a key sample to disentangle the relative contribution of brain maturation and language experience in the emergence of SI. If language experience plays a role, then (1) differences between monolinguals and bilinguals should be present in its timing of onset (earlier in monolinguals than bilinguals) and (2) language-dominance effects should be observable within bilinguals (earlier and more robust in dominant than non-dominant language). Our study explores 1) whether bilinguals follow the same developmental trajectory of SI as monolinguals, and 2) whether SI differs between bilinguals' dominant and non-dominant language across time. We will longitudinally measure SI in bilinguals (Polish-Norwegian, n=60) and monolinguals (Polish, n=60; Norwegian n=60) at 18 and 24 months. By using a picture-word semantic priming paradigm, either congruent or incongruent pairs of words and pictures will be shown while measuring toddlers' EEGs. We hypothesize (H1) that monolinguals will show SI at an earlier time-point than bilinguals. At 18 months, monolinguals will show a higher negative deflection in the incongruent vs. the congruent condition (i.e., N400 effects), while bilinguals will show no N400 effects, indicating a lack of SI. In contrast, at 24 months, both groups will show an N400 effect, thus succeeding in SI. We also hypothesize (H2) that, at 18 months, bilinguals will not show N400 effect either in their dominant nor non-dominant languages, while, at 24 months, N400 effect will be only shown in their dominant language. To contrast H1, we will run a 2 x 2 x 2 ANOVA on the amplitude of N400, with Language Group (Monolingual vs. Bilingual) as between-subjects factor and Time (18 vs. 24 months) and Type of Trial (Congruent vs. Incongruent) as within-subjects factors. We predict a significant interaction between language group, time and type of trial, with higher amplitude to incongruent (vs. congruent) trials only in the monolingual group at 18 months. H2 will be contrasted in bilinguals by a 2 x 2 x 2 ANOVA on the amplitude of N400, with Time (18 vs. 24 months), Language Dominance (Dominant vs. Non-Dominant) and Type of Trial (Congruent vs. Incongruent) as within-subjects factors. We expect a three-way

significant interaction, with a higher amplitude in incongruent (vs. congruent) trials only in the dominant language and exclusively at 24 months. Our results will clarify if SI is a language experience-dependent mechanism and if it is robust across language environments, contributing to neurodevelopmental theories and models of dual language acquisition.

P3-D-423 - The Influence of Bilingualism on Pitch in Infant-Directed Speech (Cheng)

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The objective of this study is to investigate the phonetic characteristics of Infant-Directed Speech (IDS) in English when English is a late-acquired second language (L2) of the speaker. Many new parents in Canada's Vancouver metropolitan area are bilinguals who acquired English in late childhood or adulthood. When bilingual parents speak to their infant children, they may use a mix of both languages. Given that IDS has been demonstrated to vary among languages (Fernald et al., 1989; Benders, 2013; Han et al., 2018), we investigate whether the pitch range, level, and variance of IDS in English as a second language show signs of phonetic influence of the speaker's first language. Exaggeration of pitch properties in IDS (compared to Adult-Directed Speech, or ADS) is present in English and Mandarin, but IDS in Mandarin also employs tonal exaggeration (Tang et al., 2017), while English IDS does not. A total of 20 parents with infant children around 18 months of age (17 months, 3 weeks to 19 months, 1 week) will be recorded during a one-hour directed play session. Ten parents will be monolingual parents who use only English with their infants. Ten parents will be bilingual in Mandarin and English, who have learned English as a second language in adulthood. During the session, parents will engage in spontaneous play and directed play with their infant, and then they will read a list of words and speak casually with an adult to capture their "baseline" pitch. We hypothesize that in comparison to the monolingual English group, the Mandarin-English (L2) bilingual group will demonstrate a wider pitch range, a higher pitch level, and greater pitch variance in their IDS. That is to say, the difference between ADS and IDS registers in English will be greater for the bilinguals than the monolinguals. To demonstrate this comparison, we will take 500 measurements of pitch at regular intervals during the running speech of each parent (e.g., 1-2 measurements per second for approximately 5 minutes) and calculate the range, mean, and variance per parent. Then, we will employ linear mixed effects models to determine the effects of register (IDS vs. ADS), first language, English proficiency, and bilingualism type (monolingual vs. bilingual) on each variable. Should our hypotheses be supported by the data, we will learn a great deal about the prosody of IDS, as well as about late-acquired bilingualism and the social and pedagogical goals of IDS. Very few studies of IDS phonetics have focused on bilingual parents, and none compare Mandarin-English bilinguals. We expect that our findings will support past reports that bilingual parents employ separate types of IDS for each language they speak to their infant children, rather than using a similar IDS register across languages (Danielson et al., 2014). In addition, we believe that our novel study will provide a closer look at some of the strategies parents may employ when using IDS in a second language (Fish et al., 2017), which will be a foundation for future studies on how L2 IDS affects infant speech and communicative development.

P3-D-424 - Contextual Cues to Everyday Math Language (Shahnooshi)

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Learning specific math words can be abstract and challenging for young learners to grasp. Still, comprehension and even production of math language occurs in infancy, with words like up, down, and more appearing in children's early vocabulary (Wordbank). How do mothers scaffold their children's understanding of abstract math language (whether intentional or not)? Mothers' attunement to children's interest supports relevant language development by building connections between referents and verbal communication (Tamis-LeMonda & Bornstein, 2002). For example, when a mother points and says "the block goes up on top" or "that blue car under there" as a child engages with the blocks or car, contextual cues are naturally built into the structure of their communication. Here, we examine mother-child conversations in the home from 2-hour video-recorded observations. Participants were 50 mothers and their 13- to 23-month-old infants. We ask: (1) What are the most common referents that mothers use in conjunction with math language? (2) How often are specific referents used? (3) How often is the referent present or visible in the child's environment? We first identified math words across 10 conceptual categories: number, shape, magnitude/comparison, location/direction, deictics, orientation, spatial features/properties, functions, ordinals, and superordinates. For each utterance containing one or more math words, we coded whether the utterance was child-directed; we identified the specific referent(s) of each utterance; and we named whether the referent(s) were present/visible to the child. For example, if the mother said "she's upside down!" while pointing to the child's doll, we recorded the doll as the referent and marked it as present (i.e., visible to the child). Coding of 9 initial dyads resulted in 2,090 utterances containing math language. Mothers averaged 232 math utterances during the 2-hour observation (SD=130.5; range=99-552), with nearly all (93.9%) directed to the child. Across the sample, the most frequent referents of mothers' math language were the child (17.4% of math utterances; e.g., "stand up"), books (14.8%), toys (11.0%), and food (6.3%). Similarly, all mothers used math language to refer to the child, toys, and food, and nearly all mothers used math language in reference to kitchenware, rooms in the home, and mothers themselves (Figure 1). Within these broader categories, we found immense variety in the specific referents of talk. For instance, mothers used math language to talk about stacking blocks, sharing toy food, searching for stuffed animals, counting Cheerios, and cutting oranges (Figure 2). Additionally, when mothers used math language, they often referred to people, objects, and spaces that were visible and salient to the child in the moment. Approximately 80% of mothers' math utterances corresponded to visible, present referents in the physical environment around the child (66.9%) or in a two-dimensional format (14.0%), such as on pages of a book. Thus, similar to word learning more generally, children may exploit visible and highly salient referents and cues to learn the meaning of abstract math concepts.

Thematic Poster - Western Biases in Infant Research: The state of the field and strategies for change. (P3-D-425, P3-D-426, P3-D-427, P3-D-428)

P3-D-425 - Why is Infant Research still so WEIRD? Barriers and bridges towards a diversified science of infant development (Singh)

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The past decade has seen intense discussion of narrow sociodemographic representation in psychological research (Heinrich et al., 2010). Issues of diversity and representation are central to infant

research given the focus placed on universality and uniquely human behaviors in infant research. In this paper, we examine sociodemographic diversity in infant research. In addition, we analyze changes in sociodemographic diversity over the past decade. Finally, we propose principles and practices for actionable changes that would lead to more diverse science of infant development.

We analyzed sociodemographic representation in all empirical papers that sampled typically-developing infants from birth to 30 months published in Developmental Psychology, Developmental Science, Infancy, and Child Development from 2010 to 2020. A total of 1383 papers were individually coded for participant race/ethnicity, geographical origin, and socio-economic status (SES). All analyses aggregate across the four journals.

With respect to participant race/ethnicity, race/ethnicity was not reported for the 73% of participants. For studies that reported race/ethnicity, 68% of participants were White. Representation of Asian, Black, Latinx, Native American, and other racial/ethnic groups amounted to less than 4% of participants per group. Over the decade, there was no evidence of diversification.

Similar calculations were computed for geographical location. Over the decade, only 55% of studies directly stated the location of study. Thirty-one percent of studies did not state location at all and 14% of studies indirectly stated location (e.g., this study was approved [institutional IRB]). Within studies that directly stated the location of study, 85% reported collecting data in North America and Western Europe. This geographical focus remained stable over the decade. There was an overall decrease in studies that did not report geographical origin.

For SES, 55% of studies did not report SES. Nine percent of studies reported SES information in ambiguous terms without characterizing SES measures in context (e.g., stating monthly income without characterizing SES or including reference categories for the setting). Of the studies that reported SES, 51% of studies sampled middle class or high SES participants, 19% sampled low SES participants, and 28% sampled a range of SES levels. All of these trends remained stable over the decade.

As evident in Figures 1a through 1c, representation in infant studies remain narrow with a persistent concentration of studies conducted with mid-to-high SES, White infants from North America and Western Europe. There also remains a significant tendency to not report sociodemographic information. To re-balance representation, we present four principles to address non-reporting of sociodemographics and to diversify our science. These include uniform acknowledgment of sociocultural bias and data-driven statements of generalizability in all studies, increased methodological diversity to incorporate the range of methods needed to conduct research in more diverse settings, an orientation away from cultural dichotomies (e.g., WEIRD/non-WEIRD) and towards a more nuanced description of socio-cultural context, and a movement away from nativist or universalist accounts of infant development based on small and narrow sampling. We further elaborate on specific practices to diversify infant research within the larger research ecosystem.

P3-D-426 - Developmental trajectory of infants? discrimination of stop-contrasts revisited: New data from Korean-, Thai- and Japanese-learning infants (Mazuka)

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Perceptual narrowing is one of the seminal theories of infant development. It is often considered to be a universal transition from general to specialized phonological sensitivities. Yet the majority of the data that have given rise to this view come from studies of infants learning English or a few other Indo-European languages. Without testing infants who are learning a wider range of languages, we cannot rule out the possibility that the dominance of the perceptual narrowing pattern is a characteristic limited to infants learning Western languages.

In this talk, we will present experimental results from infants learning three widely-spoken Asian languages -- Korean, Thai, and Japanese -- measuring their sensitivity to their native stop contrasts, and we suggest that the perceptual narrowing pattern of development may not occur as frequently as previously assumed. We will focus on voicing contrasts in stops such as /p/ versus /b/. Early studies on infants' sensitivity to voicing contrasts played an important role in establishing the perceptual narrowing view. In particular, Aslin et al. (1981)'s finding that English-learning infants are sensitive not only to the difference between voiced and voiceless stops in English but also to the difference between prevoiced and voiceless stops, which is phonemic in Thai but not in English. To date, however, Thai infants have not been tested for sensitivity to the Thai stop contrasts.

Like English, Japanese has a two-way stop contrast between voiced /b/ and voiceless /p/. Thai has three-way contrasts among prevoiced /b/, voiceless /p/ and voiceless-aspirated /ph/. Korean also has three-way contrasts, but they are all voiceless; lenis /p/, fortis /p'/ and aspirated /ph/. Using naturally recorded tokens in each language, infants in each language were tested on the discrimination of their native stop contrasts using the standard (i.e., not infant-controlled) habituation-dishabituation paradigm. In Thai, only 10- to 12-month old infants reliably discriminated voiceless /p/ from voiceless aspirated /ph/, but not at 7-9 or 4-6 months of age. Similarly, Korean-learning infants became able to discriminate lenis /p/ from aspirated /ph/ only at 10-12 month of age, but not at 7-9 or 4-6 months of age. In Japanese, neither the 4-6 nor 8-10 month old infants discriminated voiceless/p/ from voiced/b/ when the contrast was presented word-initially as /pe/ vs /be/. When the contrast was presented word-medially in /epe/ vs /ebe/, however, even the youngest group of infants (4-6 months) were able to discriminate it.

The results from these three Asian languages showed that the discrimination of some of the most widely distributed phonemic contrasts, i.e., stop contrasts, does not necessarily follow a developmental trajectory of perceptual narrowing. In Thai and Korean, infants become able to discriminate the contrasts as they grow older, showing an enhancement pattern. In Japanese, infants were able to discriminate the contrast only when it was presented in perceptually salient word-medial context. Our results indicate that testing languages outside of the usual Indo-European selection may elucidate a more representative view of how infants learn language.

P3-D-427 - Using big data from long-form recordings to study development and optimize societal impact (Cychosz)

Margaret Cychosz[1], Alejandrina Cristia

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Big data are increasingly common in infancy studies. One example is long-form, child-centered recordings collected using wearable technologies. Because these recordings are simultaneously

unobtrusive and encompassing, they may be a break-through technology for clinicians and researchers from several fields. In this presentation, we demonstrate these possibilities by outlining three applications for the recordings---clinical treatment, large-scale interventions, and language documentation---where we see the greatest potential.

Regarding clinical treatment, the use of new, semi-automated tools in the clinic could be timely given a dire shortage of speech-language pathologists: in some geographical regions, there is just one speech-language pathologist estimated per 2-4 million people in sub-Saharan Africa (Wylie et al., 2013). Long-form recordings can help with clinical observation and treatment because they are highly adaptable across mono- and multi-lingual settings and cultural backgrounds and capture sufficient data to measure outcomes in infants with limited verbal production. Furthermore, algorithms promise effortless characterization of infant vocal maturity and complexity (Oller et al., 2010).

Another application for long-form recordings in infancy research is early childhood interventions. Many interventions have demonstrated positive impacts throughout a child's academic career and into adulthood (Heckman, 2006). However, high quality evidence, from children in a variety of learning environments and international settings, is scarce (Busso et al., 2017). We argue that long-form recordings could help in this setting too: they provide culturally-adaptable measures of child development and can even help measure potential effects on others (e.g., caregiver language directed to children, caregiver stress).

Finally, long-form recordings are proving to be important vehicles for documentation of child language behavior and learning, especially for under-documented languages, because the thoroughness of the recordings facilitates comprehensive, accessible documentary materials. These could additionally serve community goals for language documentation and revitalization (Nee, 2021).

In sum, incorporating long-form recordings of infants' everyday lives into basic and applied research can result in more equitable diagnoses, more reliable measurements of the effects of interventions on real-world behavior, and deeper scientific insights with less observational bias, particularly if these developments are accompanied by an increase in the diversity of researchers using these methods (see Figure). To optimize the positive impact of this research, it is likewise crucial to pay attention to potential risks, including challenges to privacy and algorithmic bias. Our talk will address implications of these issues for our field. We will conclude by outlining a proposal for a semi-structured online platform where vast numbers of long-form recordings could be hosted and more representative, less biased algorithms to process these data could be trained.

P3-D-428 - Running a truly international school on early language development (Garcia)

Rowena Garcia[1], Paulina Aravena Bravo, Bolanle Elizabeth Arokoyo, Mulat Asnake Goshu, Silvia Benavides-Varela, Titia Benders, Natalie Boll-Avetisyan, Alex Carstensen, Alejandrina Cristia, Margaret Cychosz, Rodrigo Dal Ben, Yatma Diop, Ilse van den Dobbelsteen, Catalina Durán-Urzúa, Naomi Havron, Hiromasa Kotera, Ramona Kunene Nicolas, Ronel Laranjo, Marie Adrienne R. Manalili, Bhuvana Narasimha, Paul Okyere Omane, Caroline Rowland, Leticia Schiavon Kolberg, Andrew Ssemata, Suzy Styles, Belen Troncoso-Acosta. Fei Ting Woon

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A survey of linguistic diversity in leading language acquisition journals revealed that only 2% of the 7,000+ languages of the world are represented (Kidd & Garcia, 2021). With a long-term mission of enabling researchers everywhere to contribute to this literature, we organized the First Truly Global /L+/ International Summer/ Winter School on Language Acquisition (/L+/), a free, online, 5-day winter/summer school aimed to share expertise among early career researchers about phonological, lexical, syntactic learning, and environmental factors influencing language development in mono- and multi-lingual contexts. The format was designed to facilitate involvement of globally under-represented groups.

We asked for volunteers through the LangVIEW consortium (https://alecristia.github.io/LangVIEW/), with astoundingly high levels of participation: 26 researchers (17 from underrepresented areas: Subsaharan Africa, South and Southeast Asia, and Central and South America) volunteered to organize the school (working in smaller subteams, which allowed for effective, decentralized decision-making). Moreover, 70 researchers from 28 countries volunteered as lecturers, discussants, practical session leaders, and assistants.

To promote inclusivity (Levitis et al., 2021), our school (1) employed asynchronous (pre-recorded lectures) and synchronous elements (e.g., discussions to place the recorded lectures into participants' context; networking events, opportunities sessions) across three time zones (UTC+8, UTC, UTC-4); (2) provided closed captions for lectures and international sign interpretation for live sessions; (3) issued a code of conduct (e.g., reminder on what might be offensive in other cultures, of zero tolerance for harassment).

We hosted the school on Whova, a platform providing announcements and conversations, in addition to personalized schedules for the recorded lectures (hosted on YouTube), and the Zoom links for the live discussions. We also used Gather.town to encourage social interactions across a virtual dinner, networking events, and interviews.

We promoted the school through international and local mailing lists and our own networks. Overall, we had received 958 applications from 88 different countries. To optimize discussions, for each time zone, we limited participation in the synchronous events to 100 attendees. For each time zone, an algorithm selected 120 participants (80% from traditionally under-represented regions), maximizing the number of countries represented. Overall, we had 61 countries represented across the three conference time zones.

A post-school questionnaire (N = 177) revealed that 99% of participants enjoyed taking part in the school. They found events to be interesting and informative (lectures 100%; discussions sessions & practicals 83%; social 60%). Moreover, over a third of respondents were interested in joining the organization team for future editions of the school. Qualitatively, discussions evidenced relevant methodological and theoretical challenges of studying language development in underrepresented contexts.

Future editions of the /L+/ school will aim for greater geographic diversity among lecturers and greater customization of contents to the participants' contexts. In addition, randomly assigning registrants to synchronic events will allow us to measure the impact of these time- and people-intensive components on participant diversity. Although much remains to be done to promote inclusivity in linguistic research,

we hope our school will contribute to empowering researchers to investigate and publish on language acquisition in their home languages.

P3-D-430 - Babbling and Infant Agency in Generating Vocal-motor and Auditory-perceptual Experience (Fagan)

Mary Fagan[1]

[1]Chapman University

Introduction: One mystery surrounding the development of language and cognition is why infants engage in repetitive vocal behaviors such as, "da-da-da." Babbling syllables such as these are widely produced among 6- to 12-month-old hearing infants (Stark, 1980) but they remain a little-understood phenomenon in language development. Previous studies have shown that auditory feedback is a critical component in motivating both vocalization frequency and syllable production in deaf and hearing infants (Fagan, 2014, 2015). However, relations between auditory feedback generated by their own vocalizations, consonant production, and word use in infants with hearing loss is unclear.

Hypothesis: One hypothesis about the role of babbling in language development is that, as infants vocalize and repeat syllables, they gain experience exploring auditory-motor feedback, learning sensorimotor patterns beneficial for later word production (Fagan, 2015; Jung & Houston, 2019). In keeping with this hypothesis, profound hearing loss, by compromising infants' access to auditory feedback from their own vocalizations, results in little opportunity for infant agency in auditory-motor learning. Previous studies, for example, have shown that hearing infants show interest in self-generated auditory feedback and syllable repetition in the first 12 months of life; however, deaf infants produced these behaviors only in the second year, a few months after receiving CIs at 12 months of age (Fagan, 2015). Studying babbling and consonant production in infants who use CIs earlier in the first year will increase our understanding of infants' agency in generating auditory-motor feedback and its effects on consonant and word production. Questions about these effects are important, given that vocabulary acquisition is an area of weakness for children with hearing loss, even after cochlear implantation (Fagan & Pisoni, 2010).

Population: Access to CIs at 12 months of age and later created unique conditions of auditory manipulation that allowed empirical tests of hearing, vocalization, and consonant production during babbling. With recent authorization (in 2020) of earlier cochlear implantation, more infants began receiving CIs at 9 months of age. The current study includes thirteen 17-month-old infants who received CIs at a mean age of 12 months, six who received CIs at 9 months, and hearing infants matched by age to the infants with CIs.

Method: All infants freely vocalized during video-recorded play with objects. Frequency of vocalization, consonant production, and consonant inventories were identified from the video records. Word production was documented both from the video-records and with the MacArthur-Bates Communicative Development Inventory (Fenson et al., 2007).

Results: Hearing infants produced significantly larger and more varied ($p < .05$) consonant inventories than infants who received CIs at 12 months of age. As shown in Table 1, the consonants most frequently

produced and the percentage of participants who produced them also differed. New analyses in progress will examine vocalizations, consonant use, and word production for hearing infants and infants who received CIs by 9 months of age in comparison to those who received CIs at 12 months. Infant agency will be discussed in relation to hearing, vocalization frequency, consonant production, and associated effects on word use.

Thematic Poster - Structure in the input: statistical patterns across multiple timescales support early word learning (P3-D-433, P3-D-434, P3-D-435, P3-D-436)

P3-D-433 - Korean mothers' strategies to place nouns in the utterance-final position: Comparison to American child-directed speech and Korean adult-directed speech (Ko)

Eon-Suk Ko[1], Jihyo Kim[1], Jinyoung Jo[2]

[1]Chosun University, [2]University of California, Los Angeles

Comparison to American child-directed speech and Korean adult-directed speech:

The right-edge of an utterance is considered to be privileged because of its acoustic salience (Beckman & Pierrehumbert, 1986; Fernald & Mazzie, 1991) and memory recall advantages (Sundara, 2018). American mothers use the utterance-final position to introduce new terms to their infants, typically accompanied by enhanced acoustic cues. We investigated if mothers speaking Korean, an SOV language, might adapt the word order to place nouns in the utterance-final position. We show that Korean mothers adopt strategies such as tag-repetition (e.g. rice-eat, rice!) and scrambling (e.g. eat, rice!) to present nouns in the utterance-final position. We further show that Korean mothers adopt these strategies more frequently in addressing infants than adults.

In Experiment 1, 36 Korean mother-infant dyads divided into three groups of Preverbal (M=0;08), Early Speech (M=1;02), and Multi-word stage (M=2;03) freely interacted with each other for 40 minutes (Ko et al., 2020). Their interactions were recorded and transcribed. We constructed a matching data set of American mother-child dyads by assembling samples from the CHILDES database (MacWhinney, 2000). Ten most frequent concrete nouns were selected in each dyad, which yielded 2,812 tokens and 3,774 tokens in Korean and English. We coded each target noun for its repetition, scrambling, and sentential position. Multiple regression analyses showed an interaction between age and language for tag-repetition and scrambling (p's<0.001), indicating that Korean mothers adapt the word order in attunement to the child's development (Figure 1). Interestingly, American mothers showed a marginal age effect (p=0.055) on position, reflecting the greatest ratio of nouns in the utterance-final position at 13 months.

To clarify if the adaptation of word order serves a didactic function for infants beyond the generally flexible word order of Korean, we conducted Experiment 2. Twelve Korean mothers taught novel objects to their 10-month-old infant and to an adult confederate. They first read a custom-made book containing the target words, and explained it in their own words. A total of 1,836 tokens were yielded. Multiple linear regression found a significant interaction between task and register in tag repetition (p<0.05), suggesting that mothers use the tag-repetition more frequently when spontaneously talking to their children than when reading or talking to another adult.

Our findings suggest that Korean mothers might have a tacit knowledge of the privileged status of the utterance-final position and strategically take advantage of it in presenting new words to their children. Although the flexibility in word order is a general property of Korean, adaptation of word order was a more salient characteristic of speech addressed to children than adults. The proportion of adaptation was highest for the tag-repetition to the youngest infants, suggesting the importance of repetition and position for infants beginning to learn sound-meaning association. Further, the ratio of utterance-final nouns in English and scrambling in Korean both being highest at 13 months might reflect a parallel mechanism of word order scaffolding word learning. Our results are reminiscent of Turkish mothers who demonstrated a similar mutation of syntactic structure for the utterance-final position (Aslin, 1993, cf. Kuntay & Slobin, 1996).

P3-D-434 - Hands create high-quality naming moments in three different everyday activities (Schroer)

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The importance of manual activity in eliciting object labeling during optimal learning moments has been shown repeatedly in parent-infant toy play (e.g., Yu & Smith, 2012; Chang, de Barbaro, & Deák, 2016; West & Iverson, 2017). Recently, home observations have revealed that different activities create unique contexts for language learning (e.g., Soderstrom & Wittebolle, 2013; Tamis-LeMonda et al., 2019). Built upon those recent findings, the goal of the present study is to examine the role of manual actions in shaping learning opportunities in three different everyday activities: toy play, book sharing, and meal preparation.

We recruited 38 12-to-24-moth-old infants and their parents to wear head-mounted eye trackers while playing with 24 toys, "reading" a wordless book together, or making peanut butter and jelly sandwiches (meal prep). Dyads were positioned differently in each activity, creating unique interaction opportunities (Figure 1). We identified parent naming utterances as a "hit" if the infant looked at the referent during labeling, or a "miss". We coded manual activities as when infant or parent was holding (toy play, meal prep) or pointing to (book sharing) the referent around a naming utterance.

To study the behaviors that create high-quality naming events, we analyzed manual actions in the 3 seconds before hits and misses (Figure 2A). Using mixed effects logistic regressions, we found that the proportion of time the parents held the referent before labeling positively predicted whether the naming event was a hit in both toy play and meal prep. Similarly, in book sharing, parent pointing to the referent was moderately associated with a hit (using Yule's Q).

To understand the pathways that sustain naming hits, we then analyzed manual actions and infant visual attention in the 5 seconds after naming (Figure 2B). In toy play and meal prep, we see that parent holding predicts a hit. When infants could also interact with the referent, we see that hits are followed by increased infant holding in toy play and a substantial association with infant gesture in book sharing. We then compared infant attention to the referent after naming. Toy play had the greatest amount of sustained attention (Mall-naming= 0.336, Mhits-only=0.456, ps<0.001). And, while attention in book sharing is greater than meal prep when comparing all naming moments (Mbook=0.127, Mmeal=0.060, p<0.001), there was no difference between the two activities following hits alone

(Mbook=0.219,Mmeal=0.208). We hypothesize that infants' differing ability to interact with the referents across the three activities impacted their ability to sustain attention to the referent.

Our results suggest that manual activities from both infants and parents are critical for early word learning. In book sharing and toy play, the increased likelihood of child's manual engagement is accompanied by greater attention to the referent after naming. In meal prep, when infants were just an observer, this pattern falls apart. To create and maintain high-quality learning moments, parent manual activity leads the way by guiding infant attention to the target, after which infants' own manual activity needs to take over to sustain the learning moment.

P3-D-435 - The Rich Language of Book Sharing (Tan)

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It is well-established that shared book reading benefits children's learning outcomes. Caregivers who read books to their children tend to have children with more advanced vocabularies and stronger pre-literacy skills (e.g., Bus et al., 1995). This may be grounded in the types of language input that books themselves, as well as the book-sharing context, provide. For example, large-scale corpus analyses show that the language in book texts is more lexically diverse and syntactically more complex than the language in child-directed speech (CDS) (Dawson et al., 2021). Moreover, caregivers' spontaneous speech related to the book in book-sharing interactions is more complex than spontaneous speech in other contexts (Demir-Lira et al., 2019). While these results are strongly suggestive, they relied on corpora of either texts or speech, collected independently from each other. Here we directly compare all of these types of text/speech within the same sample of families.

In this study, we first collected all-day naturalistic recordings using LENA from 22 monolingual English-speaking families with 24-mo-old children from diverse socioeconomic backgrounds. For each family, we used the LENA automated adult word counts to sample the six densest 10-min segments containing CDS. Then we coded all activities in which caregivers were verbally engaged, including book-sharing, play, routines, meals, and unstructured conversation. All CDS was transcribed verbatim. For book-sharing episodes, we annotated all utterances as either read-aloud CDS or spontaneous-book CDS. For all non-book-sharing activities, we annotated all spontaneous-other CDS. Finally, all books used in the recordings were transcribed as book text in their entirety.

These four sources of linguistic input were analyzed by: (1) concatenating all transcripts within categories to form "mega-transcripts", and examining the type and type-token ratio curves; and (2) calculating by-transcript measures of lexical diversity (measure of textual lexical diversity [MTLD]), lexical density (proportion of lexical words), lexical sophistication (mean token frequency and contextual diversity in SUBTLEXus), and grammatical complexity (mean length of utterance in words [MLU-w] and proportion of complex utterances). We compared these measures across sources via mixed-effects regressions with family as a random effect.

Replicating results of previous studies, the "mega-transcript" measures showed that book text had more types and higher type-token ratios than spontaneous-other CDS. We also found that book texts and read-aloud CDS were more lexically diverse than spontaneous talk during both book and non-book

activities (Figure 1). The by-transcript measures showed that read-aloud CDS was similar to book text in all measures other than MLU-w, while spontaneous-book CDS was similar to spontaneous-other CDS (Figure 2). Read-aloud CDS was also richer than spontaneous-book CDS in all measures other than MTLD.

We conclude that the richness of language during book sharing may largely be driven by caregivers' speech as they read book texts aloud with their children, rather than by the extra-textual spontaneous speech that also occurs during book sharing. The latter may serve important but different functions, to be investigated in ongoing analyses.

P3-D-436 - The Extralinguistic Environment and Early Word Learning: The Importance of Partial Information in both Input and Learning (Suanda)

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A tension exists in the literature on the role of the extralinguistic environment for word learning. One body of evidence suggests that various contextual, non-verbal, and socio-interactional variables support word learning (Golinkoff et al. 2015, Tamis-LeMonda et al. 2014, Yu & Smith, 2012). A separate literature however stresses the limits of these variables (see Gillette et al., 1999; Medina et al., 2011). These limits are most evident in the Human Simulation Paradigm (HSP) in which participants are asked to guess the identity of words from muted videos of parents uttering words while interacting with their language-learning toddlers. HSP studies reveal that access to the extralinguistic environment in which words occur are rarely enough for identifying word meaning (e.g., Gillette et al., 1999). Through a mixture of observational and experimental data, this paper explores the tension between these literatures and stresses the importance of the concept of "partial information" in characterizing both the input and toddlers' word knowledge.

HSP Study.Ten parent-toddler dyads (Mtoddler age = 19.7mos) were recorded in free-play (Fig 1A). From these recordings, sixty muted video vignettes were constructed around the moments parents uttered a randomly-selected set of target nouns (e.g., "airplane", "sandwich"; Fig 1B); beeps were inserted at the moments parents uttered the target nouns. Forty adult participants viewed the vignettes and guessed the identity of the target nouns. Like previous HSP studies, participants performed poorly, guessing correctly on only 35% of vignettes (Fig 1C). Thus, despite access to several non-verbal, contextual, and interactional cues to reference, identifying precise word meanings in child-directed speech from extra-linguistic information alone is challenging, even for adults.

HSP Error Rating Study. Although extra-linguistic information may not afford learners precise word meanings, it may nonetheless provide valuable partial information about word meanings. To explore this, a separate group of adults (N = 52) rated the HSP errors from the study above. Participants rated whether nouns parents uttered were closer in meaning to the HSP errors made in response to those nouns or to errors made in response to different target nouns (Fig 1D). Semantic associations (Fig 1E) between parents' words (e.g., "sandwich", "picture") and HSP errors (e.g., "bread", "painting") highlight that although many parent naming events may be referentially ambiguous, they nonetheless carry partial information for word meaning.

Cross-Situational Word Learning Study. Can referentially ambiguous naming events containing partial semantic information be useful for word learning? Adult participants (N = 50) saw five referentially

ambiguous scenes, each paired with a novel word (e.g., "modi"). Scenes were pages from children's picture books that had contained an early-learned English noun in its original text (e.g., "apple"), though all text were removed in the scenes presented (Fig 2A). A norming study revealed all individual scenes to be referentially ambiguous (guessing the English noun from scenes averaged at 6%). Some scenes however contained partial information for word meaning, while others contained little information. When participants saw multiple referentially ambiguous naming events with partial information for word meaning, learners eventually identified the target word (Fig 2B).

P3-E-437 - The neonate brain's sensitivity to repetition-based structure: specific to speech? (Nallet)

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Newborns are able to extract and learn repetition-based regularities from the speech input, i.e. they show greater brain activation in the bilateral temporal and left inferior frontal regions to trisyllabic pseudowords of the form AAB (e.g. « babamu ») than to random ABC sequences (e.g. « bamuge »; Gervain et al., 2008, 2012). Is this sensitivity specific to speech and language? To answer this question, we tested whether newborns are sensitive to repetition-based regularities when those are implemented with musical tones. Twenty-three neonates listened to blocks of AAB and ABC tones sequences (fourteen blocks per condition and ten items per block) [Figure 1. Panel A] while their brain activity in the temporal, parietal and frontal areas was recorded using functional Near-Infrared Spectroscopy (fNIRS) [Figure 1. Panel B]. Each of the 20 unique syllables comprising the stimuli in the original study with speech (Gervain et al. 2012) was mapped onto a different piano tone. Thus the paradigm, the frequency of occurrence and the distribution of the tones were identical to those of syllables in Gervain et al. (2012). NIRS data was pre-processed following Gervain et al. (2008, 2012). The permutation analysis over oxyHb concentration changed revealed four significant clusters of channels where brain activity differed between the AAB and the ABC conditions: one in temporal and one in fronto-parietal areas in both hemispheres [Figure 1. Panel B and Figure 2. Panel A]. A linear mixed effects model over these clusters revealed a significant main effect of condition due to larger inverted (negative) responses to AAB than ABC. The main effect of time was also significant due to a general decrease in response amplitude over time [Figure 2. Panel B: correlation between the grand averaged oxyHb concentration and time in the fronto-temporal cluster of the left hemisphere]. These findings show that newborns' ability to discriminate AAB from ABC sequences is not specific to speech - it also extends to musical tones. However, the neural response is markedly different. First, we observed a strong overall habituation pattern over time, whereas for speech an increase was present over the time course of the study. Second and relatedly, the repetition regularity gave rise to an inverted hemodynamic response, while it was canonical for speech. Thus newborns' ability to detect reduplication is present in auditory modalities other than speech, but the underlying brain mechanisms may be different.

P3-E-438 - Integrating gestures and words to communicate: a study on full-term and low-risk preterm late talkers (Zuccarini)

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Introduction. Young children use gestures to practice communicative functions that foster the development of their expressive and receptive linguistic skills. Studies investigating the use of gestures by late talkers - i.e., children exhibiting an expressive vocabulary at or below the 10th percentile with the use of standardized tools - are limited and leave some aspects of this communicative competence nearly unexplored, as the study of gesture-word combinations (Thal & Tobias, 1991, 1992; O'Neill & Chiat, 2015, 2019). This study aimed to investigate the use of gestures and gesture-word combinations and their associations with linguistic abilities in late talkers, born either full-term or low-risk preterm. A further purpose was to investigate whether a set of individual and environmental factors, previously identified as predictors of language delay, accounted for interindividual differences in late talkers' use of gestures. Methods. Sixty-one late talkers, including 35 full-term and 26 low-risk preterm children, with no neurological damage, congenital malformations, sensory impairments, or cognitive deficits, exposed to the Italian language from birth, participated in the study at 30 months (corrected age for preterm children). Parents filled-out the Italian Short Forms of the MacArthur Bates Communicative Development Inventories (MB-CDI), "Gesture and Words", to assess action and gesture production and word comprehension, and "Words and Sentences", to assess word production and sentence production (Caselli et al., 2015), and were invited to participate in a book sharing session with their child. Children's gesture and word productions during the book sharing session were transcribed and coded into CHAT format of the CHILDES software (MacWhinney, 2000) from the video-recordings by a trained observer and a second independent one to compute interobserver reliability. Type of spontaneous gestures- deictic and representational- and gesture-word combinations -complementary, equivalent, and supplementary- were coded following Capirci et al. (1996). The Bayley scales of Infant and Toddler Development, Third Edition (BSID-III) (Italian version, Ferri et al., 2015) were administered to ascertain that children had no cognitive delay. Results. Correlational analyses documented that children's spontaneous use of gesture-word combinations - particularly complementary and supplementary forms - in the book sharing session was linked to larger receptive and expressive vocabulary and greater sentence production at the MB-CDI. In addition, children's action and gesture production and receptive vocabulary at the MB-CDI were positively associated. Concerning predictors, female gender, low-risk preterm status and a higher cognitive score were positively associated with gesture-word combinations. Conclusions. The study's findings point toward a comprehensive consideration of communicative gestures in examining late talkers' communicative profiles for both assessment and possible interventions. Use of gestures and, in particular, gesture-word combinations represent a point of strength in the profile of late talkers promoting communicative functions fundamental in the process of receptive and expressive language acquisition. Individual factors need also to be considered in investigating late talkers' gestural production.

P3-E-439 - Differences in noun production by late-talking and typically developing 30-month-olds predict denominal verb production (Biblin)

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Known words in one word class may influence subsequent word learning in another at different points in development. For example, the number of nouns produced at 16 months predicts the number of verbs produced at 20 months, but verbs produced at 20 months predicts nouns produced at 24 months (Longobardi et al., 2017). Little is known about how early production of nouns that can be

'denominalized', or used as a verb, is related to early use of denominal verbs, which hinges on flexibly using a lexical item in different word classes. Many early single-word utterances include these nouns, which can refer to objects and be action words, such as "swing", "drink", and "wipe." Within two-word utterances, they can clearly denote word class - e.g., "swing" as a noun in "a swing" or as a verb in "I swing." For typically developing (TD) toddlers, nouns tend to dominate early vocabulary (McDonough et al., 2011) with adult-like verbs appearing as expressive vocabulary increases and two-word combinations emerge (Bates et al., 1994). It is also not clear what the relation between these nouns and their denominal verb forms may be for late talkers (LT) with expressive vocabulary scores in lower percentiles and delayed word combinations (Ellis Weismer, 2007; Fenson et al., 1993, 2007). LTs have fewer verbs (Horvath et al., 2019) and may not have a sufficient foundation of noun vocabulary to support verb learning in the ways that TDs do. The noun vocabulary composition of LTs is different compared to TDs, even when controlling for size (Colunga & Sims, 2017; Perry & Kucker, 2019; Perry et al, 2021). These potentially important noun and verb vocabulary differences between LTs and TDs motivate the research question: Do nouns that have a related denominal verb form that are produced at 30 months old differentially predict denominal verb production at 42 months and 54 months for LTs and TDs? Using the corpus from the TalkBank database (Ellis Weismer et al., 2013; MacWhinney, 2000), longitudinal data from 15 TDs (expressive vocabulary >20%ile) and 25 LTs (expressive vocabulary <15%ile) were taken from transcripts of language samples elicited during structured play sessions at 30, 42, and 54 months. A list of related noun / denominal verb pair keywords (i.e., specific lexical items) was used in a CLAN search for all toddler utterances and each use of the keywords was coded as a noun or verb. Each child's inventory of denominal verbs at 42 and 54 months, and related nouns at 30 months, were compared across language status using multiple regression analyses. Regardless of language status, noun production at 30 months significantly predicted denominal verb production at 42 months ($R2 = .37$, $F(3,36) = 6.84$, $p < .001$), but nouns at 30 months did not significantly predict denominal verbs at 54 months. At 54 months, denominal verb production was significantly different for language status ($R2 = .24$, $F(3,36) = 3.69$, $p < .05$), with TDs producing more denominal verbs. These results suggest that individual differences in denominalizable noun inventories determine cross-class use of these lexical items as verbs for both LTs and TDs, but only for an early window of development. This cross-class flexibility may indicate better learning of salient semantic features that allow for correctly using a lexical item in different syntactic frames. Given the cascading effect of denominalizable nouns to later related verb use, intervention for LTs may be improved through targeted teaching of nouns that may promote verb learning.

P3-E-440 - Language Exposure in the NICU Before and During the COVID-19 Pandemic (Mullins)

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Social distancing and restricted visitation in hospital settings resulting from the COVID-19 pandemic has negatively impacted the well-being of individuals around the world. Preterm infants at risk for developmental deficits such as memory issues, language and speech delays, and auditory impairment (Webb et al., 2015; Graven & Browne, 2008) may be especially vulnerable as a result of reduced visitation in Neonatal Intensive Care Units (NICU). Human auditory systems are functional at approximately 25 weeks gestation, and experience with low-frequency sounds, such as the human

voice, is protective and promotes the development of healthy cognitive auditory pathways in the preterm infant (McMahon et al., 2012; Yan, 2003). In contrast, damaging high-frequency sounds (Wachman & Lahav, 2011), which are typically filtered out in the uterine environment, tend to be prevalent in the NICU (e.g., high pitched alarms, ventilatory sounds; Altuncu et al., 2009). Moving families into single-family rooms, implemented in part to limit exposure to noxious sounds, has unintentionally resulted in a reduction in speech input to these at-risk infants (Vohr et al., 2017; White et al., 2008). Visitation restrictions in response to the COVID-19 pandemic may further impact infants' access to speech input necessary for the healthy development of cognitive pathways. In the current study, we assess the impact of the COVID-19 pandemic on the quantity of speech input available to low-birthweight (LBW; ≤1800g) preterm infants (24-32 weeks gestation). We analyzed word count data collected in the NICU from two cohorts of infants: one born before the onset of the pandemic (July 2019 through February 2020; N=39) and one born during the pandemic (April 2021 through October 2021; N=22). Importantly, as a result of the pandemic, maximum visitation in the hospital NICU was reduced from 6 family members to 2 parents. To capture word count information, a Language ENvironmental Analysis (LENA) device was placed inside the neonatal incubator. The LENA recorded speech input over a 16-hour period, which included 8 daytime and 8 nighttime hours. Average noise levels were also collected during the same time periods. Across both cohorts of infants, there was enormous variability in the quantity of words spoken in the infant's environment (M=2,785, SD=3,483; range: 85-17,885), suggesting that some infants may be particularly at risk due to extremely limited language exposure. Infants born during the pandemic were exposed to approximately 20% fewer words (M=2,438, SD=2,579; range: 133-10,158) than infants born before the pandemic (M=2,981, SD=3,920; range: 85-17,885). Although this difference did not reach statistical significance, compounded over time, this difference may prove to be of clinical significance. It is noteworthy that despite efforts to reduce noise in the NICU, the average noise levels (M= 52.3dB; range: 31.7-83.1) far exceeded the noise limit guidelines of 45 decibels (A-weighted scale; dBA) set out by the American Academy of Pediatrics (AAP). Comparison of visitation logs across the cohorts may reveal meaningful patterns. Clinical relevance of these findings will be discussed.

P3-E-441 - Examining the Effects of Caregiver's Social Contingency in Infants with Familial History of Autism Spectrum Disorder (Tauxe)

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Infants' early social-communication skills develop through their engagement in contingent interactions with their caregivers. These early interactions may be even more crucial for infants with greater likelihood for developing Autism Spectrum Disorder (ASD) due to an older sibling's diagnosis. Past research suggests that infants without familial history of ASD (FH-) prefer highly contingent social interactions over non-contingent interactions (Bigelow & Birch, 1999; Keemink et al., 2019) and infants with familial history of ASD (FH+) prefer highly contingent and predictable non-social stimuli over non-contingent stimuli (Northrup et al., 2017). However, the literature on how FH+ infants respond to different levels of social contingency is limited, so little is known about whether their non-social contingency preferences extend to social interactions in infancy. Given that typical symptoms of ASD include social challenges and preferences for predictable and repetitive stimuli, it is critical to measure behavioral differences surrounding these topics in FH infants. Furthermore, it is unknown how both FH-

and FH+ infants respond to more moderately contingent and familiar social interactions with their caregivers relative to extremely high levels of contingency. To address these questions, we compared FH- and FH+ infants online in their homes in highly and moderately contingent interactions with their caregivers at 3-, 6-, 9-, and 12-months of age. In our study, infants played with their caregiver in two 5-minute conditions: moderate and high contingency. In the moderate contingency condition, caregivers played with their infant as they normally would, without any specific instructions. In the high contingency condition, caregivers responded with "hi, baby!" every time their infant looked at them and "ba-ba-ba!" every time their infant vocalized. We measured infants' positive emotions, negative emotions, gaze to their caregiver, turn-away behavior, vocalizations from the infant, vocalizations from the caregiver, and verbal turn-taking behaviors. Because our recruitment and coding is still ongoing, our preliminary results will be presented from 44 infants: 24 FH- and 20 FH+. On average, infants in both groups vocalized more in the highly contingent interaction condition than the moderately contingent interaction, regardless of age ($p = 0.04$). These findings suggest that both FH- and FH+ infants may increase their levels of vocalizations during highly contingent social interactions, which could aid in language development (Roseberry & Hirsh-Pasek, 2014). We also found that older infants gazed at their caregiver significantly less than younger infants, across both levels of ASD familial history ($p < 0.001$). We found no differences between FH- and FH+ infants for any of our measured variables. It may be that the behaviors we measured may not be informative as a diagnostic tool in the first year of life in a naturalistic, online format. It may also be that the high and moderate contingencies as manipulated here are not different enough to reveal group differences. Future research could benefit from measuring similar behaviors past the first year of life, contrasting conditions more strongly, or measuring interactions in-person where greater experimental control is possible.

P3-E-443 - Multimodal Communication in Non-Structured Interactions of Children with ASD: Bringing Language, Gestures And Gaze Together (Casla)

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Communication difficulties in children with autism spectrum disorders (ASD) are shown early in the production of preverbal, referential behaviors such as directed gaze, gestures and vocalizations; these can be produced unimodally (on its own) or in combination (multimodally). A recent study1 has shown that both the production of some unimodal communication behaviors and their multimodal combinations by young ASD children are comparable to those of typically developing children (TD) once they acquire an equivalent high-level of productive vocabulary; language development, therefore, may compensate the difficulties of ASD children in early communication. These findings, however, apply to structured interactions with a professional. Whether they also apply to non-structured interactions, where ASD communication difficulties usually emerge, is still to be ascertained. Here we compare the communication behaviors of children with ASD and with TD in non-structured interactions with their mothers. The study looks at: (1) quantitative and qualitative differences in unimodal and multimodal communication and (2) the effect of the level of productive vocabulary on the communication in the two groups. A total of 20 children participated in the study (10 with ASD, ages 28-79 months; 10 with TD, ages 12-30 months). Children in the two groups were matched by their productive vocabulary score (MacArthur Communicative Development Inventory (CDI)). Participants were subsequently allocated to either a Low-CDI group or a High-CDI group. Unimodal behaviors include directive gaze (Gz), gestures (G)

and vocalizations (V) produced in isolation. Multimodal behaviors include the following combinations: gesture-vocalization (GV), gesture-gaze (GGz), vocalization-gaze (VGz) and gesture-vocalization-gaze (GVGz). The frequency of communicative behaviors was measured as the rate per minute and as mean proportion. Types of deictic gestures include proximal and distal. Types of vocalizations include verbal and pre-verbal. Results show significant differences between the two diagnostic groups in the rate of multimodal behaviors. TD children produce significantly more multimodal behaviors than ASD children while there is no difference in the production of unimodal behaviors. Qualitatively, the multimodal communication also shows differences between the two groups; ASD children produce significantly less proximal gestures (see figure 1) and less preverbal vocalizations than TD children. The level of CDI has also an effect on the rate of behaviors. Low-CDI children produce significantly lower rates of unimodal and multimodal behaviors than High-CDI children. There are differences, however, in the type of multimodal combinations affected by the diagnosis and the level of productive vocabulary. In particular, the three-way multimodal combination of GVGz is overall higher in the high-CDI group but low-CDI TD children show significantly more three-way multimodal communication behaviors than children with ASD at the same CDI level (see fig.2). In sum, both the level of productive vocabulary and the diagnosis have an effect in the multimodal communication shown in non-structured interactions. In line with the previous study, findings indicate that language development may compensate, to some extent, ASD early difficulties. The differences in specific types of behaviors, however, indicate that ASD multimodal communication may follow a different trajectory to bring together language, gaze and gestures in the communication event.

P3-E-444 - Infant Gestures and Caregiver Responses Across the Transition from Crawling to Walking (Plate)

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Learning to walk supports the production of gestures. With free hands, infants can carry objects and share them while on the go. Research has shown that following walk onset, the rate of gesture growth increases, infants gesture more while moving, and caregivers increase in their responses to moving communication (Karasik et al., 2014; West and Iverson, 2021). Specifically, when infants gesture while moving, caregivers are most likely to respond with verbs that direct infant play or descriptions of objects in their hands (Karasik et al., 2014). Here we expand on this work by examining the different types of gestures that infants produce (both in general and while moving) and in turn, the types of responses that caregivers provide when infants gesture across the transition to walking. Twenty infants and their caregivers were observed at home monthly from 8 to 20 months. Dyads were videorecorded for 30 minutes while engaging in everyday activities. We anchored observations to the onset of walking (5 steps, M = 12.2 months, SD = 1.21) and coded the sessions from one month prior to two months following walk onset. Coders first tagged infant gestures (e.g., gives, requests, points). Then, for each gesture, we identified whether caregivers responded within two seconds and classified their responses as including a translation (labeling the target of the infant's gesture), other label (nouns not translating the gesture), action directive (directing the infant to perform an action), or other response (without nouns or verbs). Coders also identified when infants moved (e.g., crawling, cruising, walking) and whether infants' gestures co-occurred with locomotion. Infants nearly doubled in their rates of gesture production from one month prior (M = 14.36) to two months following walk onset (M = 26.90, p = .024;

Figure 1a). Specifically, give gestures increased significantly between walk onset and two months post-walk onset ($p = 0.01$). Caregivers responded to gestures at the same rate across time ($M = 65.87\%$, Figure 1b). However, they did increase the proportion of gestures that received translations as responses from walk onset to one and two months walking experience ($p = 0.02$). Infants spent twice as much time in motion at the final session compared to the pre-walk session ($M = 11.86\%$ to $M = 19.26\%$; $p < 0.01$). And while no gestures co-occurred with bouts of crawling, the number of gestures during upright locomotion increased as infants became proficient walkers, from 0.94 to 3.5 gestures at the final session (Figure 2). Consistent with prior studies, infant gestures increased across the transition to walking and these differences may be driven by an increase in give gestures. Additionally, while the proportion of gestures that received responses remained the same, caregivers increased their translations of infant gestures as infants learned to walk. Lastly, after infants learn to walk, the number of gestures they use while moving increased. This increase occurred when infants had two months of walking experience, suggesting that infants need to be proficient in hands-free locomotion before they begin using their hands to communicate while moving.

P3-E-445 - Exploring how mothers help children see events using gesture (Delgado)

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Languages differ in which event component they highlight in an event. Specifically, the way speakers encode path (i.e., the direction of movement with respect to a ground object; across) and manner (i.e., how the action is executed; walk) forms two categories of languages: verb-framed and satellite-framed (Özçalışkan, 2016). A verb-framed language (e.g., Spanish) describes the path of the figure in the verb and describes manner in an optional subordinate clause (e.g., a gerund clause; Konishi et al., 2016). On the other hand, satellite-framed languages (e.g., English) use verbs to describe the manner of motion and lexicalize both the path and manner of an event by encoding manner in the verb and path in a satellite prepositional phrase. Acknowledging these differences across languages raises the question: How do children learn which features of events align with how their language describes events? Along with linguistic exposure, children may also learn which event component is prioritized by their language through their parents' gestures, as parents often modify their gestures to emphasize or clarify what is being spoken with infants (i.e., motionese; Brand et al., 2002). The current study asks, do mothers utilize gestures that align with their language structure when interacting with their 14- to 20-month-old children? We offer two hypotheses. First, all parents will use gestures that align with the structure of the language they speak. Parents who speak verb-framed languages (Spanish) may describe path before manner using a separated strategy when producing gestures (i.e., moving the hand away from the body and then wiggling fingers to convey "running away"). Parents who speak satellite-framed languages (English) may encode manner by gesturing manner and path using a conflated strategy (i.e., wiggling fingers while moving hand away from oneself to convey "running away"). Alternatively, there is a universal bias to separate event components (McNeill, 2005), suggesting all parents may use separated gestures. Monolingual English- and monolingual Spanish-speaking mothers and their infants will be recruited. Depending on the language infants predominantly hear, the procedure will be administered in English or Spanish. Mothers will be asked to describe two scenarios to an experimenter to obtain a baseline of how mothers use gestures as they speak. Next, mothers will be asked to describe an event to their child in whatever way feels natural to them (the spontaneous gesture-phase) and then will be

given explicit instructions to use their hands (the gesture encouraged phase). To address our research question, we will calculate the proportion of path and manner gestures mothers produce when describing events to their child and assess whether these proportions align with their native tongue. Future directions will consider how mothers' gestures relate to their child's ability to recognize a novel event. Findings may reveal how language and gesture shape children's perception of events, illuminating the relation between language and cognition.

P3-E-446 - Toddlers' Ability to Learn New Syntax-Semantics Links (Amarakoon)

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Young children can exploit the syntactic context of a novel word to narrow down its probable meaning (syntactic bootstrapping; Gleitman, 1990). How do they come to identify the semantic information that a syntactic context provides? Based on the semantic seed hypothesis (SSH: Christophe et al., 2016), children discover the semantic predictiveness of syntactic contexts by tracking the distribution of a handful of familiar words. Recent work has indeed demonstrated toddlers' and preschoolers' ease to discover the semantic predictiveness of novel function words from short naturalistic training videos (e.g., Babineau et al., 2021). However, in these key studies, the categorical distinction was already marked in the participants' native language (e.g., 'ko' before verbs or nouns), or it was one common in natural languages ('ko' marking animacy). Can children easily learn to predict any conceptual distinction? As certain conceptual categories (part of core knowledge) are often marked in languages' morphosyntax, young learners might be biased (Strickland, 2017). Our study will test children's ability to learn novel noun class systems, one marking a core knowledge category and another one marking a non-core knowledge category. French-learning monolingual toddlers (19-21 months) will be randomly assigned to the vehicle condition (non-core-knowledge; N=32) or the animacy condition (core-knowledge; N=32). During the training phase, infants will watch a video of a woman telling stories, once a day for 3 consecutive days. In these videos, the determiners un/une ('a') and le/la ('the') are replaced with 'ko' before animates or vehicles and replaced with 'ka' before inanimates/non-vehicle objects (figure 1). Crucially, in both videos, the storyline and the number of occurrences of the novel determiners are identical, but the words co-occurring with 'ko' vary. During the test phase at the lab, children's gaze will be recorded with an Eyelink 1000 eye-tracker. They will see two pictures presented side-by-side while they hear sentences containing familiar words (N=10) or novel words (total N=8, 4 targets presented twice) preceded by either 'ko' or 'ka' (figure 2). If toddlers can identify the semantic information cued by the novel determiners (e.g. ko+vehicles and ka+non-vehicles in the vehicle condition), they should look more to the appropriate novel item (e.g. look more to the novel vehicule if they hear 'ko'). Cluster-based permutation analyses (predefined threshold: t = 1.5) will be used to compare looks to novel animates (or vehicles) during trials presenting 'ko' with those presenting 'ka'. We will also compare looking times averaged over a 2 s window (starting 300ms after 'ko' or 'ka') using paired-sample t-tests. Test trials with more than 25% missing data frames will be removed from statistical analyses. Participants with more than half of the trials missing will be excluded. In sum, our study will shed light on the SSH learning mechanism, either showing that it is limited by core knowledge (if differential looks are only found in the animacy condition) or that toddlers' ability to learn syntax-semantics links is powerful (if differential looks are found in both conditions).

P3-F-447 - Logging the continuous video content viewing behaviors of infants and their relationships with learning effects (Matsunaka)

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There are many video contents available for infants and toddlers, however, there are few studies that have evaluated the learning effects of continuous viewing of such video content. The learning effects in continuous viewing are expected to be influenced by many factors: for example, the level of infants' interest in the video content, the number of fixations during viewings, the infants' viewing attitude, the interaction with caregivers during viewings, and so on. Therefore, it is important to examine the relationships between these factors and the learning effect by collecting and analyzing the actual viewing behaviors in detail. Then, we have currently collected images of infants daily watching video contents at home continuously using a 360° camera (Figure 1) and assessed infants' implicit acquisition of picture-sound and letter (hiragana)-sound correspondence contained in the video contents regularly at laboratory or home via Zoom. The video contents are taken from a TV program for infants and toddlers which is daily broadcast in Japan. The assessments at the laboratory or home are conducted approximately every four weeks. The number of participants at this point is 20 infants (at laboratory: n=10; at home: n = 10) and their age at the first assessment ranged from 7 to 24 months (M = 322.7 days, SD = 47.0 days). For the regular assessment, we examine the acquisition of the picture-sound and letter (hiragana)-sound correspondence with the looking-while-listening (LWL) paradigm (e.g., Bergelson & Swingley, 2012). In the LWL paradigm, we presented a pair of visual stimuli side by side (pictures or letters) and presented a corresponding sound of the target stimulus. Then we calculate the increase in target looking. Infants' looking behaviors are collected with an eye-tracker at the laboratory and with recorded videos at home environments. At this point, one participant has completed all the assessments at the laboratory, and the other participants are ongoing the experiment. The result of the change of the increase in target looking score for one participant who completed the assessment is shown in Figure 2. In the poster, we will report the changes of the increase in target looking scores and daily video content viewing behaviors for all participants and discuss which factors of infants' usual video content viewing behaviors contribute to the individual differences in the learning effect.

P3-F-448 - Examining Visual Selectivity and Individual Variability in Infants' Viewing of Naturalistic Egocentric Scenes (Zhang)

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With many objects in the everyday visual world, visual attention serves as a filter through which the selected information passes through for internal learning processes. Understanding the attentional mechanisms that drive infants' in-the-moment selection is a fundamental question in research on infant attention (i.e., Amso et al., 2014; Frank et al., 2009; Markant & Amso, 2015; Pomaranski et al., 2021; van Renswoude et al., 2019). In the context of early word learning, what visual objects or events infants selectively attend at the moments of hearing a label is critical for them to build correct word-object mappings. The current study aims at understanding the role of selective attention in word learning. We collected a set of toy-play videos from eight 12-month-old infants and their parents, in which the dyads

were instructed to play for 10 minutes with 25 toys as they naturally would at home. The play session was recorded from the child's perspective using a head-mounted camera. From these play sessions, we selected forty-four egocentric scenes at the moments when parents named toy objects. We then conducted a screen-based eye-tracking experiment with another group of 12-month-old infants (n=23) by showing them these pre-selected egocentric scenes with varying visual properties and measuring their eye-gaze during free viewing. Selectivity: We found that infants' attention is highly selective. With a 7-second temporal window of viewing a visual scene consisting of many available objects (M=11.48 objects), they consistently attend to a small subset of objects (M=4.02, Figure 1). Moreover, they tended to choose a single object over other selected objects and spent over half of the looking time attending to that object (M=61.14%, Figure 1). Thus, given many available objects in view and different scene compositions, infants' selective attention significantly reduces in-the-moment uncertainty. Variability: We next examined what infants chose to attend. Specifically, whether individual infants attended to the same or different regions on a given scene. By correlating each infant's fixation density map with every other infant's density map and averaging the Pearson correlation coefficients across participants, we found relatively low consistency (M=0.23). Different infants tend to sample different regions of the scene (Figure 2), creating their own filtered input for learning. Altogether, our findings suggest that infants' attention consistently and reliably gates the learning input independent of the complexity of visual scenes, which challenges the general assumption that infants distribute visual attention more widely when viewing more cluttered vs. cleaner scenes. Meanwhile, we also found that infants sample different regions when viewing the same visual scene, suggesting individual variability in terms of what information is selected. This finding indicates that individual variability in visual attention may be a key factor contributing to individual differences observed in early word learning. Our results are novel and unexpected as they shed light on how we should rethink the learning input and how it is created through the learners' own attentional mechanisms.

P3-F-449 - Attention bias to emotion and gaze direction in 18-month olds (Kwasneski)

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Increased attention to threat-related cues is evident as early as age four months, though only fearful (and not angry) facial expressions receive increased attention relative to neutral facial expressions at this age (Leppänen et al., 2018). Further, emotion cues about the context of the environment may influence attention allocation, such that attention has been found to be greater to facial expressions with direct, rather than averted, eye gaze (Babinet et al., 2021). However, the link between emotional expression and gaze may be dependent on the social information relevant in combinatory sets, as Adams et al. (1999) found increased amygdala activation to ambiguous threats (i.e., averted anger, direct fear) rather than clear threats (i.e., direct anger, averted fear). However, it is not clear when in development this differential salience of cues may affect attention. In the current study, we used eye tracking to measure 18-month-old toddlers' attention to faces when displayed with a panel combination of different emotions and gaze directions. We predicted that 18-month-olds would attend more to threat-related cues and explored whether eye gaze direction may be relevant as a main effect and in interaction with emotion type. Toddlers (N = 38; M = 18.73 months; SD = 0.63 months; Range: 17.75-20.12 months; 14 girls) were part of a larger longitudinal study following mother-child dyads from pregnancy. Toddlers were seated in their mothers' lap in front of a laptop screen equipped with a Tobii

eye tracker and presented with 12 sets of four faces which appeared on the screen for 12-seconds. Each set displayed two of the three emotions and both gaze directions (e.g., direct fear, averted fear, direct neutral, and averted neutral). Toddlers showed an attentional preference for fearful (M = 1.15, SE = .12) over both angry (M = 0.78, SD = .08) and neutral faces (M = .80, SE = .07), $F(2, 74) = 18.25$, $p < .001$, $\eta^2 = .08$ (see Figure 1). We did not find evidence of a preference for directed or averted gaze as toddlers looked roughly equally to faces showing direct (M = .92, SE = .09) and averted (M = .90, SE = .09) gaze, $t(37) = .55$, $p = .59$ (see Table 1). In addition, there was no evidence of an emotion by gaze interaction. Consistent with prior literature, toddlers demonstrated an attention bias towards fearful faces. Fearful faces often represent a clear threat to well-being which makes them one of the most salient emotion cues for toddlers (Leppänen & Nelson, 2012). Angry faces represent a more subtle threat cue that children appear to learn to process later in development, by around 36 months (Leppänen et al., 2018). However, in this study we found no evidence of bias towards direct gaze, which may suggest that emotion cues were more salient than gaze cues at this developmental stage. Emotion and gaze direction may interact in complex ways, though the present study indicates that perhaps it is not until later in development that attentional processes integrate these in context-specific ways.

P3-F-450 - 20-month-old infants dynamically control their attention to a talker's face during a word learning task (Birulés)

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While most studies have explored word learning in highly simplified settings, infants' more usual experience involves rather complex face-to-face audiovisual environments. This suggests that infants' attention development is crucial for selecting the relevant information from a talker's face--both social and speech cues--to learn novel word-object associations. In the present study we explore the relationship between 20-month-olds selective attention to a talker's eyes and mouth, their gaze-following ability and their word learning performance. To do so, we analysed infants' eye gaze while performing an audiovisual word learning task. During the learning phase, a speaker looks at one of two objects (head-turn) and then names it three times (object-naming). Then, at test, two objects are presented side by side while the voice of the speaker asks for one of them. Results (N=21) showed that, during the head-turn, infants favoured the talker's eyes over the mouth ($t(20) = 5.69$, $p < .001$, $d = 1.24$) and showed significant gaze following to the target object ($t(20) = 2.39$, $p = .027$, $d = 0.52$). During the subsequent object-naming phase, infants favoured the talker's mouth over the eyes ($t(20) = 3.18$, $p = .005$, $d = 0.69$). However, at test, they showed no preference for the named object ($p = .43$), nor was this performance modulated by their selective attention pattern during the learning phase. These results suggest that while infants were able to flexibly control their selective attention and focus on the relevant cues at each key-moment during learning, they did not succeed in forming the name-object associations. Potential explanations for these results will be presented and discussed together with on-going follow-up experiments.

P3-F-451 - 12- to 14-month-olds' adaptive evaluation and use of information to predict future events (Varga)

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In spite of ongoing research into infants' early exploratory behavior, the developmental origins of the capacity to adaptively seek out information are still unclear. Particularly, studies with infants rarely quantify and modulate the expected information that subjects can gain by their actions. In a novel eye-tracking paradigm, we investigate 12- to 14-month-olds' ability to adaptively evaluate and select information sources in novel situations. Our paradigm is based on the assumptions that (1) infants can learn statistical contingencies (Saffran & Kirkham, 2018), and (2), similar to human adults (Eliaz & Schotter, 2010) or nonhuman animals (Stagner & Zentall, 2010), infants are driven to gain advance information about future events. We hypothesize that when uncertain about future events, infants are motivated to attend to cues they judge to be more informative regarding these events, using what they learned about statistical regularities. During the paradigm, infants are first presented with scenes in which the appearance of two cues predict the appearance of animals (targets) in different locations (boxes) with different probabilities. For example, the appearance of cue A predicts that the target is either in Box 1 or Box 2 (66-33% probability), while the appearance of cue B is predictive for Box 2 and Box 3 (33-66% probability). The cues are occluded in the beginning of each trial, so infants can observe which cue appears only when the occluders disappear. This cue revealing event is always preceded by a sound, so in test, we can use this sound to trigger anticipations to one of the two occluders. In test, one of the possible target locations is eliminated, while both possible cue locations (occluders) are displayed on the screen. We measure infants' anticipatory looking towards the two possible cue locations. When one target location is eliminated, the information that the two cues provide has to be updated (e.g., if Box 1 is eliminated, cue A will predict the target in Box 2 with 100% probability, while the second cue's information value remains unchanged). Given the assumption that infants are motivated to find advance information as soon as possible, we hypothesize that they will look more in anticipation towards the cue location which they expect to be more informative in these situations. In Experiment 1 (n = 16), we tested whether infants could learn statistical regularities where two cues nondeterministically predicted three targets - a precondition for Experiment 2, targeting adaptive information seeking. The results show that in response to trials where Box 2 was initially revealed to be empty (thus it was excluded as a possible target location) subjects anticipated more to the box that the given cue now predicted 100% than the other one ($p = 0.001$, one-sample t-test against chance), indicating that infants could learn from the presented information sources. Data collection for Experiment 2 is currently in progress, asking whether infants will also adaptively search for information at the more informative cue location, prior to its appearance (e.g. when Box 1 is eliminated).

P3-F-452 - Distractibility and Joint Attention in Infants and Toddlers (Frick)

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Joint attention (JA), the sharing of attention among persons towards a common referent through the use of gesture and eye gaze (Mundy & Newell, 2007), is a widely studied developmental phenomenon and core attentional skill in infant development, contributing to early social and language development. Researchers have discovered many social predictors of JA, but less is known about how it is shaped by the developmental emergence of core attentional properties. Joint attention requires the child to share attentional focus with a social partner while referencing an external object. Thus, the ability to focus attention is key to the emergence of JA. Previous work has uncovered links between EF and JA (Miller &

Marcovitch, 2015; Gago-Galvango et al., 2019, 2021); these studies, however, have typically been conducted in controlled, relatively low-distraction experimental settings. The aim of the current study is to examine the links between distractibility as measured in a free play setting (with competing exogenous stimuli) and JA in typically developing children. Method: The sample consists of 100 children (17-34 months old) who were recruited as part of an ongoing study on the links between attention, distractibility, and auditory discrimination. Toddlers engaged in a laboratory-based free-play task with toys over the course of four trials averaging two minutes each, sitting in a caregiver's lap across from an experimenter. The trials followed a two (non-social vs. social) by two (no distractors vs. distractors) factorial design, and progressed in a fixed order. In non-social trials, the experimenter remained quiet and did paperwork. In social trials, the experimenter made social bids towards the child at scripted intervals, thus allowing for JA opportunities. In no distractor trials a TV in the child's periphery remained off. In distractor trials the TV played 7-second clips from Sesame Street episodes at various intervals throughout the trial. Coding of child behavior is being done off-line in Datavyu, measuring looks to both the experimenter, toys, and to the distractor clips, and also the child's initiation as well as response to JA bids. Analyses: Previous analyses from this project (Mulak et al., 2021, under review) show that the infant's response to the experimenter varies as a function of age, experimental condition, and presence vs. absence of distractors (see Figure 1). For the current poster, analyses are planned between measures of initiating and responding to joint attention (IJA and RJA, respectively) and measures of distractibility. We will control for age in these analyses, since it is expected that JA measures as well as distractibility will vary as a function of age. We hypothesize an inverse relationship between JA and distractibility within age. We plan to analyze the effects of other variables of interest such as child sex. Contribution: This study would be among the first to directly test the influence of distraction on JA in infants, in the context of a controlled experimental paradigm. Further, while the existing literature has studied JA in controlled settings, this project has greater external validity, examining JA in an environment where exogenous stimuli are present and competing for attention.

P3-F-454 - Does curiosity enhance word learning in 18-month-old infants? (Bazhydai)

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Abstract: The cognitive mechanisms and benefits of active learning in early child development are poorly understood. The current study will investigate 18-month-old infants' curiosity-driven information selection in a novel word learning task, designed to identify any potential advantage for active learning over passive learning. In a gaze-contingent eye-tracking paradigm, infants in one condition will be given the opportunity to structure their own information seeking to actively create word learning opportunities for themselves, while infants in two other conditions will engage in learning novel words passively. Infants' learning of word-object associations will be compared across active and passive learning paradigms. This study will advance our understanding of early word learning, and of the mechanisms and benefits of active, curiosity-based learning in infants. Pre-print of Stage 1 Registered Report protocol is available on OSF: https://osf.io/bm5a9. Method: Infants aged 18 month will be tested (N = 51-75, with an application of the Bayesian sequential testing principles). We will use gaze-contingent eye tracking to enable infants to exert choice over which objects presented on a screen are labeled at a certain point in time. As we are interested in whether the freedom to select information benefits word learning, we will contrast this active learning (Curiosity) condition with two passive

learning control conditions. In one control condition (Random control), which is akin to traditional ways of presenting information in word learning studies, objects will be labeled in a random order. In the other control condition (Yoked control), infants will experience a sequence of labeling events that was actively generated by another infant. See Figure 1 for the experimental design flow and examples of stimuli. Hypotheses and implications: We expect to observe advantages for curiosity-driven learning on subsequent label recognition. We therefore hypothesize that infants in the Curiosity condition will show better retention of novel object labels than infants in the Random and Yoked control conditions. Such a result would provide evidence that self-motivated information selection and the freedom to choose what to learn about (albeit without their metacognitive awareness) are important aspects of infants' learning in the real world, optimizing their learning by reducing referential uncertainty, and thus providing support for the learning progress theory of curiosity. We further expect that infants in the Yoked condition will show slightly higher rates of learning than infants in the Random condition, based on the reasoning that such sequences are in part systematically and optimally determined (although not through an active choice of the learner), e.g., by the perceptual features of the objects or their spatial location. Alternatively, if infants show better recognition following passive learning (i.e., in the Yoked and Random conditions), or similar rates of learning across all three conditions, this will suggest that curiosity may not provide a unique advantage in infant word learning. Data analysis plans: One-way ANOVA and mixed effects regression modelling will be used (see Table 1), to test whether condition assignment had an effect on two outcome measures of successful word learning at test: the proportion of infant looking at the target image and the binary trial-level accuracy score.

P3-F-455 - Examining Clustered Presentation Timing in Category Learning (Slone)

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All learning depends on both the input and the learning mechanism, both of which unfold over time. Accordingly, much research has investigated how presentation timing affects learning, particularly in the domains of word and category learning. A vast literature demonstrates a robust spacing effect, in which words or categories spaced out in time are retained best over time (Cepeda et al., 2006). The spacing effect has been demonstrated in infants, children, and adults (e.g., Vlach & Johnson, 2013; Vlach et al., 2008; Kornell & Bjork, 2008). Nevertheless, research pitting spaced schedules against "massed" schedules that have very short delays between presentations occasionally reveal a benefit of massing, but often among only some of the age groups tested (e.g., Vlach & Johnson, 2013; Vlach & DeBrock, 2019; Benitez et al., 2020). Current theories lack the ability to fully predict and explain these findings (Knabe & Vlach, 2020). Although the spacing-massing dichotomy has long provided a convenient theoretical comparison in laboratory tasks, a growing body of research demonstrates that natural human activities embody a more clustered schedule; bouts of close-in-time events are interspersed with longer periods of inactivity in domains such as email, phone calls, and written text (Goh & Barabasi, 2008). Moreover, parent speech to infants - critical data for infant learning - also appears to exhibit clustered timing of object references (e.g., Frank et al., 2013). What remains unclear is how learning from clustered timing compares to learning from other timing patterns better studied in the literature, and whether this changes across development. The present work is designed to test the hypothesis that clustered schedules are optimal for learning because of their unique combination of both spaced timing and massed timing. That is, repeated learning instances within a cluster may allow benefits typically

associated with massing (e.g., stronger encoding), while gaps of time between clusters may provide additional benefits typically associated with spacing (e.g., encoding variability, retrieval practice). We describe here two experiments that will compose a registered report to be conducted with adults. We aim to first present this work at ICIS to get feedback from infancy researchers because our long-term goal is to conduct a similar set of experiments with infant and child participants. Participants will take part in a category learning task in which they will learn artists' painting styles. Training exemplars are images of paintings paired with their artist's names (Kornell & Bjork, 2008). After training, learning will be assessed by examining whether participants correctly categorize novel paintings from each artist. Experiment 1 will compare learning of categories presented with Clustered timing versus Random timing, and Experiment 2 will compare Clustered timing with Massed timing and Spaced timing (Fig. 1a). Both experiments will be within-subjects designs, with order of timing conditions counterbalanced across participants. Learning will be tested both immediately after each timing category block, and again after a short delay (Fig. 1b-c). Repeated-measures ANOVAs will be used to compare the percent of correct classifications. Findings have the potential to unify the literature showing seemingly contradictory benefits of spacing and massing, and provide a foundation for later comparisons of similar studies with infants and children.

P3-F-456 - The Impact of Community Integration on the Other Race Effect in Infancy (Guy)

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The other race effect (ORE) is characterized by attentional and perceptual biases that benefit processing of a face of one's own race over a face of another race and is typically apparent by approximately 9 months of age (Kelly et al, 2007). Environmental exposure to other races has an impact on the development of the ORE (e.g., Bar-Haim et al., 2006) and we seek to determine the effects of community racial integration on the ORE in 5- and 10-month-olds from a large variety of communities across the United States. We hypothesize that community racial diversity will influence the amount of experience that infants have individuals of other races and will be an important factor in predicting the ORE across broad regions of the U.S. We predict that infants from more diverse communities will exhibit novelty preferences for own- and other-race faces, but that infants from less diverse communities will exhibit novelty preferences for own-race faces and not other-race faces. This would indicate that the other race effect is exhibited more strongly in infants from less diverse communities than infants from more diverse communities. Our study utilizes the online platform, Lookit, to examine the ORE in the context of community diversity in infants from across the U.S. Participants complete a two-part visual paired-comparison task. First, they are familiarized with an own-race or other-race face. Then, they view the familiarized face beside a novel face of the same race. This procedure is repeated with the set of faces that was not included in the first part (i.e., either own-race or other-race faces). Visual attention is measured to determine whether the infant demonstrates a novelty preference, evidenced by increased looking to the unfamiliar face, which indicates that the infant remembers the familiarized face and is able to discriminate it from the unfamiliar face. Looking preferences will be examined in relation to community diversity. Level of community diversity will be determined based on data from the U.S. Census and American Community survey, using measures of racial segregation and integration based on participants' zip code (Massey and Denton, 1988). Multiple logistic regressions will be utilized to predict looking behavior on the visual paired-comparison task based upon scores of community diversity,

participant age, and stimulus type (i.e., own- or other-race faces). Our study has the unique quality of measuring the ORE in relation to community diversity across a wide array of communities in the U.S., as participants from anywhere in the nation will be eligible to participate. This breadth of community measurement has not yet been found in the literature on the ORE. This study has far-reaching implications in the study of infant face perception, child development, and social justice, as the ORE develops at a young age, and it may lead to a complex pattern of racial biases contributing to systemic barriers in society. It is important to understand ways in which early experience may inhibit these early biases from forming.

P3-F-457 - Using fNIRS to investigate the neural correlates of the orienting response in 8-month-old infants (Serino)

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Objectives: The integrity of the attention system is vital for navigating within our environment. To succeed in a huge variety of cognitive tasks, humans must master the ability to detect and orient towards relevant stimuli, maintain focusing on them, and simultaneously inhibit distractors. Since birth infants are able to select and acquire the most relevant information from the environment. By the end of the first year of life, they can recognise their native language, discriminate between informative and uninformative stimuli, and favour predictable over unpredictable cue-reward associations (Saffran & Kirkham, 2018). In adult studies, behavioural relevance of stimuli outside the current focus of attention seems to be the prime candidate that activates a set of fronto-parietal regions predominantly in the right hemisphere (Corbetta et al., 2008). However, less is known about how the attention system supports learning during infancy, helping infants to rapidly acquire new information. The present study aims to shed light on the mutual interplay between learning and attention during the first year of life and its neural underpinning.Methods:In the first phase of the study, thirty 8-month-old infants are exposed to two different shapes: one shape paired with a social reward (informative distractor) and one shape without a paired reward (uninformative distractor). Participants' looking preference for each shape prior and after the shape-reward association is then compared. In the second phase of the study, short video-clips are played in the middle of the screen, while the uninformative and informative distractors are randomly presented in the periphery of the screen. A 2 x 24-channel Baby Brite NIRS system (Artinis, NL) with a custom designed array and a TX300 eye-tracker (Tobii, SW) will be employed to record participants' bilateral brain activity from fronto-parietal regions and eye-behaviour respectively. fNIRS data pre-processing will be conducted using existing lab-based data analyses pipelines (by LG, PP). Hypothesis & analysis plan: To assess the effectiveness of the experimental manipulation, a GLMM with subject as a random intercept will be used to assess mean looking preference (i.e., total time spent lingering on the AOI of the distractor) for the informative and uninformative distractor after the shape-reward association. Participants that do not show the hypothesized looking preference for the informative distractor will be flagged for further investigation and analyses will be conducted with and without including these participants. A second model will then be run to analyse fNIRS brain activation patterns associated with informative and uninformative distractors in the second phase of the study. Specifically, we expect to replicate the right hemisphere specialisation as reported in adult participants (Corbetta et al., 2008) in our infant data. In addition, the nature of the distractor stimuli will be modelled as a predictor variable to understand if attention

orienting is driven by relevance rather than saliency as prior studies suggest in the adult literature (Indovina & Macaluso,2007). Significance: This study will provide key insights into how the brain supports attention orienting during the first year of life, helping the young infant to discriminate amongst the salient features that compete for attention. In particular, we hope to replicate brain regions highlighted by prior studies (Ellis et al., 2021).

P3-F-458 - Cross-situational word retention (Kuznia)

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Infants learn words rapidly across situations (Smith & Yu, 2008). However, infants' memory for newly learned words is fragile and decays without additional supports (Horst & Samuelson, 2008). One support for memory retention is distributing learning opportunities over time (Rovee-Collier et al., 1995; Vlach et al., 2008). Current evidence about how distributed schedules help word retention is primarily based on learning opportunities distributed over seconds and minutes, rather than hours and days as in everyday life. This pre-registered report tests the extent to which distributing word learning opportunities across days helps infants retain newly learned words. Two pre-registered experiments will be conducted using Lookit (Scott & Schulz, 2017), an online platform well-suited for multi-day experiments because families participate from home instead of repeatedly traveling to a laboratory. 24-month-old infants will encounter novel object-word associations and their word retention will be assessed using a looking-while-listening paradigm (Fernald et al., 2008). Power analyses based on data simulations using effect sizes from related literature will determine the number of infants who participate in each experiment. Experiment 1 aims to establish that word learning success, and word retention fragility, replicates when infants are tested using Lookit. Infants will encounter four novel object-word associations across 24 trials in a single session. Infants will see two novel objects and hear two novel words on each trial. Word learning will be assessed by test trials in which one of two objects is named; we will calculate the proportion of time that infants look to the named object. Infants will be tested either immediately (learning) or after a 24-hour delay (retention); performance will be compared using an independent samples t-test. We predict that infants who take the immediate test will be more successful than infants who take the 24-hour-delayed test, replicating prior evidence (Horst & Samuelson, 2008) that infants can initially learn words when encounters are bunched in time but retention over 24 hours is fragile. Experiment 2 tests the hypothesis that infants' word retention improves when initial learning opportunities are distributed over multiple days. Here, infants will encounter novel object-word associations either within a single session ("bunched"; like Experiment 1) or distributed across six days ("extended"). Infants in both conditions will encounter the same total number of object-word associations across their respective learning schedules. All infants will complete a 24-hour-delayed test (like Experiment 1) and another retention test one week later. Performance will be assessed as in Experiment 1 and analyzed using a linear mixed-effects model to account for both repeated measures (retention tests) and the between-subjects manipulation (learning schedule). We predict that infants in the extended condition will successfully retain more words than infants in the bunched condition (who will perform at-chance replicating Experiment 1), at both the 24-hour and 1-week retention delays. These results would suggest that temporal spacing supports cross-situational word retention over extended timescales. These pre-registered studies will advance our understanding of how infants move from fragile initial encoding to robust retention of words in their rapidly growing vocabulary.

P3-F-459 - Monolinguals and Bilinguals' Visual Recognition Memory of Socially Relevant Stimuli at 8-10 Months (Freda)

Kate Freda[1], Joscelin Rocha-Hidalgo[1], Leher Singh[2], Kimberly Chanchavac[1], Sydney Wasserman[1], Rachel Barr[1]

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Objectives. We will use a novel visual recognition memory (VRM) task to assess the relationship between language exposure (monolingual vs bilingual) and selective attention to socially salient stimuli. Prior research has demonstrated that bilinguals show faster habituation than monolinguals (Singh et al., 2015) and infants vary in their responses to different race faces based on the environment in which they live (e.g. Singh et al., 2019). We predict bilinguals have better VRM than monolinguals for all stimuli, suggesting that they more effectively make use of socially relevant perceptual cues. We predict an interaction effect between language exposure and social relevance of the stimuli, such that the difference between bilinguals and monolinguals will be lowest for least socially salient, highest for the most socially salient stimuli. Methods. Language Exposure. The Language Exposure Assessment Tool (LEAT; deAnda et al., 2016) will be used to assess language exposure. Infants will be classified as bilingual if they are exposed to a second language (L2) for at least 20% of the time since birth, otherwise they will be considered monolingual. We will also consider L2% as a continuous variable. Visual Recognition Memory. There are three stimuli sets: static images of cats and dogs, animated mailboxes, and animated faces of different races that vary on social salience ranking from lowest (cats/dogs) to highest (different races). For each visual paired comparison trial, infants will be familiarized with one of the stimuli for 10s (cats and dogs) or 20s (mailboxes, faces). The familiar stimulus is randomly selected for cats/dogs/mailboxes and matched to the primary caregiver's race for faces. In the test phase, infants will be presented with the familiar stimulus and a novel stimulus from the same category for 10s (cats and dogs) or 20s (mailboxes, faces), with the position of the novel stimulus on the screen (left/right) switching at the midpoint. There will be 2 (cats and dogs, mailboxes) or 3 (faces) trials, with infants being refamiliarized before additional test phases. The order of the stimuli sets will be pseudo-counterbalanced with cats and dogs being presented second, and the novel stimuli for each set will be counterbalanced. Infants' eye gaze will be captured using a Tobii X300 eye tracker. Analysis Plan. For each trial, a novelty score will be calculated as the fixation time for the novel stimulus divided by the sum of fixation time to the novel and familiar stimuli. We will use multilevel modeling to assess novelty scores trial-by-trial, with stimulus set and language status as Level 1 predictors and parent education, parent income, and child age as Level 2 predictors. We will also compare novelty scores against chance by language status. Impact. Despite the fact that many infants live in multilingual homes, much of the research on infants' perceptual development has focused on monolingual infants. This study will use a novel task to explore how bilinguals' linguistic environment may affect the way they make use of available social information.

P3-F-460 - Infants act to learn verbs from ambiguity (Li)

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When learning verbs, infants are confronted with ambiguity (Scott & Fisher, 2012; Horvath & Arunachalam, 2021). Different than when encountering nouns, verb-meaning mappings vary from encounter to encounter. For instance, a single verb "twist" can be applied to multiple different objects (e.g. twist a toy and twist her hair). How do infants resolve such ambiguity and figure out the correct verb meaning? One possibility is that infants adopt a cross-situational learning mechanism (CSL) (Zhang et al., 2020) by tracking the number of times when each verb and action co-occur across encounters. Another possibility is that verb learning can be facilitated by perceptual cues present in the environment, such as acting out the verb (Glenberg et al., 2004). This study explores the independent and combined effects of CSL and action on infants' novel verb learning. Twenty 20- to 24-month-old English-learning infants (N = 80) will be taught 4 novel actions (Imai et al., 2005) in one of four conditions (see Figure 1). Infants will watch a video of an actor performing a novel action on the same object three times (Baseline condition) or on three different objects (CSL condition) (Imai et al., 2005), or infants will be instructed to play with the toys each time after watching a video of an actor performing an action on the same object three times (Action condition) or on three different objects (CSL Action condition). During each video display, the verb that depicts the action appears in an auditory sentence "Look! She is blicking a toy". At test, infants will be presented with a target trial (the same action on a changed object) and a foil trial (different action on the same object) for each verb taught. Verb learning will be indicated by a longer looking time to foil trials over target trials. We will analyze participants' looking time during the test as a function of trial (target vs. foil) and condition in a 2×4 mixed ANOVA. We expect a significant trial×condition interaction: the difference in looking time between the target and the foil differs by condition. Specifically, infants are expected to look longer towards the foil (indicating learning) in the CSL, Action, and CSL Action conditions, but not in the Baseline condition. The difference in the looking time between the target and the foil (foil - target) is expected to be the highest in the CSL Action condition. Overall, we expect CSL and action each to facilitate infants' verb learning individually, and provide stronger support jointly. Prior studies suggest that adults learn verbs from statistically accumulated events (Zhang et al., 2020). This study is the first to examine infants' abilities to learn novel verbs cross-situationally in the context of action. In all, we aim to unveil the myth of whether and how perceptual cues (i.e. action) plays a role in early language acquisition (i.e. verbs) in a naturalistically ambiguous and chaotic learning environment.

Thematic Poster - Modeling Curiosity as an explanation for habituation and learning (P3-F-461, P3-F-462, P3-F-463, P3-F-464)

P3-F-461 - Using curiosity as a lens to understand visual (dis)habituation in infants (Raz)

Gal Raz[1], Anjie Cao[2], Michael Frank[2], Rebecca Saxe[1]

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Infants do not just passively receive information - they actively decide what to engage with and what to ignore. In fact, most of what we know about infants relies on their active choices about what to look at. Research about infants' cognition has long used looking time as a major tool to index their internal representation. Yet existing models of infant looking fall short in explaining known characteristics of infants' looking time or do not explicitly capture the real-time encoding of information during looking (Sirois & Mareschal, 2002; Kidd et al., 2012; Poli et al., 2020). We aim to bridge this gap by describing infant looking formally as an information-maximization process. Through the combination of a

behavioral experiment and a computational model, we show that infants' looking time at stimuli can be explained by the expected information gain (EIG) offered by the stimuli.

To test this hypothesis, we implemented a Bayesian binary feature-based concept learning model (e.g., Goodman et al., 2008). Unlike classic concept learning models, however, this model received noisy samples from the perceptual input (Callaway et al., 2021). On each timestep, the model selected whether to view another noisy sample from a stimulus or whether to disengage (analogous to the choice faced by infants in a standard looking time experiment). This decision was computed as a softmax choice based on the EIG to the learning model from continuing to view samples from the current stimulus. We predicted that the distribution of samples taken by this model would conform to infants' looking behavior.

We first tested whether sampling based on EIG can generate two key phenomena known from the infant looking literature: habituation and dishabituation. To do so, we exposed both our model and 7-10-month-old infants (n = 36) to 3, 5 or 7 fixed-duration presentations of a familiarization stimulus, and then to a test stimulus that is either identical to the familiarization stimulus, or a completely novel stimulus (Fig. 1). We find that as a function of familiarization duration the number of samples taken by our model decreases steadily for familiar stimuli and increases for novel stimuli, much like infants' looking times (familiarization duration x novelty interaction: ß = -0.35, p = 0.003; Fig 2).

We next wondered whether our model could reproduce familiarity preferences. Existing accounts suggest that infants should sometimes prefer to look at familiar stimuli, particularly when encoding is incomplete (Hunter & Ames, 1988; Kidd et al., 2012). Our model did not show familiarity preferences for any duration of familiarization. Infants on the other hand, did appear to look longer at the familiar stimulus after three familiarizations (Fig. 2); a replication is in progress.

Our work suggests that habituation and dishabituation of infants' looking time can be accounted for by a shallow concept learning model in which sampling is anchored to EIG. However, familiarity preferences might require either more complex models or a different curiosity function. Together, these results present a real-time encoding account of basic looking time phenomena

P3-F-462 - A model-based approach to infants? curiosity reveals (meta)learning abilities and individual differences in cognitive functioning (Poli)

Francesco Poli[1], Rogier Mars[2], Sabine Hunnius[3]

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Infants learn to navigate the complexity of the physical and social world at an outstanding pace, but how they accomplish this learning is still largely unknown. Recently, it has been proposed that curiosity is a main drive of infants' learning and information seeking. To test this, we collected eye-tracking data from ninety 8-month-old infants while they performed a visual learning task. The task consisted of sequences of cue-target trials (Figure 1). The cue was a shape appearing in the middle of the screen, and the target was the same shape reappearing in one of four screen quadrants around the cue location. In each sequence, the target could appear in any location, but one location was more likely than the others. Infants could thus learn to predict the most likely target location. We developed an ideal learner model that uses incoming evidence to update internal models of the environment in an optimal way (Figure 2). We exposed the model to the same sequences that the infants in our experiment observed and fitted it

with infants' eye-tracking data. In doing so, we introduced a model-based definition of curiosity as search for information gain. This allowed us to disentangle the unique contribution of curiosity to infant looking behavior, and disentangle it from other environmental variables such as stimulus surprise and sequence predictability.

Our results show that multiple components of infants' looking behavior are curiosity-driven. Specifically, we show that saccadic latencies, looking time, and time spent engaged with a stimulus sequence can be explained by multiple properties of the learning environment, including the curiosity induced by incoming stimuli, but also the level of surprise of the stimuli and the overall predictability of the environment.

In a second study, we show how our modeling efforts can leverage the relationship between infants' looking behavior and curiosity to investigate other cognitive abilities. Specifically, analyzing infants' curiosity over multiple time scales allowed us to detect infants' ability to meta-learn (i.e., the ability to use prior experience to optimize future learning).

Finally, we propose an extension of our computational model of curiosity that allows for the measurement of individual differences in the cognitive abilities underlying infants' looking behavior. We address the accuracy of such measures, their relationship to classical measures of infant cognitive functioning (i.e., habituation and dishabituation performance), and some early applications of these measures to predict the effect of early environmental factors on infants' cognitive functioning. To conclude, we discuss the benefits of a model-based approach to the study of infant cognition, and the future lines of research that this approach will allow us to pursue.

P3-F-463 - A formal approach to dissociating triggers of curiosity in childhood (Liquin)

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Curiosity motivates us to explore, and therefore plays an important role in learning. However, not all quests for information successfully lead to learning. In order to maximize the success of our exploration, it would be optimal to experience curiosity about--and therefore explore--queries that have the strongest potential for learning. Young children are more likely to explore when they are surprised (Stahl & Feigenson, 2015) or uncertain (Schulz & Bonawitz, 2007), and exploring under these circumstances makes sense: if one is surprised and/or uncertain, it is likely that exploration would lead to learning. However, surprise, uncertainty, and expected learning can come apart (Liquin et al., 2020), and it is unclear whether children's curiosity optimally tracks expected learning under these circumstances.

To answer this question, we recruited adults on Prolific (N=55) and a community sample of 5- to 9-year-olds (N=55) in Study 1. The method was adapted from Dorfman et al. (2019). Participants chose one of two candy machines across 20 trials. Each machine, when chosen, produced virtual "candy" with some probability. On 1/3 of trials, a hidden agent intervened, in which case the participant received candy with 100% probability or 0% probability (between subjects), regardless of the chosen machine. On each trial, participants rated on a 4-point scale how much they "wanted to know" whether the hidden agent had intervened (curiosity rating).

For each trial, we used a Bayesian model to quantify how much the evidence violated expectations (surprise), how uncertain one should be about the chosen machine's candy probability (global uncertainty), how much one should expect to learn about the chosen machine's candy probability (global learning), and how uncertain one should be about whether an intervention occurred (equivalent with expected learning about this quantity; local uncertainty/learning). In adults, only local uncertainty/learning (β=0.32) and global learning (β=0.29) explained significant variance in curiosity ratings when controlling for the other candidate triggers (ps<.001). In children, surprise (β=-0.13), global uncertainty (β=0.08), global learning (β=0.17), and local uncertainty/learning (β=0.12) all explained significant variance in curiosity (ps < .05). Comparing children and adults (see Fig. 1), global uncertainty and surprise were stronger predictors of curiosity in children (ps<.05), while local uncertainty/learning was a stronger predictor of curiosity in adults (p=.006).

In Study 2 (data collection ongoing), we will replicate these results and rule out possible alternative explanations in a new, simplified task. In the revised method, children and adults observe pre-determined outcomes from a single source. This allows us to match the evidence observed by children and adults, which differed in Study 1. In addition, we measure participants' learning throughout the task, in order to determine whether the Bayesian model provides a good description of both children's and adults' learning.

Taken together, these results provide preliminary evidence for a developmental shift in the triggers of curiosity, from broadly tracking many cues in childhood to narrowly tracking expected learning in adulthood. This work has the potential to refine theories of curiosity and shed light on when and how curiosity motivates exploration and learning across development.

P3-F-464 - ManyBabies5: A large-scale, collaborative investigation of the Hunter & Ames Model of infant looking preferences (Zettersten)

Martin Zettersten[1], Jessica Kosie[1]

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Infants' tendency to visually explore familiar versus novel stimuli has been widely used to make inferences about their cognitive processing. Since Fantz's seminal "visual-interest" studies in the 1960s, the conditions under which infants show preferences to attend to and explore different stimuli has been a key question in infancy research, from both a methodological (Aslin, 2007) and theoretical perspective (Berlyne, 1966). Hunter and Ames (1988) proposed a model of infants' preferences for familiar and novel stimuli, suggesting that this preference is affected by three key dimensions: infants' age, amount of familiarization, and task difficulty (e.g., stimulus complexity). While this model provides widely-used guidance for infant researchers using looking time methods and offers theoretical foundations for models of infant information-seeking and visual exploration, there has not yet been a large-scale investigation testing the predictions of the Hunter and Ames model.

ManyBabies5 is a collaborative research project conducting a large-scale, cross-cultural investigation of the Hunter and Ames model of infant looking preference. The goal is to conduct a multi-lab experiment that tests Hunter and Ames' (1988) prediction that infant age, familiarization time, and stimulus complexity interact to predict the trajectory of infants' looking to novel vs. familiar stimuli. Thus far, 192 researchers from 118 labs spread across 40 countries and 6 continents (Figure 1) have signed up to

participate. The project is currently in its final planning stages, with the goal of submitting a Registered Report by March 2022.

The currently proposed design of the task is modeled after past studies testing infants' looking time preferences (e.g., Rose et al., 1982). In the task, infants will first be familiarized with a visual stimulus for a fixed familiarization time (Figure 2). Then, the familiarized stimulus will be presented alongside a novel stimulus matched in visual complexity. The main dependent variable of interest will be infants' looking time to the familiarized vs. the novel stimulus. We will manipulate three main factors of interest: (a) infants' age (between-participants), (b) how long infants are familiarized to a given stimulus (within-participants), and (c) the complexity of the visual stimuli (within-participants). The prediction (following Hunter & Ames) is that (a) infants should shift from a familiarity to a novelty preference faster as they grow older; (b) longer familiarization times should lead to shifts in infant looking towards a novelty preference; and (c) more complex visual stimuli should lead to shifts in infant looking towards a familiarity preference.

In our presentation, we will share our experimental design and procedure, which was collaboratively developed by researchers from many backgrounds and communities. We will also discuss current plans to use the rich dataset generated by the project to inform current models of infant curiosity, focused on how infants' visual exploration changes as a function of age, experience, and properties of the visual stimulus. The project aims to advance our understanding of the factors influencing infants' behavior in preferential looking paradigms, and their generalizability across participants and communities from around the world.

P3-F-465 - Relations among maternal intrusiveness, infant distractibility from social events, and infant receptive language (Testa)

Kaitlyn Testa[1], Elizabeth Edgar[1], James Todd[1], Bret Eschman[1], Lorraine Bahrick[1]

[1]Florida International University

Mothers who are more intrusive (i.e., interfering, over-controlling, focused on their own agenda during interactions; Cuevas et al., 2014) have children with poorer language outcomes (e.g., Baumwell et al., 1997) and poorer attentional control (e.g., lower levels of sustained attention; Graziano et al., 2011). Research has also shown that infants with poorer attentional control (e.g., more distractibility) have poorer language outcomes (e.g., Salley et al., 2013). However, developmental pathways to language outcomes remain unclear, as few studies have assessed maternal intrusiveness, infant attentional control, and child language outcomes together. To explore these relations, we assessed infant distractibility from faces (an index of attentional control) at 12-months via the Multisensory Attention Assessment Protocol (MAAP; Bahrick et al., 2018), a novel, fine-grained measure of attention to audiovisual social and nonsocial events. We also assessed maternal intrusiveness at 12-months and child language outcomes at 18-months. We predicted that greater maternal intrusiveness and greater infant distractibility would predict poorer language outcomes. Children (N=104) participated in an ongoing longitudinal study from 3- to 72-months. Predictors: Infant distractibility from faces of people speaking was assessed at 12 months using the MAAP. Each trial of the MAAP begins with a silent 3-second central visual distractor event followed by two lateral social events depicting women speaking (Figure 1). The visual movements of one lateral event are synchronous with its natural soundtrack while those of the other are asynchronous. For half of the trials (distractor trials), the central distractor event remains on

during the lateral events. Infant distractibility is measured as the proportion of total looking time to the central event (divided by the looking time to all three events) during these distractor trials. Maternal intrusiveness was assessed at 12-months, a semi-structured free-play interaction in the lab. Examples of intrusiveness included failing to modulate behavior in response to the infant's negative affect or turning away, taking away objects while the infant was engaged, or overstimulating the infant. Trained coders rated maternal intrusiveness on a scale from 1 (no evidence of intrusiveness) to 4 (high level of intrusiveness). Outcome: Infant receptive vocabulary at 18-months was assessed using the Mullen Scales of Early Learning (Mullen, 1995). Correlations revealed that greater maternal intrusiveness at 12-months predicted greater infant distractibility at 12-months, which in turn predicted poorer receptive language at 18-months, ps<.001. However, maternal intrusiveness did not predict receptive language, p=.11. We next tested a model to characterize potential meditational pathways from our predictors to infant language outcomes (Figure 2). Results indicated that infant distractibility fully mediated the relation between maternal intrusiveness and infant receptive language, p=.01. Findings demonstrate that greater maternal intrusiveness predicts greater infant distractibility, which in turn predicts poorer language outcomes. This suggest that interventions aimed at improving infant attentional control (reducing distractibility, increasing sustained attention) may help to reduce the negative effects of maternal intrusiveness on infant language.

P3-F-466 - Infant Attention and Social Competence Predict Childhood Temperament (Ramirez)

Bethany Ramirez[1], Elizabeth Edgar[1], James Torrence Todd[1], Bret Eschman[1], Lorraine Bahrick[1]

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Individual differences in temperament across infancy and childhood are influenced by early social interactions and foundational skills, such as attention and perception (e.g., Kochanska et al., 2000; Ruff & Rothbart, 1996). For example, greater sustained attention (an index of attentional control) predicts lower negative affect (e.g., Kochanska et al., 1998) and greater effortful control (e.g., Eisenberg et al., 2011). Further, greater social competence predicts greater effortful control and lower negative affect (e.g., Rothbart & Putnam, 2002; Eisenberg et al., 2011). Although much of the research on social competence and temperament has focused on individual differences, until now, there have been few individual difference measures appropriate for assessing attention, particularly to dynamic faces and voices. Thus, developmental relations among attention, temperament, and social competence remain unclear. To address this gap, we used a new fine-grained, individual difference measure of multisensory attention skills (sustained attention, shifting/disengaging, and intersensory matching) appropriate for preverbal infants, the Multisensory Attention Assessment Protocol (MAAP; Bahrick et al., 2018). The present study explored developmental pathways from infant sustained attention and social competence to childhood temperament. Children (N=90) participated in a longitudinal study from 3- to 72-months of age. Predictors: At 12-months, sustained attention to social events was assessed by the MAAP (see Figure 1) and was calculated as the proportion of total looking time to video displays of women speaking in the presence of a distractor event. At 18-months, social competence was assessed via the Infant Toddler Social Emotional Assessment (Carter & Briggs-Gowan, 2006). Outcome: At 48-months, surgency, negative affectivity, and effortful control were assessed via the Children's Behavior Questionnaire (Rothbart et al., 2001). Correlational analyses revealed that greater sustained attention at 12-months predicted greater social competence at 18-months, and lower negative affect at 48-months, ps=.05. Greater social competence also predicted greater effortful control, p=.001. No significant correlations

between predictors and surgency were evident. Given these patterns of correlations, we used structural equation modeling to assess developmental pathways from sustained attention to social competence, and in turn, negative affect and effortful control (see Figure 2). The model showed excellent fit ($\chi 2$=.88, p=.35). Results revealed that social competence at 18-months mediated the relation between sustained attention at 12-months and effortful control at 48-months, ps=.02 (but not negative affect). Further, sustained attention independently and marginally predicted negative affect, p=.06 (but not effortful control). Findings demonstrate a novel link between infant attention at 12-months and temperament outcomes at 48-months, and that this relation is mediated by social competence at 18-months. Greater sustained attention to faces predicts greater social competence and in turn greater effortful control. Further, infants with greater sustained attention to faces also showed lower negative affectivity. These results provide support for the foundational role of early attention and social competence on temperament development and could inform the creation of interventions to improve temperament, and in turn socioemotional, cognitive, and language outcomes.

P3-F-467 - Hidden in Plain Sight: Infants' Failure to Respond to Violations of Solidity (Fisher-Thompson)

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Novelty preferences obtained during serial looking tasks are rarely above 60% (Fisher-Thompson, 2017; Mather et al., 2011; Simpson et al., 2011). Infants are presented with one familiar stimulus in a serial task, paired with a series of novel events that differ on each trial. Because infants are expected to show familiarity preferences near the beginning of the session (Roder et al., 2000), with time spent looking at novel stimuli below 50%, averaged novelty preferences across all trials are relatively low. To test whether perceptually impossible novel stimuli might lead to stronger novelty preferences, infants were presented with possible and impossible novel stimuli using terminology from violation-of-expectation tasks (Baillargeon, 2008; Spelke & Kinzler, 2007). The hypothesis was that stimuli that violated the principle of solidity, that failed to move as solid, cohesive objects, would increase infant attention and improve novelty preferences. Infants were expected to look longer when one object moved through another object: fragmenting, partially disappearing, or fusing with a second object. Twelve infants (half female) were tested at 3, 4, and 5 months of age. Stimuli were 9-sec videos containing two objects created using 3D graphics software (e.g., spheres, cubes, stars, etc.). Each stimulus contained one stationery object and one animated object. Animated objects in possible stimuli moved above or below the stationary object, often rotating or cartwheeling in a 2D plane. Animated objects in impossible stimuli moved through the stationary object (Figure 1). Familiar and novel stimuli were presented simultaneously on each trial, with possible and impossible stimuli appearing on alternate trials. Infants averaged 31 to 36 trials per visit. Looking behavior was coded from videotapes made during each session. Mixed ANOVAs were run to assess statistical significance, with solidity (impossible or possible motion), novelty (novel or familiar stimuli), and visit (1, 2, or 3) as within subject variables; p values and confidence intervals for partial eta squared values are noted in Table 1. Impossible events violating the principle of solidity did not improve infant novelty preferences. Although novelty preferences improved across visits, impossible stimuli had little effect on infant looking. Infants produced more looks per trial by Visit 3, but look number differed little between possible and impossible trials. Looks aimed at novel stimuli were longer than were looks aimed at familiar stimuli, and look duration decreased across age,

but solidity had little effect on look duration. The young infants tested here failed to show increased looking when animated objects moved through stationery ones. Data are not consistent with outcomes reported using violation-of-expectation tasks. Prior tasks, however, did not show the infants the violation: expectations were measured in order to assess infant "knowledge" rather than perceptual skills (Spelke et al., 1992). In contrast, the videos presented here did not conceal violations of solidity: infants watched one object move through another much like cartoon ghosts move through solid walls. These videos, however, did not capture infant attention and failed to improve novelty preferences. Implications for assessing perceptual skills directly will be discussed.

P3-G-468 - Parental language input and its relation to bilingual children's vocabulary size (Lepadatu)

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To what degree does the early home language environment influence the language outcome of a bilingual child? While there's a lot of variability in bilinguals' overall exposure to their two languages, we can split parental input in the home environment into three patterns: one-parent-one-language approach (1P1L) (Barron-Hauwaert, 2004), where one parent speaks the majority language (i.e. spoken by a majority of the population in a country or region) and the other the minority language (i.e. spoken by a minority of the population in a region); language mixing (Mixed) (Byers-Heinlein, 2012), where either one or both parents use both languages, and cases where both parents speak the minority language at home (MLAH) (Pearson, 2007). In this study we looked at 12- to 36-month-old toddlers (N = 460) growing up in the United Kingdom in bilingual families (i.e. exposed to English and one additional language: Dutch, French, German, Italian, Polish, Portuguese or Spanish). Each family was asked to complete an online language exposure questionnaire (Bosch & Sebastian-Galles, 2001) and bilingual vocabulary questionnaires: the Oxford Communicative Development Inventory (Hamilton et al, 2000) for English, and a translation equivalent for the other languages, as a measure of early vocabulary size. Families were also invited to complete follow-up questionnaires approximately every two months. In order to understand if there is an association between the parental language input and vocabulary size, similarly to Floccia et al. (2018), we decided to look at the total number of concepts bilingual children in our sample know and produce. Children are defined to know a concept if they understand the English word, its translation equivalent, or both. Our preliminary analysis shows that the general trend in both receptive and expressive vocabulary is similar across the three groups (1P1L, Mixed and MLAH). A multiple regression was carried out to investigate whether age and parental language input could significantly predict bilingual children's vocabulary size. The results indicated that the addition of the language input groups did not significantly contribute to the model for conceptual vocabulary comprehension ($F(2, 458) = 0.51$, $p = .59$) or conceptual vocabulary production ($F(2, 458) = 0.05$, $p = .95$), after accounting for age. Similar results were found when looking at bilingual children's total vocabulary (English + additional language), where language input did not significantly improve the model for the total number of words known ($F(2, 458) = 2.76$, $p = .06$) or produced ($F(2, 458) = 0.34$, $p = .70$). We will also present detailed analysis of growth curves for vocabulary size for each group, comparing them with English monolingual data. Preliminary results suggest that, regardless of the language strategy parents use, the trend for conceptual vocabulary comprehension, when comparing our bilingual and monolingual samples, is very similar. However, significant differences emerge in the second year for conceptual vocabulary production. Implications will be discussed.

P3-G-469 - The content and context of infant media exposure is differentially associated with developmental outcomes (Bellagamba)

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With the advent of portable touchscreen devices early screen exposure is increasing, even though potential long-term effects of very early screen-based media use remain unknown. High levels of screen time has been negatively associated with attention, inhibitory control and language development issues. The content and context of media exposure are a better predictor of outcomes than overall amount (Barr & Linebarger, 2017). Specifically, background television exposure has been reported to disrupt infants' toy play and parent-infant interactions. Infancy is a period of rapid communicative and cognitive development. Examination of associations of early media use during infancy is warranted to examine whether how screentime displaces or augments time available to jointly engage with infants. The present study aimed to evaluate whether the frequency of media exposure in 8-month-old infants was related to their communicative and cognitive development, as measured by mother-report questionnaires. 180 mothers of Italian 8-month-old typically developing infants completed: (i) a questionnaire on family media exposure in different contexts (adapted from Barr et al., 2020), (ii) the short form of the MacArthur-Bates Communicative Development Inventories to assess child language comprehension and production (Caselli et al., 2015), (iii) the Developmental Profile 3 (DP-3; Alpern 2007) to assess infant development, and (iv) a socio demographic questionnaire (see Table 1). A multiple linear regression tested whether gender, siblings, maternal education, infant temperament and frequency of infants' media exposure were related to developmental outcomes. Results showed that the time infants spent listening to an adult reading (either paper or electronic books) was positively related to their scores in the cognitive subscale of the DP-3 ($R2 = .164$, $F13,134 = 2.029$, $p = .023$; $\beta = -.246$, $p = .029$). Another series of multiple linear regression tested whether gender, siblings, maternal education, infant temperament and frequency of interactions between mother and infants during media exposure were related to developmental outcomes. It emerged that the time mothers spent to read their child paperbooks at playtime was positively related to the cognitive and to the communicative subscale and to the general score of the DP3 ($R2 = .191$, $F17,156 = 2.165$, $p = .007$; cognitive subscale: $\beta = .208$, $p = .015$; communicative subscale: $R2 = .195$, $F17,156 = 2.227$, $p = .005$; $\beta = .304$, $p < .001$). Moreover, the frequency of the mother-child interactions during television view was positively related to the number of infants' gestures ($R2 = .197$, $F17,157 = 2.270$, $p = .004$; $\beta = .248$, $p = .026$). Conversely, the time the television was on while nobody was watching it was inversely related with the infant scores in the adaptive behavior subscales of the DP3 ($R2 = .102$, $F17,156 = 1.047$, $p = .411$; $\beta = -.170$, $p = .046$). The findings replicate and extend prior findings to younger infants in Italy. Positive linguistic parental strategies during book reading (electronic or paper book) and during child-directed screen time are positively associated with the infant's cognitive and communicative development, whereas television left on in the background is detrimental for cognitive skills.

P3-G-470 - Maternal odor influence on rapid neural face categorization in natural vs. edited images at 4 months of age (Kiseleva)

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From birth, human infants are exposed to novel sensory information that they must learn to categorize (i.e., discriminate objects belonging to different categories and generalize across objects from the same category). In the visual environment, faces represent one of the most relevant categories that infants apprehend during the first months of life (Pascalis et al., 2011). However, under high visual constraints, face categorization remains challenging for the young infant brain. For instance, when using a large set of widely variable natural face images briefly presented among equally variable images of living and non-living categories, the face-selective neural response recorded in scalp electroencephalography (EEG) evolves from a weak and focal activity over right occipito-temporal regions at a few months of age, to a larger activity over posterior brain regions in children and adults (de Heering & Rossion, 2015; Lochy et al., 2019; Rossion et al., 2015). Interestingly, adding maternal odor during such challenging visual stimulation enhances face-selective neural activity in 4-month-old infants (Leleu et al., 2020; Rekow et al., 2021). Yet, it remains unknown whether such intersensory influence of olfaction on visual categorization is particularly effective because the latter is challenging for the immature brain. In the present study, we thus aimed to determine whether maternal odor still favors face categorization when visual stimulation is less challenging. We recorded scalp EEG in 2 groups of 4-month-old infants (N = 19 and 11; ongoing recruitment) while they were watching streams of 6 pictures per second (stimulation frequency: 6 Hz) with faces inserted every 6th picture (face presentation frequency: 1 Hz). This frequency-tagging approach dissociates two brain responses: the general visual response recorded at 6 Hz elicited by all cues rapidly changing 6 times per second, and the face-selective response recorded at 1 Hz representing a neural signature of face categorization. For one group, images were edited to remove the background, and made homogenous across category exemplars to facilitate their categorization. In the other group, we used unedited natural images with variable backgrounds and viewpoints across category exemplars, following the previous paradigm showing the odor effect (Leleu et al., 2020). During visual stimulation, infants were alternatively exposed to a T-shirt worn by their mother or an unworn, control T-shirt. For both groups, we found a face-selective neural response over occipito-temporal regions, but with a larger amplitude for homogenous edited images, reflecting more efficient categorization. Importantly, while the face-selective response to variable natural images tends to be enhanced in the maternal odor context, it seems equivalent in both odor contexts for edited images. The general visual response over middle occipital regions is lower for edited images, and remains unaffected by the odor for both groups of infants. Our results thus suggest that maternal odor appears prone to shape face categorization when the latter is challenging for the 4-month-old visual system. This trade-off between both senses supports the view that categorization relies on multisensory cues when unisensory inputs are not fully effective.

P3-G-471 - Four-month-old infants rely on symmetry/asymmetry in perceptual grouping to discriminate sets of elements (Geraci)

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A recent study revealed newborn chicks' ability to create same-sized subsets of elements (symmetrical grouping) to inspect numerosities (Loconsole et al., 2021). This suggests the existence of a spontaneous mechanism that relies on a perceptual strategy and enables chicks to discriminate numerosities by disassembling sets of elements into smaller and same-sized subgroups. Human studies report the use of

a similar grouping strategy in numerical cognition, but it is unknown whether this spontaneous perceptual mechanism is early-emerging or it emerges during development. Four month-old infants were familiarized to different even numerosities, and then they were tested in a preferential looking task presenting simultaneously two sets of elements, one being of a prime and one of a composite numerosity, i.e. 7 versus 9 (Experiment 1) or 11 versus 9 (Experiment 2). We found that infants could discriminate among the two sets, and preferred the prime set over the composite one, irrespective of it being the smaller or the larger of the comparison. We discuss these results in terms of novelty preference, since the infants looked longer at sets of elements for which same-size grouping is never possible (prime numerosities). These findings suggest the existence of an early-emerging spontaneous mechanism that enables infants (and chicks) to spontaneously process sets of elements into symmetrical (same-sized) subgroups, shedding light on the biological origin of this mechanism.

P3-G-472 - The quality of the educational environment relating to emergent literacy practices: links to children's engagement in preschool and kindergarten (Lachapelle)

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The main objective of this study is to examine the relationships between the quality of the educational environment and the child's engagement in developmental and learning situations relating to emergent literacy in preschool and kindergarten classes in Québec (Canada). Oral language, reading, and writing are generally considered to be interrelated processes that correspond to emergent literacy in children ages 0 to 6 (Morrow et al., 2019). Through quality educational practices, the educational environment of the classroom supports the child's engagement in emergent literacy development and learning situations (Baroody & Diamond, 2016). The educational environment includes the physical dimension (classroom layout, resources, books, writing materials) as well as the interactive dimension (teacher and child interactions) (Guo et al., 2012). Child engagement refers to interactions with the teacher, peers and his or her involvement within tasks and activities (Bohlmann et al., 2019; Downer et al., 2010). The quality of these interactions plays an essential role in the development of 4 and 5-year-olds' emergent literacy and in their current and later educational success (Sabol et al., 2018). As part of the implementation of the new integrated preschool and kindergarten educational program in Québec (MEQ, 2021), it is important to develop knowledge regarding the quality of the educational environment and the child's interactions within this environment considering the importance of language development in preventing later reading and writing difficulties. This research project has 3 objectives: 1) To measure the quality of the physical environment and the interactive environment relating to emergent literacy in preschool and kindergarten classrooms; 2) To measure children's level of engagement in their emergent literacy development and learning situations; 3) To analyze the relationships between the quality of the educational environment relating to emergent literacy and children's level of engagement in these emergent literacy development and learning situations. The sample will consist of 30 preschool and kindergarten teachers and children in their class (N=150). The classroom observations will allow us to assess the overall educational environment supporting emergent literacy using the ELLCO Pre-K observation tool (Smith et al., 2008). On the other hand, the inCLASS observation tool (Downer et al., 2010) will measure children's level of engagement with the teacher, peers and tasks in emergent literacy development and learning situations. The results will contribute to a better understanding of the relationships between the quality of the educational environment

(physical and interactive) and children's engagement in their emergent literacy experiences. This new knowledge will support research-based educational practices that promote children's educational success (MEES, 2018). In addition, the results can be incorporated into pre-service and in-service teacher training as the new preschool and kindergarten curriculum is implemented.

P3-G-473 - Infants' and preschoolers' inferences about factors affecting task performance (Cao)

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Learning from others requires understanding their abilities and limitations. For example, we generally opt to learn from those who exhibit more competence at a task, compared to people who appear less skilled. Yet, a variety of factors can contribute to the outcomes of people's efforts. Sometimes these outcomes genuinely reflect people's abilities (e.g., an artist can likely create a better drawing than a toddler), whereas other times, performance outcomes may merely reflect temporary constraints (e.g., an artist drawing with their eyes shut will likely create a worse drawing than if their eyes were open). In the present work, we asked whether infants and young children are sensitive to the shorter- and longer-term factors that affect whether people achieve their goals. First, in Experiment 1, we asked whether three- and four-year-old children expect certain kinds of agents to exhibit more competence than others, based on enduring traits including their age or species. In a forced-choice task, we found that children (N = 52) predicted that an adult would execute tasks (building a block tower or drawing a picture) more successfully than a child, and that a human would execute these tasks more successfully than an animal (Figure 1). Next, in Experiment 2, we asked whether children (N = 52) also consider temporary constraints when predicting agents' performance. Children watched movies in which two people attempted to build a block tower or draw a picture. Children successfully predicted that agents who were physically constrained (because their hands were prevented from touching the objects, or because they wore large mitts) would perform worse than agents who were unconstrained. Children also predicted that agents who built block towers or drew pictures with limitations on their perceptual access (due to wearing a blindfold), or on their attentional allocation (due to talking on the phone) would create worse outcomes (Figure 1). In Experiment 3, we examined the preverbal origins of these performance judgments. Infants (21-months; N = 23) saw movies in which two people built block towers: one person wore a blindfold and the other did not. The movies culminated in either an Expected Outcome (the blindfolded person was revealed to have built a worse tower than the non-blindfolded person), or an Unexpected Outcome (the blindfolded person was revealed to have built a better tower than the non-blindfolded person). We found that infants looked significantly longer at the Unexpected Outcome ($t(87.46) = 1.79$, $p = .039$; see Figure 2), suggesting that they had expected a person's limited perceptual access to negatively impact their tower-building performance. Indeed, infants in this looking-time task successfully recognized that impaired visual access would impair an agent's performance, even though 3-year-olds struggled with an explicit version of this task in Experiment 2. Collectively, our findings suggest that young children, and even preverbal infants, make inferences about how various enduring traits and temporary constraints contribute to the outcome of goal-directed actions.

P3-G-474 - How verbs are represented in caregiver-infant interactions (Zhang)

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How do infants learn language through everyday interactions? Contexts matter: the highly non-random linguistic contexts in which a given word tends to occur can help children induce word meaning (Mintz, 2003). The embodied contexts of caregivers' and infants' attention or action when caregivers produce object names can help infants learn these nouns (Yu & Smith, 2012). However, previous research on how infants can learn words through contextual co-occurrence patterns has focused primarily on object nouns. Little is known about distributional information in social interactions for words with more dynamic or less perceptible meanings, like verbs (Maguire, Hirsh-Pasek & Golinkoff, 2006). To investigate how verbs are represented in infant everyday interactions, we (1) annotated the linguistic and embodied contexts of verbs used in naturalistic caregiver-infant interactions, (2) found reliable asymmetries in co-occurrences of different verbs and contextual variables, and (3) applied hierarchical clustering to characterize the verbs space in infant-directed speech, based on contextual co-occurrences.

Forty-two caregivers and their 12-month-old infants were video-recorded in 15-min object play sessions. We examined the 69 most frequent verbs, classified by meanings as movement, object-oriented action, cognition, or volition verbs. For contexts, we included 17 frequent pronouns, classified as 1st, 2nd, 3rd, or deictic. We also coded infants' looking and holding targets, infant locomotion, and whether caregivers' holding target matched the infant's concurrent gaze target. We constructed Binomial Generalized Linear Mixed Models for each verb category. Each utterance, represented in each row, was tagged for the presence or absence (1 or 0) of each verb category and contextual variable. Verb categories were entered as predicted variables, and linguistic and embodied contextual variables were entered as predictors. We calculated effect sizes of contextual predictors in terms of odds ratios.</p>

We found that movement verbs and cognition verbs were differentiated by opposing co-occurrences with contexts. Movement verbs co-occurred significantly more frequently with infant locomotion and 2nd and 3rd person pronouns, whereas cognition verbs did not. However, cognition verbs co-occurred more when caregiver was handling the object of infant's gaze, 1st person or deictic pronouns, whereas movement verbs did not (Table 1a). In addition, cognition and volition verbs were differentiated within mental verbs: volition verbs co-occurred significantly above chance with 2nd person pronouns, but cognition verbs did not (Table 1b). Lastly, caregivers used object-oriented verbs significantly more during joint-attention with infants (i.e., when infants were holding one object, and caregiver and infant were both gazing at another object) (Table 1c).

To characterize the patterns of verb similarity in the dataset we applied hierarchical clustering to verbs based on their co-occurrences with linguistic and embodied contexts (Figure 1). This shows many clusters that fit adult intuitions about verb semantics and usage. These results show that although verbs are more abstract and contextually dependent than nouns (McDonough et al., 2011), their use is predictable from statistical cooccurrences of contextual content in caregiver speech, as well as caregiver and infant actions. These results contribute to the statistical learning literature, and reveal new statistical regularities in English verb usage in caregiver-infant interactions.</p>

P3-G-476 - Infant sleep and development during the first 8 months of life (Pecora)

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During the first months of life, dramatic changes occur in infants' sleep, with sleep-wake patterns starting to consolidate within the first 6 months of life. Sleep hours usually reduce from 16-17 hours in newborns to 13-14 hours at around 6 months of age, and to 9-11 hours when approaching the first year of life. Moreover, while nighttime sleep gradually increases, with fewer awakenings and longer uninterrupted sleep periods, daytime sleep tends to reduce. Remarkably, research indicates that changes in infant sleep are in interaction with important acquisitions in other domains of child maturation, such as cognitive and language development. In the present study, we aimed to investigate concurrent and longitudinal relations between sleep and development in 156 4-months-old infants and in a subsample of 103 8-months-old infants. Infants' sleep was assessed through the Brief Infant Sleep Questionnaire (BISQ; Sadeh, 2004), whereas cognitive development was evaluated using the Developmental ProfileTM 3 (Alpern 2007). We also examined infants' language comprehension through the short form of the MacArthur-Bates Communicative Development Inventories (MCDI; Caselli et al., 2015). Finally, information about infants' temperament and maternal practices potentially relevant for sleep quality, such as the use of a pacifier at nighttime, co-sleeping and exclusive breastfeeding, was detected. Linear Mixed-Effects Modelling showed that at 4 months of age infants sleeping less both during the day and the night obtained higher scores on the DP-3 Physical subscale (Table 1), extending previous findings (Hauck et al., 2018) and suggesting that the time infants spend sleeping during the 24 hours may be related to the kind of movements they produce. However, this finding did not remain significant four months later. At 8 months of age, the night sleep duration was related to the DP-3 General Development scale and to the Adaptive Behavior subscale (Table 1), whereas the daytime sleep was positively related to the DP-3 Social-Emotional subscale (Table 1). Surprisingly, both the language understanding score and the action and gesture production score of the MCDI were positively related to the number of night awakenings. It may be the case that mothers of infants waking several times during the night may give less reliable responses, likely as a consequence of the sleep deprivation to which they are subjected. However, this aspect merits consideration for further investigation. Finally, we found a negative relationship between the day sleep duration at 4 months and the DP-3 General Development score at 8 months (Table 2) and positive relationships between the time infants spent awake at night at 4 months and (i) the DP-3 Adaptive Behavior subscale and (ii) the MCDI's number of actions and gestures at 8 months (Table 2). Overall, despite the relatively limited and controversial evidence for longitudinal relationships between sleep and infant development, our results provide support and extend previous findings showing that a better sleep quality is associated with a greater cognitive maturation even at very early ages and point out that healthy sleeping in infants is important for cognitive, physical, and socioemotional development.

P3-G-477 - Factors Influencing Caregiver and Infant Enjoyment of Shared Picturebook Reading (Mills-Smith)

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There is an abundance of literature establishing how early reading experiences promote general cognitive development, language development preliteracy skills, and social skills in children. To better understand these wide-ranging child outcomes, studies have attempted to quantify the kinds of language and illustrations children are exposed to in the books being read to them in the most read picturebooks. (e.g., Greenhoot, Beyer, & Curtis, 2016; Hudson Kam & Matthewson, 2017; Wagner, 2017). The purpose of this study is to generate a list of most read picturebooks while extending our knowledge of what characteristics of caregivers, children, the books themselves contribute to enjoyment of caregiver-child shared reading. Based on these studies, a survey was created asking caregivers of 0- to 3-year-olds about their shared book reading experiences with their children. Modelled after Hudson Kam and Matthewson's (2017), caregivers were asked demographic questions and to give up to 5 titles they were reading with follow-up questions about reading frequency, style, and environment. Most importantly, enjoyment ratings for each title were provided for each caregiver and child. Participants were recruited through Prolific and were native speakers of English with a child between aged 0-3 years to whom they read. This resulted in 211 survey responses. Focusing on caregivers of children aged 0-24 months only (n=87), they reported 179 unique and identifiable book titles. Nine titles were reported by 5 or more caregivers. "The Very Hungry Caterpillar" was the most popular title (n=22). Average Enjoyment scores were generated for infants and their caregivers by calculating the mean of the enjoyment ratings given for each title. Similar calculations were made for reading frequency, reading style, and how often the target child is read to alone. Infants' average enjoyment was positively correlated with the dyad's average reading frequency, the infants' expressive language ability but negatively correlated with the caregiver's age (ps <.05). Caregivers' average enjoyment was positively correlated with reading to the target child alone often than when another child was also present but negatively correlated with the elaborateness of their reading style (ps <.05). Regression analyses indicated infant age was the most important factor in predicting infant reading enjoyment (ß=0.48, p<.001), with older infants enjoying reading more than younger infants. Average reading frequency, the infant's sex, caregiver age, and caregiver education level were also significant predictors. In contrast, caregiver enjoyment was significantly predicted by caregiver age and education as well as the elaborateness of their reading style and reading to the child alone more often than with another child present. Thus, caregivers of infants enjoy reading more when their reading style is less elaborate and when they are reading to only one child at a time. Ultimately, the factors influencing enjoyment of shared reading are reflect the roles of each party. Caregivers, as the reader, take on a more active role, thus their enjoyment is related to the demands of the reading environment more so than the listening child. Infant enjoyment of reading is more influenced by where they are in their development.

P3-G-478 - Validating a novel dyadic task for assessing early neuro-cognitive development (DeWald)

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Secondary engagement (SE) represents a dyadic process of shared attention to an external referent. For infants, participating in such interactions provides a powerful nexus for learning across multiple domains (Tomasello, 1999). Indeed, quantity and quality of infants' early SE interactions predict many facets of their subsequent socio-cognitive development (e.g., Smith, Adamson, & Bakeman, 1988). Surprisingly, SE interactions are rarely included in clinical assessment of infants' neuro-cognitive development. We

developed a new SE task designed for this purpose and report on preliminary findings from the task. This research was conducted within the context of a large, randomized controlled trial in Cambodia investigating possible links between maternal thiamine supplementation and breastfed infants' neurocognitive development (Measelle, et al., 2021; Whitfield, 2019). 335 breastfeeding mother-infant pairs participated in the larger clinical trial. We report preliminary analyses based on SET videos of 54 of these mother-infant dyads. Task participation occurred when infants were both 12 and 24 weeks. Caregivers were told the overarching goal of the task was to establish and sustain infants' interest in a novel object over the course of the interaction. As the task progressed across five 30-second "epochs," mothers were prompted to add and then subsequently remove cues to secondary engagement (e.g., line-of-regard, voice and gesture, see Figure 1). To validate the SET task, we rated mothers' behavior via Likert scales ranging from 1 (behavior not exhibited) to 5 (behavior clearly present throughout epoch) on four dimensions: affective tone, contingent responding, joint engagement, and object presentation. We expected ratings on each of these dimensions to display a quadratic trend across the five epochs. A five (epoch) X two (timepoint: 12 vs. 24 weeks) mixed-design multivariate ANOVA including all four maternal SE variables revealed a significant main effect of epoch, $F(16, 848) = 17.30$, $p = .000$, partial eta-squared = .246. Confirming our prediction, all four variables displayed a significant quadratic trend across epochs (univariate F's > 83.12, p's < .000) (Figure 2). This analysis also revealed a significant main effect of the timepoint factor, $F(4, 50) = 13.73$, $p = .000$, with higher overall mean levels for three (object presentation, joint engagement, affective tone) of the four variables when infants were 12 relative to 24 weeks. No significant epoch X timepoint interaction emerged in the analysis. Our preliminary findings provide initial validation for the SE task when infants were both 12 and 24 weeks. In accord with task instructions, Cambodian mothers first scaled up and then scaled down their efforts to engage jointly with infants regarding a novel object. As the full dataset emerges, subsequent analyses will examine infants' responsiveness to maternal secondary engagement efforts, and the degree to which infants' responsiveness was associated with other aspects of their neuro-cognitive development. Also of interest will be the extent to which maternal thiamine supplementation influenced a) mothers' ability to engage in SE efforts, and b) infants' SE skills. Taken together, findings from this research hold potential to document the SE task as an innovative clinical tool for assessing early neuro-cognitive development.

P3-G-479 - How stable are scores for general developmental based on parental observations across infancy? (Pauen)

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MONDEY ("Milestones of Normal Development in Early Years") is an observational tool for caregivers of young children (0-3 years), developed in Germany (Pauen, 2011), but also available in other languages, including English. The developmental status of a given child is assessed by adults who see the child on a regular basis (e.g., parents, daycare teachers). They evaluate how many milestones the child has already achieved. Milestones refer to simple behaviors, observable in everyday situations. Each milestone can be assigned to one of eight developmental dimensions (gross-, and fine motor-, perceptual/memory-, mental-, language-, social-, emotional-, and self-regulation development). Previous findings reveal that MONDEY has very good construct validity (Pauen et al., 2012), and inter-rater reliability (Heilig & Pauen, 2013). The present study investigates how MONDEY total scores (z-standardized) change with age during the first year of life - a highly dynamic phase of general development. The total Z-score correlates

highly with age in a cross-sectional study referring to children aged 0-3 (Pauen et al., 2012). But different MONDEY-dimension dominate at different points in time, especially in the first year of life (e.g., perceptual development advances quickly during the first months whereas language- and fine-motor skills become more relevant towards the end of the first year), thus leading to shifts in the relevance of single dimensions and their contribution to the total score. Hence, we expect to find only moderate stability of the total MONDEY Z-score across age when focusing on the first year of life, and using a longitudinal design. Data from a socially diverse sample of parents that take part in an ongoing longitudinal study (Bremen Initiative to Foster Early Childhood Development, BRISE; Schuette et al., 2020) were used to test this assumption. Complete MONDEY data sets are available for the first wave (N = 105) at three different measurement points (i.e., when infants are about 3-5, 7-9, and 12-15 months old, respectively), respectively. We used simple regression analyses to predict the MONDEY z-score (total) at any given measurement point (T1 - T3) based on the data of previous ones. Corresponding findings are listed in Table 1. T1 -> T2: Beta = ,459; T = 5,243; p = .000 T2 -> T3: Beta = ,516; T = 6,108; p = .000 T1 -> T3: Beta = ,438; T = 4,951; p = .000 As expected, later MONDEY Z-scores can be predicted based on previous ones, despite the high dynamic of changes during the first year of life. This supports the claim that MONDEY offers a valid observational tool to assess and predict developmental progress in early childhood. When more data will be available, analyses will be conducted for separate developmental dimensions and for additional (later) measurement points to further evaluate this finding.

P3-G-480 - Everyday, Spontaneous Math Talk Among Mothers and Infants at Home (Swirbul)

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"Math talk" is particularly challenging for children to decipher and learn. Unlike the concrete nouns that dominate children's early vocabularies (e.g., mama, ball), math words are abstract, often describing quantities ("one cookie"), features ("the big dog"), or relations between objects ("the rug under the couch"). Yet, during the second year of life, children begin to produce math language: Over half of 19-month-old infants produce words like up, down, and more, then on, out, and big before 24 months (WordBank). As with all language, children only learn these words through exposure accompanied by contextual cues that highlight word meaning ("on top" while stacking blocks, or "up" as mom lifts the child up). We expand on existing work in several ways. We examine spontaneous mother-child math talk in the ecologically-valid home context, where math language learning naturally occurs, over an extended 2-hour observation period. We focus on the period of early emergence, when children require additional support to learn the meaning of these abstract terms. Finally, we examine talk within the two overarching classes of math language, numeracy (e.g., numbers, ordinals) and spatial talk (e.g., shapes, orientation), which are often studied separately. We ask: (1) How much math language do children hear and which types are most frequent? (2) Does variation among mothers in math talk relate to variation among children at this early period? (3) What are the social and contextual cues that accompany math talk (e.g., gestures, materials available)? Participants were 60 mothers and their 13- to 23-month-old toddlers. Dyads were video-recorded for 2 hours at home during their everyday activities. We transcribed and coded videos for total number of mother and child utterances, total number of math words, and 11 specific math concepts at the word level: number, shape, magnitude/comparison, location/direction, deictics, orientation, spatial features/properties, functions, ordinals, superordinates,

and time. Mothers varied widely and used substantial math language and overall talk. Transcripts on 27 initial dyads show that mothers averaged 885 total utterances per hour (SD=353.8; range=285-1541). Of those, nearly 20% contained math language, with mothers averaging 219 math tokens (SD=111.5) and 39 different math types (SD=13.9) per hour. Dominant categories of math language used by mothers included location/direction, magnitude/comparison, and time words. Figure 1 highlights the striking variation between mothers and distribution of words by categories. Mothers' most frequently used math words were in, here, and where. Mothers' math language also related to children's math language (Figure 2), r(25) = .48, p = 0.108. Notably, 70% of toddlers used math language, with 18- and 23-month-olds using more math language than 13-month-olds [F(2, 22) = 3.30, p = 0.056]. Mirroring mothers, location/direction were most frequent in children's math language. Consistent with WordBank, down, up, and more were used by the most children. Preliminary coding of social and contextual cues surrounding mothers' math language suggests that location/direction words are typically used to describe the child's position in space, rather than objects ("stand up" vs. "it's up here"). Further inquiry will quantify different types of social and physical cues to meaning.

P3-G-481 - Revisiting the particularity of words in early cognitive development: how words and actions modulate infant categorization behaviour (Bothe)

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From early on, infants form object categories based on object shape (Behl-Chadha, 1996; Eimas & Quinn, 1994; Landau et al., 1992) and object labels (e.g., Althaus & Westermann, 2016; Booth & Waxman, 2002; Plunkett et al., 2008). While language aids categorization processes from early on, non-linguistic auditory information like tones appear not to play a similarly critical role (e.g., Ferry et al., 2010; Fulkerson & Waxman, 2007). Such findings have sometimes been taken to suggest that language plays a special role in human cognitive development as young children start to create sensible concepts about their world. Other non-verbal cues, however, like object actions and movements, are also very salient for young infants because actions help infants to direct their attention towards the moving object, specifically during the first year of life when linguistic knowledge is premature (e.g., Kemler Nelson et al., 2000; Träuble & Pauen, 2007). The goal of the present web-based looking time study is to compare how object labels and actions affect categorization behaviour differently across early development. Specifically, using a novelty-preference task, we aim to qualify the role of input (i.e., words & actions) in early object category learning as we present infants with novel single-category objects, either accompanied by a single isolated cue (action-cue or word-cue), combined cues (word-action-cue) or in the absence of additional cues (i.e., object only). During training, infants (n=160) aged 1- and 2-years of age, see eight videos of single objects with varying perceptual features that share category membership in one of the four conditions (word-cue, action-cue, word-action-cue, no-cue). At test, infants see a novel object of the trained category and a novel object from an unknown category side-by-side on the screen. Decreased overall looking towards the end of the training phase and increased looking at the novel object from a different category at test is typically interpreted as evidence for category formation and generalization of the objects from the trained category. We'll report differences in the extent to which words and actions influence looking behavior during object familiarization and category formation at test. We predict that actions will support categorization behaviour similarly to object labels, suggesting that input salience, rather than initial expectations about

category labels, drives category behavior in early development. The study is pre-registered on OSF (https://osf.io/emd3p) and we will analyze the data once the pre-registered sample size has been reached.

P3-G-482 - The distribution of study participation on the Lookit online experiment platform (Kline Struhl)

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In the last two years, research with infants and children has been fundamentally altered by the COVID19 pandemic. Out of necessity, many researchers have turned to remote methods to replace in-person sessions (c.f. the special issue in Frontiers in Psychology, 2021.) While many studies will return to in-person testing when it is safe to do so, remote data collection presents an enormous opportunity. Much of the time and cost associated with "running a baby" are not incurred by the protocol per se, but on recruitment, scheduling and coordination with participants and partner institutions like preschools, children's museums, and hospitals. If even a portion of studies can be conducted online in the long term, these same resources can go farther, enabling faster data collection and larger sample sizes. This shift in has another potential impact: many of the 'rules of thumb' that guide our intuitions about study design may not translate online. One potential source of information comes from Lookit, a video-based online platform launched by MIT's Early Childhood Cognition lab. Parents browse the website to find studies appropriate for their child, and (after providing a verbal statement of consent to participate) proceed to complete a study with their child, with webcam video recorded and sent to the lab for later analysis. More recently, the platform has expanded to allow for scheduled studies (conducted over video chat) and for response data collected using other platforms such as Qualtrics. Lookit has expanded from an initial proof-of-concept to its current use by research teams around the world: as of November 2021, there are 62 labs from 50 institutions with signed access agreements, and in an average month hundreds of families participate in one of around 50 studies active at a given time. There are significant economies of scale that come from centralizing recruitment, but researchers may wonder how individual studies may fare when (potentially) pitted against each other. What makes studies attractive for families as well as informative for researchers? This talk will present descriptive statistics on the use of the Lookit platform over time, with a focus on both the kinds of studies that are available, and how those studies vary on features such as study length which might influence uptake by participating families (see figure). It will also discuss the measures that Lookit takes to make sure that all researchers using the platform are able to conduct high-quality, successful studies. Our study designs vary not just on the topics of research, but on our intuitions about what kinds of protocols are possible or practical to conduct. For instance, researchers running between-subject designs might move to within-subject if babies can tolerate a longer session, increasing statistical power. Re-making our intuitions about what kinds of designs, measures, and interventions are possible has the potential to shift how we think about data from infants and children across the developmental sciences.

P3-G-483 - Stability of infant play behaviors: A person-centered approach (Lee)

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The concept, Stability, implies that individual orders in a group remain consistent regarding the expression of a characteristic across substantial times (Bornstein et al., 2017). Because infancy is a period of rapid cognitive and behavioral growth, capturing behaviors that remain stable can extend our understanding of individual variation across development. Past research mainly focused on the qualitative transformation of infant play behaviors such as change from Nonsymbolic Play to Symbolic Play, which occurs as a result of the infants' emerging cognitive competence. While infants gradually develop into having the ability to symbolize, it is understudied whether infants who displayed more symbolic play behaviors continue to demonstrate more symbolic play behaviors at a later age. Exploring the stability of symbolic play (i.e., cognitively high level of play behaviors) can be an important cornerstone to reveal the path that can be linked to a later specific cognitive ability. The current study investigates the stability of infant play behaviors using a person-centered approach to empirically derive profiles of play behavior across individuals at 15 and 24 months and examines their relative associations. Participants included 1,364 infants from the NICHD Study of Early Child Care and Youth Development. Infants playing with age-appropriate toys (e.g., a doll, toy telephones, spoon) were video-recorded at 15 and 24 months. Trained coders recorded the infant's play level every 15 seconds. Interrater reliability was high (k =.87). The coding scheme consisted of fourteen play levels that reflect varying levels of cognitive sophistication (Belsky & Most, 1981), which this study abbreviated into three play behaviors: Unfocused Play (i.e., not engaging with toys), Nonsymbolic Play (i.e., play focused on the function of an object), and Symbolic Play (i.e., using toys in pretense and enacting imagined events). We used the proportion of each play behavior and removed missing values resulting in a final sample of 802 infants (401 boys). We conducted Latent Profile Model [LPM] using Mplus7 to construct profiles of infant play behaviors. LPM assigns each participant a posterior probability of profile membership, which were used as continuous indicators to examine the stability of infant play behaviors. Fig. 1 shows the best-fitted model which has four profiles at both 15 and 24 months: High in Nonsymbolic Play (Profile 1), High in Unfocused Play (Profile 2), High in Symbolic Play (Profile 3), and Averaged Play (Profile 4). Correlations among posterior probabilities of each profile showed that Profile 1 at 15 months was positively associated with Profile 1 at 24 months (r = .11**; Table 1), but negatively related to Profile 3 at 24 months (r = -.12**). Profile 3 at 15 months was negatively associated with Profile 1 at 24 months (r = -.09**), but had a positive association with Profile 3 at 24 months (r = .12**). Infants' play behaviors remained stable in their relative order, such that infants who engaged in a higher proportion of Symbolic Play at 15 months were likely to belong to 'High in Symbolic Play' Profile more, but 'High in Nonsymbolic Play' Profile less at 24 months. Our findings show that over time, infants change in their levels of play from Nonsymbolic play to Symbolic Play, yet remain stable in their order to one another. This work provides a complementary perspective on the stability of infant play behaviors. However, it should be interpreted cautiously as the correlational results present a large unshared variance despite a large sample. Thus, future work should continue to clarify the stable mechanisms of infant play behaviors.

P3-G-484 - Relations between exact number and exact equality: Developmental and cross-cultural perspectives (Bisbee)

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Children typically begin to count at around age two, but the ability to represent exact set sizes (subset-knowers) and to generate any set size (Cardinal Principle knowers) is a more protracted process. Studies

of numerical cognition in the Pirahã tribe have found that they possess exact representations for small sets (0-3) and approximate representations for large sets (Gordon, 2004; Everett et al., 2011; Frank et al., 2008). The Pirahã have three quasi-numerical words (1-2-many), which appear to designate relative rather than exact quantity (Frank et al., 2012, Fig. 1). Recent studies of the semi-numeric Tsimané tribe have also found systemic difficulties with exact representations outside their count range. Given that children go through stages of being one-knowers and two-knowers, we ask whether children map early number words onto a relative or exact numerical representation, and whether performance on nonverbal numerical tasks is linked to their current linguistic representations of number. To answer these questions, we developed a battery of tasks extended from Gordon and Frank's Pirahã studies to be tested on 2-4 year old preschoolers. In an Ascending and Descending Enumeration Tasks based on Frank et al. (2004), children counted a row of blocks that was incremented from 1 to 10 and decremented from 10 to 1. Analyses suggest that early subset-knowers use counting words much like the anumeric Pirahã (see Fig. 1). On the ascending task, one-knowers (like the Pirahã) use one or two for most responses outside their knower level. On the descending task, we find that one-knowers use two flexibly for sets larger than one block and two-knowers use one flexibly for small sets 1-5. Our findings lend support to the claim that children's initial number words are linked to relative rather than exact representations (cf. Sarnecka et al., 2007). In the second set of matching tasks, children were asked to place blocks in a row numerically matching a row presented by the experimenter that was either parallel or orthogonal to the child's. We were interested in how performance on counting tasks (rote counting and enumeration) predicted performance on these matching tasks. We constructed General Linear Mixed Models predicting exact responses, and Linear Mixed Models predicting errors to capture deviance within incorrect responses, while controlling for age and target size (see Table 1). Neither exact match model found significant effects of counting or knower status. The orthogonal error model found significantly deflated responses (ß = -2.01, $p = 0.024$) to sets outside the highest productive count and inflated responses (ß = 3.31, $p < 0.001$) to sets outside the rote count range. While we cannot interpret the directionality of these errors, it is clear that children's productive number skills change drastically outside of their productive range of known concepts. Contrary to a recent developmental study by Schneider and Barner (2020), we did not find a significant effect of CP-Knower on performance on the matching tasks. However, we replicate the findings of Pitt et al. (2021) who found a similar decrease in performance on the orthogonal task when target sets were outside the child's counting range. In summary, our findings in anumeric adults and in pre-numeric children suggest that performance on verbal and nonverbal tasks are linked to the presence or absence of exact number representations.

P3-G-485 - Maternal Thiamine Supplementation Enhances Breastfed Cambodian Infants Social Responsiveness at 24 Weeks: Evidence from the Primary Engagement Task (Rudolph)

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Infants in Cambodia are at risk of thiamine deficiency, which has negative consequences for their neuro-cognitive development. We investigated whether thiamine supplementation for lactating Cambodian mothers enhanced their infants' responsiveness to social engagement. Such responsiveness is both indicative of neuro-cognitive development and beneficial for subsequent neuro-cognitive progress. We utilized a novel task - the Primary Engagement Task (PET) - to assess infants' social alertness. The present study aimed to a) validate the PET for assessing infants' social alertness, b) investigate a possible

association between early (2 week) social alertness in the PET and later (24-week) neuro-cognitive development, and c) examine the degree to which maternal thiamine supplementation enhanced infants' social alertness in the PET at 24-weeks. This study was part of a double-blind, randomized controlled trial in Cambodia; 335 lactating mothers received one of four levels of thiamine supplementation (0, 1.2, 2.4, or 10mg/day) from 2- weeks to 24-weeks postpartum. PET participation occurred when infants were 2-, 12-, and 24-weeks. Analyzable PET videos at all three ages were available from 291 mother-infant dyads. In the PET, mothers were asked to encourage and sustain infant engagement while adding and then removing interaction modalities (facial expression, voice, and touch) across six 30-second epochs. Infants' social alertness was coded from video for each PET epoch using a 6-state alertness scale adapted from the NICU Neurobehavioral Scale. Neuro-cognitive outcomes at 24 weeks were measured via the Mullen Scales of Early Learning (MSEL). As predicted, infants across all timepoints displayed significant increases in social alertness as mothers introduced new modalities of engagement in the PET, and a partial decline in alertness as modalities were removed (linear trend $F(1,283) = 125.4$, $p = 0.000$; quadratic trend $F(1,283) = 109.3$, $p = 0.008$) (Figure 1). An overall increase in mean social alertness occurred across time-points, $F(2,566) = 97.7$, $p = 0.000$. Infants' mean social alertness in the PET at 2 weeks showed a significant negative association with MSEL receptive and expressive language scores at 24 weeks, $r's > .15$, $p's < .04$ (lower levels of social alertness at 2 weeks were associated with higher 24-week MSEL language scores). Lastly, at 24 weeks, maternal supplementation dose significantly interacted with infants' social alertness levels. Specifically, infants displayed enhanced responsiveness to caregivers' engagement cues (a more pronounced quadratic trend) at higher levels of maternal thiamine supplementation, $F(3,287) = 2.9$, $p = .036$ (Figure 2). In sum, the PET elicited predictable patterns of infant social alertness and was sensitive to developmental change. Further, an association between infants' PET scores at 2 weeks and their MSEL language scores nearly 6 months later points to the potential predictive value of the task. The PET also displayed sensitivity to nutritional intervention: infants' social alertness in the PET became more pronounced with increases in maternal thiamine supplementation dosage. These findings collectively validate the PET as a promising new method for probing infants' social responsiveness, and provide the first available evidence that maternal thiamine supplementation enhances social responsiveness in infants at risk of thiamine deficiency.

P3-G-486 - Perception of the link between manual action and magnitude in 6-month-old infants: a multidimensional investigation (Aychet)

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Human action perception system might have evolved in interaction with a possibly innate ability to conceptualize magnitude information (such as size, numbers or time). However, the developmental pathway of a link between numerical and action processing has still received few research attention. Studies suggest that six months old corresponds to an important stage in manual action production and perception development. Infants of this age start to exhibit mature thumb-opposite grasping (Butterworth et al., 1997; Daum et al., 2011) and are able to predict others' reaching actions (Kochukhova, Gredebäck 2010; Kanakogi, Itakura, 2011). Previous studies demonstrated that six-month-old babies were able to infer the goal object of a grasping action based on the experimenter's hand aperture and the goal object's shape (Daum et al., 2009, 2011). Since action perception may involve

motor resonance (Natale et al., 2014), it may be hypothesized that infants' motor system is also regulated by information of magnitude when observing manual actions. We plan to adopt an original multi-dimensional approach to investigate whether and how six months-old infants would interpret and predict others' grasping actions by relying on magnitude information, such as object size. Throughout an expectation-violation paradigm experiment, we will couple behavioral measures, including eye tracking, with surface electromyography (EMG) recordings of forelimb muscles' activity in young infants (Fig. 1A). The paradigm consists in short videos in which an adult hand is opening in a small or large grip aperture ("hand opening phase"), and is then directed towards either a small or large wooden cube ("object reaching phase"). Each infant will attend eight different videos presented in a random order (Fig. 1B) and measures will be statistically compared between conditions using mixed models. Our hypotheses are threefold. Firstly, we predict that infants will be able to anticipate the goal of the grasping actions based on magnitude information, i.e. that during the "hand opening phase", subjects will direct their gaze towards the object whose size fits the hand's grip aperture. Secondly, we expect that young infants will differentiate congruent from incongruent conditions (i.e., in which hand aperture and object size match or mismatch). Such results would corroborate findings from Daum et al. (2009, 2011). The incongruent conditions should thus elicit longer gaze durations during the "object reaching phase", and surprise induced by the unexpected action may be reflected by pupil dilatation. Finally, our third prediction is that motor resonance will be exhibited during the "object reaching phase", with infants' muscle activity amplitude correlating with information of magnitude, in congruent but not incongruent conditions. Considering that infants' sensorimotor grasping skills might affect their ability to predict such manual actions (Gredebäck, Kochukhova, 2010; Daum et al., 2011; Kanakogi, Itakura, 2011; Bakker et al., 2015), we will assess which type of grasps the subjects are able to perform (from "ulnar grasp" to mature "pincer grasp"), using questionnaires and a simple object grasping task. This multidisciplinary project will contribute to gain insights into the development of magnitude concepts by characterizing them in relation with action perception and motor development.

P3-G-487 - 24-month-olds' Understanding of Preferences for Action-Effects in a Functional Tool-Use Task (Pflueger)

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Studies examining infants' understanding of desire and preference have often focused on others' attitudes towards objects or object-categories (e.g., Kampis et al., 2013). This leaves the forming of a visual association between the actor and their desired object as possible explanation for the results. To rule out that explanation and to address the fact that action-goals often contain action-outcomes that go beyond the pure grasping of an object, we developed a novel paradigm to investigate infants' understanding of others' desires. As target of desire, we chose transient action-effects (i.e., sound / light) elicited by simple tool-use actions. Solving the task requires the infant to connect an agent to a particular action-effect rather than to one of several visually distinguishable objects. By 18 months, infants understand the subjectivity of desires (Repacholi & Gopnik, 1997) and from the end of the first year, they start performing simple tool-use actions (e.g., Meltzoff, 1988). We decided to test 24-month-olds, because at this age infants should be able to integrate their knowledge of both areas. In our study, infants are presented with two hand puppets. First, each puppet separately welcomes the child and presents their two favourite toys, which both either make a sound or light up. Through repeated

verbalization and emotional expressions, the puppets inform the infant that they like this specific action-effect (either sound or light). After familiarization, the puppets disappear, and infants are presented with a tool-use imitation task. In two trials, infants learn to perform two actions (pressing, sliding) with a magnetic stick on two boxes, eliciting either a sound or a light effect. We expect infants to learn both actions and the action-effect-combinations. Upon successful tool-use learning, infants get access to both boxes simultaneously and in each of two test-trials, one of the puppets reappears (the order is identical to the familiarization) and asks the infant to "do something that makes me happy". If infants combined their knowledge about the puppet's action-effect preference and their own action-effect experience, they should perform the action congruent to the puppet's previously proclaimed desire (e.g., pressing on the sound box or sliding on the light box). To account for possible difficulties in integrating object, action, and effect, we will also assess infants' action attempts (e.g., correct movement on wrong box, wrong movement on correct box) and their gaze towards the sound or light box upon the puppet's reappearance. In preregistered linear mixed-effects models with random slopes for the participants, we specified preference as main predictor, controlling for serial-effects and for effects of action-effects, movements, the puppets' identity, and position of the boxes. Additional insight into infants' information-processing will come from exploratory analyses on the latencies to the first touch of the box with the tool and to the first action performed. This study focuses not only on two-year-olds' ability to engage in functional tool-use to elicit a particular action-effect, but also on their choice among tool-use actions in a social context, depending on another's preferred action-outcome. This will provide new, important information on the early understanding of others' more complex desires and on infants' tendencies to use this knowledge in a prosocial way.

P3-G-488 - Caregivers' codeswitching behaviors during shared reading of bilingual books (Castellana)

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Language exchanged during shared reading (extratextual talk) is a potentially valuable source of input (Brouillard et al., 2020; Sénéchal & LeFevre, 2020), particularly for dual language learning infants whose parents may use both languages (Gonzalez-Barrero et al., 2021; Read et al., 2021). Codeswitching (mixing words from two languages) is common in speech and some bilingual books (Benitez et al., 2022; Kremin et al., 2021) and may provide rich opportunities for dual language learning (Bail et al., 2015). However, research has not yet explored how caregivers codeswitch when reading to children nor how codeswitching presented in text affects caregivers' switching and language use. Here, we provide the first examination of bilingual caregivers' extratextual speech to toddlers during shared reading interactions involving monolingual and bilingual books. We aim to 1) measure caregivers' extratextual talk and codeswitching behaviors when reading a monolingual book, 2) examine how the frequency of codeswitching in book text influences caregivers' codeswitching, and 3) explore associations between caregivers' language dominance and codeswitching behaviors. Method. Forty English-Spanish bilingual parent-toddler dyads (30-42 months) will be video recorded reading two books. All participants will read the same monolingual book (in English or Spanish) and will be randomly assigned to read one of two bilingual books (containing either frequent or infrequent codeswitching). Participants will also complete a questionnaire about parents' and toddlers' language use and dominance. Parents' extratextual talk will be transcribed and coded for language and the frequency of switching 1) within and between utterances, and 2) from the dominant to non-dominant language (and vice versa). Statistical Approach.

To examine parents' extratextual talk and baseline codeswitching during monolingual book reading (Aim 1), we will compute the overall number of utterances, word tokens, word types, and type/token ratio in both English and Spanish, and the frequency of within- and between-utterance switching. We expect parents to switch frequently, with high variability across dyads. To test how the total amount of parents' codeswitching is affected by the frequency of switching in the text (Aim 2), we will perform a mixed ANOVA with Book Type (monolingual vs. bilingual) as a within-subject factor and Switching Frequency (Frequent vs. Infrequent) as a between-subjects factor. We predict a main effect of Book Type, such that bilingual books will elicit more codeswitching than monolingual books. We also predict an interaction between Book Type and Switching Frequency; we expect that parents reading the frequent-switching book will produce more switches than parents reading the infrequent-switching book, but there will be no group differences in switching for the monolingual book. To explore the associations between caregivers' language dominance and their codeswitching (Aim 3), we will explore correlations between parents' language dominance and the direction (to or from the dominant language) and frequency of switching. Implications. By examining how bilingual parents talk to their toddlers while reading different types of books, this study can provide insight into how the text of children's books can shape parent-child interactions. The prevalence of codeswitching could offer children different patterns of language input than what they may experience in other contexts.

P3-G-489 - Early Prediction-Based Learning in Monolingual and Bilingual Infants (Zjakic)

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Prediction (i.e., using regularities in the environment to facilitate adaptive behaviour) is considered to be a key component of language processing (Zhang & Emberson, 2020). Infants as young as 6-months can generate and update predictions in anticipatory eye movement (AEM) tasks using non-verbal and verbal cues. Extensive research has investigated the effects of bilingualism on infants' performance in these tasks suggesting that bilinguals may be more successful at updating predictions than monolinguals due to advanced executive function (EF) abilities (e.g., Kovács & Mehler, 2009). However, more recent accounts suggest that bilingualism may instead influence infants' information encoding abilities, so monolingual and bilingual infants differ in the extent to which they form initial predictions involving linguistic and non-linguistic cues (Dal Ben et al., 2021). In line with this proposal, infants' abilities to update predictions are inversely related to the strength of their initial predictions. Bilingual infants are expected to form weaker initial predictions in tasks involving non-linguistic stimuli than monolinguals, but stronger predictions in tasks involving linguistic stimuli. To test this hypothesis, 72 9-month-old Spanish/Basque monolinguals and bilinguals will be tested on a non-linguistic and a linguistic AEM task (within-subjects, administered one week apart). In each task, infants' AEMs will be measured as they use auditory cues to anticipate the location of a target reward presented on one side of the screen during the pre-switch phase, and on the opposite side of the screen in the post-switch phase (see Figure 1). In the non-linguistic task, the auditory cue will be a whistle sound (identical pre- and post-switch). In the linguistic task, infants will hear 4-syllable strings matching Spanish and Basque word orders (VO/OV) and prosodic properties (duration/pitch) (see Table 1). Spanish non-words will be used pre-switch and Basque post-switch, or vice versa. Additionally, a parental questionnaire assessing infants' executive function abilities (EEFQ; Hendry & Holmboe, 2021) will be collected. Linear Mixed Effects models will be used with infants' language background (monolingual/bilingual), test block (pre-, post-), trial number

(1-9), and EEFQ scores as Independent Variables. Two Dependent Variables will be calculated: prediction accuracy (i.e., proportion of trials with correct anticipations pre- and post-switch), and the speed of updating (i.e., trials required to switch anticipation from the pre- to the post-switch location in the post-switch phase). Additionally, correlations between the pre- and post-switch performance in the linguistic and non-linguistic tasks will be computed. In the non-linguistic task, we expect bilinguals to form weaker initial predictions pre-switch, but to produce more correct predictions post-switch. For the linguistic task, we consider two alternative hypotheses: (1) performance patterns will be identical to the non-linguistic task, supporting the proposal that general- and language-specific predictive abilities stem from a single mechanism (Reuter et al., 2018); and (2) that bilinguals will form stronger predictions pre-switch than monolinguals, resulting in fewer correct post-switch predictions. This study will offer important insights into the language-general perceptual and cognitive processes, fundamental for language development in monolingual and bilingual populations.

P3-G-490 - Exploring similarities in infants' action and speech segmentation: An application of the Visual Paired Comparison Test (Hilton)

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Parallels in the structure of speech and action have given rise to suggestions that the cognitive processing in the two domains may be similar or even shared (e.g., Hilton et al., 2021). The purpose of this planned study is to examine similarities in the segmentation of action and speech during infancy. In the action domain, it has been found that at 21 months of age, memory is enhanced for information presented at the time of a boundary (a break between individual actions of an action sequence) in comparison to information presented during an ongoing action (Sonne et al., 2017). To better understand the developmental trajectory of this effect, our first aim is to examine whether it can already be found during the first year of life. Our second aim is to determine whether this effect is specific to action segmentation, or whether memory is also enhanced for information presented at boundaries in speech. In a within-subjects design, 12-month-old infants will be presented with separate blocks of action or speech stimuli while their eye movements across a screen are recorded. Action stimuli will consist of videos of human-produced actions (e.g., hands shaping objects out of clay), and speech stimuli will consist of sentences read in infant-directed speech accompanied by unrelated attention-grabbing videos (e.g., of floating bubbles). In both conditions, probe images (novel objects) will be briefly superimposed onto the video. The probe image will appear either at the end of an action or clause (action / speech boundary-position) or during an action or clause (action / speech no-boundary-position). We will then present an adapted Visual Paired Comparison (VPC) task (Fantz, 1964; Fagan, 1976) to test whether memory for the probe images is enhanced in the boundary-position condition: The probe image will be presented next to an image of an unfamiliarized image of a novel object for a duration of 5 s. We would expect enhanced recognition memory for the probe image to lead to differences in mean proportion looking time to the probe vs. the unfamiliarized image. Due to inconclusive previous data, we cannot predict whether enhanced memory would be indicated by a novelty preference (and thus longer looking to the unfamiliarized image) or familiarity preference (and thus longer looking to the probe image; e.g., Mather, 2013). Mean proportion target looking time will be analyzed via Linear Mixed Effects Models (LMEMs), with fixed effects of domain (two levels: action, speech) and condition (two levels: probe at boundary-position, probe at no-boundary-position), and

random by-participant and by-item intercepts and slopes, simplified until convergence (Barr et al., 2013). If recognition memory for stimuli presented at action or clause boundaries is enhanced domain-generally, we would expect a significant fixed effect of condition on infants' looking behavior, meaning that the position of the probe image modulated infants' recognition memory of it. If, however, the effect is specific to action boundaries, we would expect an interaction between domain and condition. Beyond further disentangling potential interrelations between action and speech segmentation during infancy, this study will help us better understand whether 12-month-old infants' sensitivity to boundary positions in action and speech affects memory processing.

P3-G-491 - Infants? reward and punishment in response to moral transgressions and social convention violations (Whiteman)

Jesse Whiteman[1], Adarsh Vallurupalli[1], Christine D'Souza[1], Jessica Sommerville[1]

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Infants expect fair resource distributions (Schmidt & Sommerville, 2011), prefer to interact with fair distributors (Burns & Sommerville, 2014) and evaluate others using their fair and unfair distributions (Lucca et al., 2018). Yet until recently it was unknown whether infants would spontaneously reward and punish fair and unfair behavior, respectively. To address this question, Ziv et al. (2021) examined whether 16-monthold infants' use of reward and punishment in response to third-party resource distributions using a novel touch screen paradigm. After learning to touch one side of a touchscreen to produce reward (giving a cookie), and the other side of the screen to produce punishment (taking away a cookie), infants saw fair and unfair distributions produced by two different actors. On test, when just the actor's face appeared (one at a time), infants touched the reward side significantly more than the punishment side when shown the fair distributor but touched both sides equally when shown the unfair distributor, providing the earliest evidence infants can spontaneously intervene in sociomoral situations by rewarding positive actions. In a pilot study, we sought to replicate the findings of Ziv et al. using a tablet (Apple iPad), facilitating 'distanced' data collection (e.g., outdoors in parks) during the COVID-19 pandemic. Participants ages 12-48 months (n = 16) were taught to use the tablet by a trained experimenter, and then watched fair and unfair distribution videos, in the same manner as Ziv et al. (2021). The general trends were similar to Ziv et al (2021): on test, participants rewarded fair distributors (M = 5.93, SD = 5.67) more than they punished them (M = 4.20 SD = 4.95), but reward (M = 7.60, SD = 8.99) and punishment (M = 7.27, SD = 8.17) of unfair distributors differed less. These results suggest the findings of Ziv et al (2021) likely generalize to a. tablet-based devices, and b. naturalistic settings. We next plan to conduct a pre-registered replication and extension of these findings, examining infants' reward and punishment behaviors in response to both moral norms (fair/ unfair behavior) and social conventions (labeling behavior); infants intervening with reward or punishment only in response to moral norms would be evidence of a uniquely moral sensitivity. To address this question, infants ages 15 months 0 days to 17 months 0 days (n = 32 per condition) will be randomly assigned to a moral norm condition, in which a central actor distribute cookies fairly (norm adherence) or unfairly (norm violation), or the social convention condition, in which the actor places cookies on a table, saying with each placement either "cookie" (convention adherence) or "duck" (convention violation). Then reward and punishment touches to actors' faces will be recorded. Data will be analyzed with a Poisson log-linear Generalized Estimating Equation (GEE) analysis on infants' touches with condition (moral norm/social convention) as a between-subjects factor and distributor (adhere/violate) and Intervention Type

(reward/punishment) as within-subjects factors. We predict infants will reward fair distributors but not punish unfair distributors, and not differ in reward or punishment of social convention violation or adherence. This work will contribute to our knowledge of early sociomoral development, clarifying the scope of infant reward and punishment interventions by locating them within the domain of morality or of convention.

P3-G-492 - Toddler Perspective Taking During Video Chat Interactions (Neer)

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Video chat is a great way for families to maintain connections with remote family and friends. In addition, the on-screen interactions through video chat allow children to practice perspective taking from a young age. Prior work has shown that caregivers (i.e., co-viewers) help young children navigate video chat interactions through language and gesture (McClure et al., 2017; McClure et al., 2018; Barr et al., 2020). Within a video chat context, parents scaffold children's perspective-taking behavior in these video chat contexts with orienting language (e.g., orienting the child to the screen, describing the limited view of the on-screen partner). More generally, parents' mental state language supports later Theory of Mind development (Ruffman et al., 2002) and children's perspective-taking abilities are related to Theory of Mind development (Kloo et al., 2021), suggesting a relationship between parental mental state language, parental orienting language and toddler's perspective-taking abilities. This study examines the relationship between caregivers' mental state language and caregivers' orienting language on two-year-olds' perspective-taking abilities in the video chat context. In this recorded Zoom study, children and their parents will complete three tasks. In the first task, parents will read a wordless book to their child (Kuriyan, 2021). In the second task, children and the experimenter (i.e., the on-screen partner) will engage in a show-and-tell task in which children will show their favorite toy to the experimenter and the experimenter shares a toy with the child. In the final task, the experimenter will test children's Level 1 perspective-taking abilities by showing the child a two-sided card with a dog on one side and a cat on the other side (Flavell et al., 1981). The card is flipped multiple times and the child is asked to state what they see and what the experimenter sees with each card flip. Trained research assistants will code for caregiver mental state language in the book-reading task, caregiver orienting language and gesture, and children's perspective-taking behavior in the second task and score the perspective-taking measure in the third task. We hypothesize that a greater presence of mental state language will predict perspective taking in the video chat experience, based on research indicating that parental mental state language supports later development of Theory of Mind. Additionally, we hypothesize that parental orienting language and gesture will influence perspective-taking behavior. Lastly, we hypothesize that higher standardized perspective-taking scores will predict toddler perspective taking in the show-and-tell task. Planned analyses will include a hierarchical linear regression. A statistical power analysis was performed for sample size estimation. The projected sample size needed with an effect size of .15 (WebPower; Zhang & Yuan, 2018) for a model with three predictors is approximately 76 two-year-olds and their primary caregivers ($\alpha = .05$, power = .80). Demographic information and video chat experiences collected from the pre-study survey will also be analyzed. This study will highlight caregivers' important role as co-viewers in their children's developing understanding of video chat interactions and developing perspective-taking abilities. Future

research should examine the effect of video chat interactions on the development of children's emerging perspective-taking abilities.

P3-G-493 - Interruptions in Mother-Child Interactions: Does Maternal Smartphone Use Prevent Children's Word Learning from Their Mothers? (Kessafoglu)

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When using their mobile phones, parents experience interruptions in their interactions with their children and are less likely to be responsive, initiate interactions, and share attention with their young children compared to when they are not using their phones (e.g., Hiniker et al., 2015; McDaniel & Radesky, 2018). Interruptions caused by parental use of mobile technology may negatively affect children's vocabulary development, given that both timely and contingent responses and engaging in shared attention foster children's early word learning (e.g., Tamis-LeMonda et al., 2014; Tomasello & Farrar, 1986). Reed et al. (2017) showed that 2-year-olds display problems in learning novel words if the mothers' teaching of novel words is interrupted by a phone call to the mother compared to an uninterrupted teaching period. However, there is yet no study investigating the effects of interruptions coming from non-technological sources, such as the parent talking to another person. Compared to these types of interruptions, technological interruptions may be more detrimental to children's word learning, given the distractive nature of mobile technologies. This proposed study aims to investigate whether a technology-based interruption is more disruptive for young children's novel word learning compared to a non-technology-based interruption. Seventy-two 24- to 30-month-old Turkish-speaking children and their mothers will participate in a within-subjects experiment. In each of the three conditions, mothers will be asked to teach a novel word (e.g., nuk as a variation on bouncing) to their children by demonstrating it on a puppet. In the technology-based interruption condition, the teaching period will be interrupted by a phone message linking to a short questionnaire for the mothers to fill out on their phones. In the non-technology-based interruption condition, the teaching period will be interrupted by instructing mothers to fill out a similar survey on paper. Finally, in the no interruption condition, the teaching period will not be interrupted (see Figure 1). Children's learning of novel words will be measured with a comprehension test. In each of the 12 trials, two videos will be presented simultaneously. Children will be asked to point to the correct video in response to the following question: "Which one is VERB-ing?" (see Table 1 for the test items). Based on the findings of observational studies showing reduced parental responsiveness and shared attention between parents and children during parental mobile phone use, we expect children to demonstrate better learning (1) in the no interruption condition compared to the other conditions with an interruption and (2) in the non-technology-based interruption condition compared to the technology-based interruption condition. To test our hypotheses, children's responses on the comprehension test will be analyzed via mixed-effects logistic regression. Children's binary responses will be used as the outcome variable, and the experimental condition will be used as a predictor variable. The number of times the mothers utter the target word will be another predictor to control for the word frequency in maternal input. The findings of the proposed study will provide insights into how children's word learning is affected by daily parental activities that impact parent-child interactions.

P3-G-494 - Do toddlers preferentially transmit generalisable information? (Karadag)

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Children actively and selectively transmit information to others based on the type of information and the context during learning. Four- to 7-year-old children preferentially transmit generalisable information in teaching-like contexts. Although 2-year-old children are able to distinguish between generalisable and non-generalisable information, it is not known whether they likewise transmit generalisable information selectively. We designed a behavioural study to address this question. Two-year-old children (pre-registered n = 44) will be presented with three novel boxes, identical except their colour. In each box, one of two equally salient actions will lead to a generalisable outcome (e.g., playing a (different) tune in each box), whereas the other will lead to a non-generalisable outcome (e.g., turning on a light, vibrating the box, or making a noise). In a discovery phase, children will have a chance to discover the functions of each box presented one-by-one. Then, in an exploration phase, they will be given the opportunity to independently explore all three boxes presented together. Finally, in a transmission phase, an ignorant recipient will enter the room and ask the child to show them how these toys work. We will measure whether children will preferentially transmit either generalisable or non-generalisable information when they are asked to demonstrate the function of the toys to a naïve adult. A preference for generalisable information in transmission might be reflected in two ways. The first is that children might transmit generalisable information preferentially by choosing the generalisable function as the first to be transmitted to an ignorant adult ("initial preference" hypothesis). Additionally, they might transmit the generalisability of the information. To do that the child must transmit different instances of this information (e.g., the same-type button playing different tunes across boxes). We will evaluate this "systematic preference" hypothesis by investigating the second function that children show to the learner on a different box after showing a generalisable function (as the first function). The findings of this study will not only inform us about two-year-old children's selectivity in transmitting information but also about the development of sensitivity to information generalisability. This study is pre-registered on Open Science Framework, full details of the procedure and analysis plans can be found here: https://osf.io/aqtwr/?view_only=2d97601d25d34f62a0ec99681ad344bb.

Thematic Poster - ManyBabies: Present and Future (P3-G-495, P3-G-496, P3-G-497, P3-G-498)

P3-G-495 - ManyBabies: How we got here and where we are going (Baumgartner)

Heidi Baumgartner[1]

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ManyBabies (MB) is a collaborative network that brings researchers together to address difficult outstanding theoretical and methodological questions about the nature of early development and how it is studied. Since its conception in 2015, the MB consortium has grown to over 400 contributors from more than 200 institutions in 46 countries on six continents. This large and sustained effort has allowed developmental psychologists to pool their expertise, resources, and participant populations to collectively study infant development in a manner that is beyond the scope of individual labs or institutions.

MB has been at the forefront of encouraging principles of open science in developmental psychology. For example, most materials generated by MB projects (and ALL stimuli, data, and processing/analysis

code needed to replicate procedures and results) are posted on a public repository, and all projects are encouraged-and soon will be required-to have an approved registered report prior to data collection.

In the first MB project, 149 researchers from 20 countries collaborated to test 2,329 infants to replicate a robust finding in developmental psychology: infants' preference for infant-directed speech. In addition to confirming the existence of an IDS preference in infants, researchers conducted planned followup analyses to examine the effects of age, native language, and procedure on the strength of the effect, comparisons that were possible only due to the scope of the project. This project not only added to our scientific understanding of infants' preference for IDS, but it also served as an important "proof of concept" for the idea that developmental researchers from around the world can come together to conceptualize, design, and execute a project using consensus-based decision making.

Following on the success of MB1, there are currently six ongoing main projects (four experimental, two methodological) and multiple spin-off projects in various stages of progress (design, data collection, analysis, and/or manuscript preparation). Three projects have registered reports approved or under consideration, and an additional two registered reports are in preparation.

With the feasibility of the MB model successfully demonstrated, MB is now turning its attention toward matters of sustainability, inclusivity, and impact. With regards to sustainability, the leadership of MB is working to further develop the policies and infrastructure that will allow projects to thrive, while still respecting the intentionally de-centralized and non-hierarchical structure of the consortium. For example, we are working to improve documentation around collaboration agreements and authorship, so that the commitments that contributors make to a project and each other are clear and transparent. We are also working to improve data sharing and validation systems to maximize the efficiency of projects' workflows, so that contributors can focus on the scientific rather than logistical aspects of participating in a large-team collaboration. Finally, we are building relationships with other big team science groups and organizations (e.g., Psychological Science Accelerator, ManyPrimates, ManyDogs) in order to proactively think about the ways in which we can learn from each other and work together to improve the impact and diversity of large-scale collaborations across behavioral science disciplines.

P3-G-496 - ManyBabies Demographics: A tool for capturing sociodemographic variation in infant research (Singh)

Leher Singh[1], Mihaela D. Barokova[2], Michael C. Frank [3], Diana C. Lopera-Perez[4], Paul Okyere Omane[5], Mark Sheskin[6], Melanie Soderstrom[7], Yang Wu[3], Francis Yuen[8]

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Reporting sociodemographic data is critical for situating research findings within their cultural context and for our ability to evaluate generalizability of research findings. However, sociodemographic information is notably absent in a large proportion of current infant studies. An analysis of all empirical papers sampling typically-developing infants, published in Child Development, Developmental

Psychology, Developmental Science, and Infancy between 2011 and 2020 (N = 1383 papers), revealed significant under-reporting of basic sociodemographic information (Singh, Cristia, Karasik, & Oakes, 2021). Over the decade, race/ethnicity was not reported for 73% of participants, location was not stated for 45% of studies, and socio-economic status (SES) was not reported for 55% of studies.

With the growing recognition of the importance of reporting demographic variation, some journals have begun to require the provision of sociodemographic data (e.g., Roisman, 2021). One barrier to reporting sociodemographic data is the lack of a standard tool to capture this information across diverse settings. As a direct consequence, it is difficult to interpret cross-cultural differences in our data without knowing how data are influenced by the sociocultural environment. In this presentation, we introduce the ManyBabies Demographics Questionnaire, which aims to provide early development researchers with a common instrument to collect sociodemographic data about their participants in a standardized manner across studies and populations.

To develop the questionnaire, participation was solicited through an open call for interested researchers. Researchers chose one of six sociodemographic areas (biographical information, caregiver details, developmental concerns, language exposure, race and ethnicity, and SES). Working groups were then assembled to create individual questions within each area. In devising questions, three key considerations were prioritized: construct validity (included items were supported by evidence that they were valid indicators of the underlying sociodemographic construct), inclusivity and global relevance (items were designed to be globally relevant across sociocultural contexts), and comparability (ensuring that items can be meaningfully compared across different studies and countries/communities).

The first section of the questionnaire focuses on biographical data, asking about current age, gestational age at birth, gender, and origins of participants and parents. The second section asks about caregiver identity, as well as regularity and hours of care. The third section asks about hearing and vision concerns, which are relevant to many infant tasks, as well as more general developmental concerns. The fourth section asks about the child's language environment and about specific input languages as well as the amount of exposure that participants have to each language. The fifth section asks about participants' racial and ethnic origins. The final section asks about socio-economic status, focusing on family income, parental education, and family composition.

In this presentation, we will present the Questionnaire as well as the rationale for individual items. We also plan to discuss challenges and key considerations in developing the questionnaire. Finally, we will discuss limitations, offering resources for extended tools for studies requiring more detailed sociodemographic analysis.

P3-G-497 - ManyBabies3 and 3-NIRS: Rule learning in infancy (Gervain)

Judit Gervain[1], Ingmar Visser[2], Andreea Geambasu[3], Claartje Levelt[3] Melanie Soderstrom[4]

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ManyBabies3 is a multi-site, large-scale collaborative project testing whether infants can form abstract rules from patterned (ABA vs ABB) syllable sequences and apply those rules to the same patterns consisting of new syllables. We are seeking to test the phenomenon reported in Marcus et al. (1999) across a wide age-range (5-12 mo) and different experimental paradigms (HPP, central fixation, eye-tracking). Novel stimuli were designed to be distinguishable for infants across a wide variety of linguistic

backgrounds. The Stage 1 Registered Report manuscript was submitted to Developmental Science in Summer 2021, and we are excited to provide an update on our plans for data collection. As of the writing of this abstract, 25+ labs signed up for an expected sample of 500+. Lab sign-ups are from 20 different countries, five continents, and many linguistic communities affording the opportunity to probe the generality of rule learning.

ManyBabies3-NIRS, a neuroimaging spin-off of MB3, also tests infants' ability to learn repetition-based regularities (specifically, ABB vs. ABC, replicating Gervain et al. 2008), but at the cerebral level. This project aims to assess the reproducibility and variability of infants' brain responses to repetition-based and random sequences using near-infrared spectroscopy (NIRS), a relatively recent brain imaging technique particularly well-suited for infant testing, but one for which hardware, data acquisition, and data analysis are only now beginning to be standardized. A replication study is thus very much needed. The project is currently in its preparatory stage. The paradigm and the stimuli have been discussed, established, and created. Channel localization and data pre-processing pipelines are currently being prepared. So far, 30 laboratories have signed up to participate in the project. We expect labs to contribute a full sample of 40 participants or a half sample of 20 participants in at least one age range. The age ranges currently span approximately 0-18 months. Data acquisition will likely not start before the end of 2022 or early 2023, also depending on the pandemic situation. We expect the project to shed light on the relative contribution to variation of a number of key factors in NIRS methodology (NIRS wavelength, headgear etc.) as well as on the brain areas that contribute to the extraction of abstract regularities at the neural level from birth onwards.

P3-G-498 - ManyBabies project updates: MB1 (Infant-directed speech preference) follow-ups and other projects (Schreiner)

Melanie Schreiner[1], Melanie Soderstrom[2]

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One of the ManyBabies spin-off projects set out to investigate the test-retest reliability of infants' preference of infant-directed speech (IDS) over adult-directed speech (Cooper & Aslin, 1990). Participating labs from MB1 brought in babies for a second appointment retesting infants on their IDS preference one to 49 days after the initial appointment, allowing us to estimate test-retest reliability. A total of 181 infants from seven labs participated in the study. To assess test-retest reliability, we conducted a multilevel analysis, with Lab as random intercept, predicting the IDS preference in Session 2 based on the IDS preference from Session 1. The results revealed that we could not predict infants' preference scores in Session 2 based on their preference scores in Session 1. Likewise, a Pearson correlation analysis suggested that there was no significant correlation between infants' preference in Session 1 and Session 2. While for these analyses infants needed to contribute a minimum of 2 out of 8 trial pairs, increasing this number to 8 trial pairs revealed a descriptive growth in test-retest reliability but also considerably reduced the study's effective sample size. Taken together, the current follow-on study suggests that the test-retest reliability of infants' speech preference measures is rather low, and the interpretation of findings needs to be treated with caution.

Another MB1 spin-off project sought to investigate whether infants' preference for IDS was predictive of later vocabulary size as measured by the CDI. Initial planned analyses found no evidence of IDS preference as measured in ManyBabies1 predicting. Results of a larger exploratory analysis with 21

laboratories across 9 languages/dialects are expected by Spring 2022. These findings will be discussed in light of the low reliability of the IDS preference measure reported in MB1-Test-Retest.

We will also provide brief updates on the other main ManyBabies projects: MB-Africa, an extension of the design of MB1 to 11 laboratories in Africa; MB2, Theory of Mind in infancy; MB4, social evaluation; MB5, an examination of the Hunter & Ames model of infant looking preference; and MB-AtHome, a methodological project to develop a global framework for online testing.

P3-G-500 - Developing an online mirror rouge test of self-recognition in infants (Cousins)

Alice Cousins[1], Roger Newport[2], Danielle Ropar[3], Andrew Bremner[1]

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The mirror rouge test is the most well-established measure of self-recognition in infants, requiring an infant to sit in front of a mirror after a red mark has been placed on their forehead. If they reach for their own forehead after seeing their reflection (referred to as mark-directed behaviour) this is taken to indicate that they recognise their own mirror image. While some have questioned the validity of the mirror rouge test, others have argued that it represents the first and best test of the emergence of conceptual self-awareness. Self-recognition in the mirror rouge test is correlated with a wide range of other skills in development including memory, empathy, pretend play, and use of symbols. It is also an important tool in understanding the nature of impairments in self-awareness in a number of neurodevelopmental conditions and disorders. In this poster we present the findings of a new online mirror rouge test, which we developed and piloted during the Covid-19 pandemic whilst in-person testing was curtailed in our lab. The online mirror rouge test scenario was achieved by presenting marks virtually via video filters applied to moving images of the infant during live videocalls. Researchers have argued that other behavioural clues to self-recognition and self-awareness are seen prior to 18 months of age, such as preference. To investigate this, we also decided to gather measures of infants' visual preferences for self vs other in the context of a paired on screen presentation of the infant's own live behaviour with that of the experimenter. We also compared mark-directed behaviour towards their own faces and hands. In the study, infants were first presented with a familiarisation period, in which the experimenter encouraged the infant to look at the screen while the infant's body part involved in the upcoming trial was visible (i.e., the hands or face). This was followed by a test trial in which the video filter was applied yielding a dynamically moving red dot on the on-screen image of the infant's forehead or hand. We measured infants' preference for looking at themselves versus the experimenter during the familiarisation period, and whether they passed or failed the mark test in each condition. So far, we have gathered data from 13 infants (15-26 months, 9 female). Six infants showed mark-directed behaviour indicating the proof of concept, that it is possible to measure self-awareness in an online mirror rouge test. Infants also, as a group, looked significantly longer at the experimenter than themselves in the hand condition (see Figure 1; the difference in "other preference" between the hand and face conditions approached significance). With further data collection we anticipate measuring the strength of association and developmental relationships between the degree of "other preference" and mark-directed behaviour in an online context. These data will help establish more efficient means of gathering data concerning self-awareness from individual infants without the necessity of experimenters or infants travelling between home and research labs.

P3-H-501 - Audiovisual synchrony processing in infants at low and high risk for ASD and adults: Evidence from functional brain network analysis (Polver)

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The emergence of social adaptation mechanisms derives from the interaction between early-emerging predispositions to orient to social stimuli and learning processes that guide the infant to bond to the environment (Klin et al., 2015). However, dysfunctions in the mechanisms that bias infants to attend socially relevant stimuli, as those found in infants later diagnosed with Autism Spectrum Disorder (ASD), may disrupt the typical trajectory that leads to the adult social brain network (Blasi et al., 2015). For example, ASD infants present a reflexive orientation to social cues, not affected by learning mechanisms, that persists beyond its appropriate time window, and this non adaptive persistence may result from considering stimuli as a composite of physical contingencies, affecting the processing of social components (Klin et al., 2015). The overall aim of the project is to investigate audiovisual synchrony processing in 9-months-old infants at high likelihood of developing ASD by virtue of having a diagnosed sibling (HL-ASD infants). To this end, HL-ASD infants will be compared with a control group of 9-month-old typically developing (TD) infants and with a group of healthy adults, as we wanted to better characterise network configurations across development. Since audiovisual percepts are characterized by a tight relation between physical and social contingencies, we can investigate impairments in social processing, due to disproportional salience attributed to environmental physical contingencies. As we were interested in how the brain functional architecture would change in relation to these dysfunctions, we referred to graph theory (Bullmore et al., 2009). Here we present preliminary data on healthy adults (N = 13), as our data collection on HL-ASD (N = 3) and TD infants (N = 1) has been delayed due to the Covid-19 pandemic. Analysis with healthy adults provides preliminary evidence regarding time-varying functional connectivity in response to synchronous and asynchronous excerpts. Adults were presented with asynchronous or synchronous social (crying and laughing) and non-social (coughing) audiovisual recordings. From EEG data we extracted the instantaneous phase, every 5 ms, between each pair of electrodes. On such data we computed the Phase Locking Value, a measure indexing the phase alignment between two signals. We then computed Minimum Spanning Trees (MST) for each time point. On trees we computed the eigenvector centrality, a measure identifying nets of highly interconnected nodes. We then applied the cluster-based statistic. The same analysis will be run on our infant samples. These preliminary results with adults reveal the presence of a significant increased activity during asynchronous compared to synchronous stimuli in the alpha band ($t_{sum} = -36.8$, $p < .05$) (Figure 1). This result is in line with the role of the alpha band in social processes and in the integration on complex information (Mantini et al., 2007). Despite the small sample size, these data provide evidence for the reliability of our task and measures, and for their applicability in TD and HL-ASD infants, for whom data collection is ongoing.

P3-H-502 - Contribution of body movements to the reading of emotional expression in infants: an eye tracking study (Jover)

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Studies on parental understanding of infant emotion have demonstrated that adults interpret or respond adequately to vocal signals (Papou?ek, 1989) and facial expressions (Arteche et al., 2016). The role played by the infants' body movements is less clear-cut. Using edited videos, Irwin (2003) showed that adults correctly rated 3 to 12 months-old-infant distress using facial and acoustic signals but failed to do it using body movements. Jover et al. (submitted) asked mothers to determine the mood of 4-months-old infants and obtained much more unanimous responses when the stimuli were faces or sounds than when they were body movements. However, the mothers coincided a few times in their interpretation of the infant's mood based on the body movements. Considering the multimodal nature of emotion expression, body movement contribution might happen in ambiguous circumstances. The present study aimed at examining the visual exploration of infants in adults trying to rate their mood. The EMO-MOVE task consists in rating 20-second-long videos of 4-month-old infants filmed in a positive or a negative mood. Stimuli were edited in order to provide facial and body cues (FAC-MOV condition), vocal and body cues (VOC-MOV condition), or body cues only (MOV condition). The ECO condition was the original film. Twenty-two women (mean age 22.2 y), nonparent, were successively presented with 3 randomized videos in each of the conditions while their eye movements were recorded with a Tobii Pro Fusion 120Hz eye-tracker. The participant had to watch the video and rate the valence (positive/negative) and the intensity (analogical visual scale) of the infant's emotion. Four Areas of Interest (AOI) were considered for analysis: infant Head, Torso, Legs, and Arms (Fig. 1). The number and summed duration of fixations in each AOI, or for all AOIs together, were compared between conditions using Mixed Models, and post hoc comparisons with Bonferroni correction were applied. Results showed that the MOV condition was the most ambiguous condition as the infant's mood was never rated at a higher rate than chance. The rating of the emotion intensity was lower in the MOV condition than in all the other conditions ($p<.001$). The total number of fixations was higher, and the total duration of fixations in the AOIs was lower in the VOC-MOV and MOV condition, when the infant's face was invisible, as compared to the FAC-MOV and ECO conditions ($p<.001$). When considering each AOIs separately (Fig.2), the effect of condition was obvious for the Head, Torso, Arms, and Legs, for both the number and duration of fixation ($p<.001$). The post-hoc comparison didn't show any difference between the FAC-MOV and ECO conditions. However, the difference between VOC-MOV and MOV was significant for the Arms both for the number and the duration of fixations ($p<.001$). In conclusion, the face constituted a fundamental cue to identify the infant's emotion, with or without vocal cue. When the face wasn't available, the participant focused mainly on the torso. The arms appeared to be considered as a potential mean to understand the infant's emotional state only when vocal and facial cues were not available. This study is the first one to investigate the visual exploration of infants in identifying their emotional state.

P3-H-503 - Associations between fine motor skills and social communication skills in infants who are later diagnosed with autism (Ueno)

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Introduction: Autism spectrum disorder (ASD) is a neurodevelopmental condition with core features including deficits in social communication and social interaction and the presence of restricted, repetitive behaviors. Early fine motor skills are positively associated with later language skills in children with ASD (Choi et al., 2018; LeBarton & Iverson, 2013). Advances in motor skills provide infants with more opportunities to interact with the environment, which supports the development of communication skills (Iverson, 2010). The objective of the current study is to extend this previous work by examining associations between fine motor skills and social communication by investigating three research questions: 1) Is there a concurrent association between fine motor skills and social communication skills at 12 months, 2) Is there a concurrent association of fine motor skills and social communication skills at 24 months, and 3) Is there an association between fine motor skills at 12 months and social communication skills at 24 months? Methods: Participant's data (N=91) were drawn from the Infant Brain Imaging Study, a longitudinal study following infants who either have an older sibling with ASD or have no family history of ASD. All participants included in this study met the clinical diagnostic criteria for ASD at 24 months and completed Communication and Symbolic Behavior Scales (CSBS) and Mullen Scales of Early Learning (MSEL) at 12 and/or 24 months (Table 1). CSBS is a standardized assessment that measures social communication abilities for children 8 to 24 months of age. In this study, CSBS composite scores (Social, Speech, Symbolic) and total score were extracted. Participant's data were analyzed using Generalized Linear Models (GLM). MSEL fine motor scores at each time point were entered into models as an independent variable. CSBS composite score and total scores at each time point were entered as dependent variables. Covariates included MSEL visual receptive scores at 24 months, age, sex of the infant, testing site, and maternal education. MSEL visual receptive scores at 24 months were included to see how much variance in social communication skill is accounted for by fine motor skills above and beyond visual reception. Four tests were conducted per aim (CSBS Total, Social Composite, Speech Composite, Symbolic Composite) using a Bonferroni adjusted alpha level of .0125 (.05/4). Results: Results indicated a significant association between MSEL fine motor skills at 12 months and CSBS Symbolic Composite score at 12 months ($F(1, 24)=7.81$, $p=0.01$, $\eta p2=0.25$) (Table 2). Infants with autism who had better fine motor skills at 12 months also had better symbolic skills at 12 months of age. The remaining models were not statistically significant. Discussion: Previous reports have found significant positive associations between fine motor and later language skills in infants at high familial risk for autism. The current study aimed to determine if this developmental cascade was specific to language or general to social communication. In a large sample of infants who developed autism we found that fine motor skills at 12 months of age were only positively, and concurrently, associated with symbolic skills.

P3-H-504 - The moderating effect of inhibitory control on the association between authoritarian parenting and prosocial behaviors (Gray)

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Prosocial behavior is related to positive outcomes across childhood and adolescence, including higher academic achievement (Blake et al., 2015), less peer rejection (Di Giunta et al., 2018), and lower aggression (Krahé & Möller, 2011). Parents play an important role in socializing children's prosocial behavior, beginning in infancy (Brownell, 2016), but the effects of particular parenting behaviors like parental control are mixed. For instance, a meta-analysis found that authoritarian parenting was

negatively associated with prosocial behaviors in children and adolescents (Wong et al., 2020). In contrast, high maternal protective behavior in toddlerhood predicted caring behaviors in children in preschool (Hastings et al., 2005). There are two possibilities from these different findings. First, the type of parental control could matter. Second, parents' responses to children's needs are critical, suggesting that in infancy and early childhood, greater parental control may be beneficial. In addition, infant characteristics also predict prosocial behavior. Infants' regulation (e.g., inhibitory control) positively predicted their prosocial behavior in early childhood (Berthelsen & Williams, 2013). To our knowledge, no work has examined how inhibitory control and parental control interact to predict prosocial behavior. This project examined the moderating effect of toddlers' inhibitory control on the link between authoritarian parenting at age 2 and prosocial behavior at age 5. Infants (N = 193, 47% female, Mage = 24.64 months) were recruited as part of a longitudinal study on child temperament. Parents reported on their authoritarian parenting (Parenting Practices Questionnaire; Robinson et al., 1995; α = .82) and their infant's inhibitory control (Toddler Behavior Assessment Questionnaire; Goldsmith, 1996; α = .81) at age 2, and their children's prosocial behavior (McArthur Health Behavior Questionnaire; Armstrong et al., 2003; α = .87) at age 5. Children also completed a free play episode at age 5 with a peer in the laboratory, and we coded their prosocial behaviors. Linear regression revealed a significant interaction of authoritarian parenting with inhibitory control at age 2 in predicting parent-reported prosocial behavior at age 5 (ß = -0.49, t(78) = -2.84, p = 0.006). When inhibitory control was low (-1SD), authoritarian parenting was positively related to prosocial behavior; when inhibitory control was high (+1SD), there was no association between authoritarian parenting and child prosocial behavior (see Figure 1). Authoritarian parenting was positively associated with prosocial behaviors (ß = 2.11, t(78) = 2.92, p = 0.005), as was inhibitory control (ß = 1.04, t(78) = 3.36, p = 0.001). Further analyses will examine whether these associations hold true with observed prosocial behavior at age 5. Parental control may be beneficial for helping children develop prosocial behaviors when parents perceive that their infants lack inhibitory control. This research follows prior work indicating that parenting that responds appropriately to children's needs may be beneficial for future outcomes (Gallagher, 2002). Future research should leverage observations of parent-infant interactions to better understand the bidirectional relations between parenting and infants' regulation and the effects of this relationship on infants' socioemotional development.

P3-H-505 - The Role of Parenting in the Relation between Infant Temperament and Toddler Socialization (Ermanni)

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Children's adaptive social functioning, including positive interactions and communication with peers, is critical to the development of later socioemotional outcomes, school readiness, and academic achievement (Keane & Calkins, 2004; Burt et al., 2008). Early adaptive socialization, and later social competence, includes skills like joint intentionality in social play, regulating impulsivity when taking turns, and managing conflict (Huber et al., 2019). Given its stability over the first three years once established, understanding the foundational intrinsic and extrinsic factors that impact social competence development is critical (Huber et al., 2019). Temperamentally surgent children can be socially competent and outgoing but can also be at risk for externalizing behaviors (Kochanska & Radke-Yarrow, 1992; Behrendt et al., 2020). Early maternal sensitivity may act to socialize infant surgent traits

(Calkins & Hill, 2007), providing strategies for adaptive socialization. This study assessed the moderating role of maternal sensitivity on the relation between infant surgency and toddler socialization skills. Data from 216 infants (50.3% female) was utilized at 10- and 24-months of age. Prior to their 10-month visit, mothers provided information on their infant's temperament via the Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003). This analysis uses the Surgency/Extraversion factor. During the visit, infants and their mothers participated in an interaction task where mothers were instructed to play with toys with their infant for 2-minutes. "Facilitates attention" and "maternal positive affect" was coded for in 30-second epochs. The two variables were centered and averaged to create one maternal sensitivity composite score. Prior to their 24-month visit, mothers reported on their toddler's socialization skills via the Vineland Adaptive Behavior Scales-II (Sparrow & Cicchetti, 1985). The questionnaire reports on four domains of social behavior. Raw scores from the socialization domain (interpersonal relations, play and leisure time, coping skills) are utilized. In a regression analysis, 10-month surgency was entered as a predictor of 24-month socialization, and 10-month maternal sensitivity was added as a moderating variable. Child sex was entered as a covariate. The described model was significant ($R2 = .11$, $F[4, 211] = 6.67$, $p = .00$), as was the interaction between infant surgency and maternal sensitivity ($p = .01$, $b = -22.72$; see Table 1). A main effect of surgency was also found ($p = .00$, $b = 15.5$). Simple slopes analysis at +/- one SD revealed that infants with greater surgency predicted more socialization skills at 24-months only for those who experienced low maternal sensitivity ($b = 19.49$, $p = .00$). There was no association between surgency and high levels of maternal sensitivity. Infant surgency was found to predict greater toddler socialization. When maternal sensitivity was added to the model, only for infants who experienced low maternal sensitivity did surgency predict greater socialization. It's possible that surgent infants do not require excessive maternal support, and this independence allows infants to naturally learn socialization strategies through their temperament. Despite the significant interaction, only a small amount of variance was observed, suggesting that other infant factors, such as emotion regulation or effortful control, may play a larger role.

P3-H-506 - Long term effects of early attachment on mentalizing capacity in early adulthood. (Sirparanta)

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Attachment security in infancy is believed to foster the development of individuals' ability to conceive one's own and other's mental states. Although links have been found between children and adults' mentalizing abilities, it remains unclear whether the capacity to mentalize is actually explained by early attachment when concurrent attachment is controlled for. This study seeks to examine the relationship between attachment security to the mother in early childhood and the capacity to mentalize in young adulthood, while controlling for concurrent attachment security to each parent in adulthood. Attachment security was assessed in 32 participants at ages 4 and 23 years using the Attachment Q-Sort and the Attachment Multiple Model Interview respectively. The attachment interviews were coded using the Reflective Functioning Scale to assess quality of mentalizing. Results show that security to the mother at age 4 is associated with mentalizing in adulthood. Furthermore, they reveal a significant interaction between attachment to the mother and attachment to the father in adulthood. By demonstrating not only concurrent but also longitudinal links between attachment security and

mentalizing, these findings emphasize the importance of early attachment security in the capacity to understand mental states beyond childhood.

P3-H-507 - Demographic Shifts in Primary Caregiver Gender (Jenson)

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Traditionally women take on more caregiving roles in the household, consistent with the nuclear family model. Women, in recent memory, have been an equal part of the paid labor market, but overrepresent in unpaid work (Baxter et al, 2008). However recent trends indicate that unpaid labor is moving away from one single woman doing a majority to more split between other members of a household. Changing household dynamics also play a role in this. Dividing unpaid work more evenly can prevent chronic stress and related illnesses (McMunn et al. 2017 & Lacey et al. 2017), increase satisfaction with relationships and lifestyle (Luecken et al., 2013), and improve understanding within the household (Lidbeck & Boström, 2020). With more equitable division of labor, it is possible that both mental and physical health can improve for women and therefore positively affect the rest of the household. The present investigation examined shifts in the gender(s) of 3.5-month-old infants' primary caregiver(s) by comparing demographic information for families who participated in studies at the University of Kentucky Infant Memory Lab in Lexington, Kentucky in 2010 and 2018. The majority of families who participated were married heterosexual couples, and the most common caregiver structures in both years was one female serving as the primary caregiver (most often the mother; 88% in 2010, 59% in 2018) and one male and one female both serving as a primary caregiver (most often the mother and father; 12% in 2010, 33% in 2018). Other caregiver structures emerged in 2018 (e.g., multiple related female primary caregivers and single male primary caregiver), however, not at a rate to allow robust analyses. Comparing the two most common family types (female primary caregiver only versus pair of female and male primary caregivers) revealed a significant shift toward the latter over the time period examined (X^2 (1, N=177)=11.71, $p < .001$). This finding suggests that even within the relatively short time period examined, the distribution of parenting labor for young infants is reported by parents to be shifting toward more egalitarian within heterosexual married couples. Future work should examine how such a shift could impact outcomes for both infants and parents.

P3-H-508 - Infants' affiliation expectations between third parties based on infant-directed communication: Insights from an online study (Oguz)

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Infant-directed speech seems to function as a social cue available to infants that drives their attention and social preferences (Cooper& Aslin, 1990; ManyBabies Consortium, 2020; Schachner & Hannon, 2011). This study adds online data to our pre-covid laboratory study and explores whether infants expect an adult who communicates with a baby using IDS to be favored over another adult who communicates with the baby using ADS. Infants aged 14 to 17 months (n=15) observed the baby crying in the two familiarization trials. The baby was then communicated with by one of the adults in Turkish IDS and the other in Turkish ADS. During the test, infants witnessed two types of events in succession: congruent events (i.e., the baby approached the adult who had previously used IDS) and incongruent

events (i.e., the baby approached the adult who previously used ADS). These events were presented to infants in alternation across three blocks. Infants watched experimental stimuli created on Pyhab via a "watch party" website (https://w2g.tv). The participant's parent was asked to open the watch party link in a web browser and make it full screen, so the infant would only see the stimuli, and then have the infant seated on their lap or a highchair located opposite to the Zoom webcam. During the session, infants' looking times were coded simultaneously with Pyhab (Kominsky, 2019). Pyhab enabled us to carry out a gaze-contingent, moderated online looking time study. According to the findings of our in-lab study, infants aged 14 to 17 months (n = 10) demonstrated a rising tendency in their preference for incongruent over congruent events: Their looking times did not differ in the first two blocks (ps >.2), but in the third block, they paid greater attention to incongruent events than congruent events ($t(9) = 2.33$; $p = .045$). We expected infants to exhibit a similar tendency regardless of the experiment type (laboratory-based vs online). We submitted the log-transformed fixation times (Csibra et al., 2016) to a mixed ANOVA with Block and Congruency as the within-subjects variables and Experiment type (laboratory-based vs. online) as the between-subjects variable. The results revealed a significant Block effect ($F(2, 23) = 9.17$, $p < .001$) as in the lab study alone ($F(2, 9) = 4.90$, $p < .05$). Further, an interaction between Block and Congruency was observed ($F(2, 23) = 3.29$, $p < .05$). During the third block, infants looked longer to incongruent events compared to congruent events ($t(24) = 2.55$; $p = .017$). A marginal experiment effect ($F(2, 23) = 3.61$, $p = .07$) emerged since infants in the online experiment watched stimuli videos more in general. In conclusion, our findings suggest that IDS allow infants to infer recipient-appropriate speech registration of whom used it in a third-party context. Moreover, a similar trend between our online and laboratory-based experiments significantly contributes to the reliability of online looking time paradigms.

P3-H-509 - It's not you, babe, it's me: Examining child and parent impacts on maternal attachment during the first year of infancy (Davis)

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Attachment research has traditionally focused on how children attach to their parents (Bell & Ainsworth, 1972). Little is known about how parents attach to their children, particularly during infancy. This seemingly "innate" bond can be quickly challenged when in the face of a colicky newborn, as frequent crying can trigger excessive stress for the mother (Liu et al., 2019). However, the infant is not solely to blame; factors of the parent likely also contribute to parent-child attachment, including the quality of the couple's coparenting (Parfitt et al., 2014). The current study examined the extent to which infant and parent characteristics might jointly impact maternal attachment. Mothers (n= 209; 64 primiparous, 145 multiparous; Mage = 31.24 yrs, SDage = 4.56) of children who were less than one year old (113 male, 96 female infants; child: Mage= 6.35 mths, SDage = 3.54) participated in an online survey study examining the factors that impact parent-child attachment. Participants completed the Maternal Postnatal Attachment Questionnaire (Condon, 2015), and then the very short form of the Infant Behavior Questionnaire (Putnam et al., 2014), measuring the frequency of their child's surgency, negative affect, and effortful control. Parents then completed the Coparenting Relationship Scale (Feinberg & Kan, 2008), followed by the Parent Stress Index (Abidin, 1995), and the Karitane Parenting Confidence scale (Črnčec et al., 2008). First, a series of Pearson correlations showed that maternal

attachment was more strongly correlated with parent characteristics, particularly stress, compared to infant temperament (Table 1). Then, a hierarchical linear regression model was used to examine the impact that infant temperament (surgency, negative affect, and effortful control) and parental variables (i.e., stress, confidence, and coparenting quality) have on maternal attachment. Infant temperament was included in the first step of the model and was found to significantly predict maternal attachment, $F(3, 180) = 11.94$, $p < .001$, explaining 16.6% of the variance in maternal attachment scores. When examining individual temperament factors, effortful control and surgency were both positively related to maternal attachment (Table 2). Parental characteristics (stress, confidence, and coparenting) were included in the second step of the hierarchical model and explained an additional 35.2% of the variation in maternal attachment; this change in R2 was significant, $F(3, 177) = 43.09$, $p < .001$, and the overall model was also significant, $F(6, 177) = 31.70$, $p < .001$. The child's negative affect, the child's effortful control, and parenting confidence were all positively associated with maternal attachment. Parenting stress and coparenting quality were negatively associated with maternal attachment (Table 2). Current findings suggest that the significant predictor of maternal attachment was parent stress, even after controlling for infant temperament and other parenting factors. In addition, the infant's negative affect had no impact on maternal attachment until the parent factors were also considered, suggesting that the impact of infant crying on attachment is highly dependent on how the mother reacts to their infants' cry signal. Further research is needed to determine the sources of parental stress that impact the parent child bond.

P3-H-510 - Identification of neonatal imitators using latent class growth analysis (Zeng)

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Neonatal imitation--newborns' ability to match observed actions--is reported across behaviors and species (Ferrari et al., 2006; Meltzoff & Moore, 1989). Yet, not every infant imitates (Heimann et al., 1989; Paukner et al., 2011). Such individual differences are theorized to predict social development, as reported in macaques (Kaburu et al., 2016; Wooddell et al., 2019). While no associations between neonatal imitation and infants' later social cognitive skills have been detected in humans (Redshaw et al., 2020), these null results may be due to the methodology used (e.g., too many conditions presented sequentially, response periods too brief; Meltzoff et al., 2018, 2019). Therefore, it remains unknown whether human newborns' imitation may offer insights into their later social development. Here, we tested a new statistical approach to characterize individual differences in human neonatal imitation. We used a lab-based experimental paradigm that successfully elicited predictive neonatal imitation in monkeys (Simpson et al., 2014), and examined temporal patterns of newborns' responses during imitation testing. Temporal characteristics of newborns' responses may reveal individual differences in imitation that are not captured by average scores (Heimann & Tjus, 2019). We tested 76 healthy, full-term newborns (36 females) at 2 and 3 weeks of age for tongue-protrusion (TP) and mouth-opening (MO) imitation. At each visit, newborns observed two 3-minute conditions in which adults demonstrated TP and MO gestures respectively (Figure 1). Trained, condition-blind, observers (N=8; interrater agreement: TP ICC=.95; MO ICC=.92) counted newborns' TP and MO in each period and condition from videos. Gesture frequencies were averaged across coders for each gesture. Within each condition, we first subtracted the frequency of TP and MO at baseline-period from all periods. For each period, we then subtracted the non-matching control condition from the matching condition, generating two

temporal sequences of frequency difference, one for each gesture, for each newborn at each visit. Gesture rates above zero indicated imitation. We conducted latent class growth analysis (Jones et al., 2001) to classify these temporal sequences into different groups separately for TP and MO gestures. For TP (Figure 2A), 17% of newborns showed a significantly increasing pattern (TP-Group4: n=11) or an inverted-U pattern (TP-Group5: n=2) in at least one visit. Newborns with these temporal patterns were classified as TP imitators as they showed increasingly more TP gestures in TP condition over time than in MO condition--an increasing specificity of TP. For MO (Figure 2B), 20% of newborns showed a significantly increasing pattern (MO-Group4: n=15) in at least one visit; they were classified as MO imitators, showing more MO gestures in MO condition over time than in TP condition--an increasing specificity of MO. In addition, 72% of newborns showed a temporal pattern of MO greater than zero (MO-Group3: n=54) who were classified as weak MO imitators. Newborns with other temporal patterns--not greater than zero or decreasing--were classified as non-imitators. The current study is the first to explore the temporal characteristics of gesture patterns during human neonatal imitation testing using a data-driven approach to classify imitators. Future studies are needed to explore whether this new classification predicts social development in humans.

P3-H-512 - An exploratory investigation of the impact of COVID-19 on young infant development (Platt)

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Over the course of the last year, there has been a notable increase in maternal depression and anxiety, caused by additional stress and strain that has been placed on parents during the COVID-19 pandemic (Davenport et al., 2020). Further, parents have become increasingly concerned about the impact the pandemic may have had on their children. Preliminary studies have shown reduced verbal, motor, and cognitive skills in children born during the pandemic in comparison to children born pre-pandemic (Deoni et al., 2021). This study explored experiences of families with young children throughout the pandemic and compared development of infants in different daytime settings throughout the year (e.g., majority of time in daycare vs. majority of time at home). Infants younger than 6 months of age (n=20) were enrolled in a longitudinal study of infant development prior to March 2020. Every 3-6 months from 6-24 months of age, the Vineland Adaptive Behavior Scales was completed. In March 2021, parents completed a virtual questionnaire reporting, on a month-by-month basis, their infants' typical daytime setting (home vs. daycare) and exposure to peers and adults outside of the home. Parents also reported any concerns related to how the COVID-19 pandemic has impacted their child's development. Infants were separated into "home" and "daycare" groups based on their daytime setting for the majority of the year. Infants of parents who completed the questionnaire were between 17-31 months of age (M=24 months). Overall, 60% of families (n=12) spent all 11 of 11 reported months in the home setting compared to 40% (n=8) who split time between the home (M=3.29 months, SD=2.29) and daycare (M=7.71 months, SD=2.29) settings. Many families also reported that their infants displayed an increase in anxious behaviors post-pandemic (e.g., shy around strangers, clingy to caregiver in social situations; n=11). 73% (n=8) of infants with increased anxious behaviors were in a home daytime setting for 11 out of 11 months. Parents also indicated having concerns about their infant's development post-pandemic (n=10) compared to pre-pandemic (n=1), and many of these concerns were in domains of social development (n=9) and language (n=5). Trajectories of adaptive behavior (communication, socialization)

did not differ for infants in the home vs. daycare during the pandemic. This study explored the setting, behavior, and concerns of families with young infants during the COVID-19 pandemic in a group of infants already enrolled in a longitudinal study prior to March 2020. Many parents indicated that they had concerns about their infants' social and language development after the pandemic, which is an increase from prior to the pandemic. Contrary to our hypotheses, daytime context (home vs. daycare) did not affect infants' social or communication development. Due to the limited sample size of this study, future studies are necessary to continue exploring the effect that the pandemic has had on infant development. However, this exploratory study provides promising results that quarantine may not have a wide-reaching impact on infant communication skills.

P3-H-513 - Real-time teaching and learning: Mothers teaching infants to descend stairs (Waugh)

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Parents shape opportunities for motor skill acquisition and affect when and how infants learn new skills. Once infants become mobile, parents reevaluate the environment and decide how much of it infants can explore and where they can roam. For young, mobile infants, a staircase, previously inconsequential, becomes attractive yet potentially treacherous if not traversed properly. For parents, staircases in the home may be blocked off by gates, or present opportunities for teaching valuable motor skill. Parents specifically report teaching infants to descend backward in a crawling position, which is particularly challenging because infants face away from the goal (Berger et al., 2007; Berger et al., 2015). When descending slopes and steps in the lab, infants tend to plunge head-first and seldom heed mothers' distal instructions (Adolph et al., 2008; Karasik, et al., 2019). In the current study, we asked mothers to teach infants stair descent strategies at home while ensuring their safety. We examined the types of instructions mothers spontaneously generated and which type elicited the backing strategy in infants.

We recorded parents (N = 38, M = 30.20 years) teaching their infants (M = 13.52 months, M = 2.47 months of walking experience) to descend stairs for 10 minutes in their homes using video-conferencing technology. Researchers instructed parents how to set up smartphone or laptop cameras to capture staircases and parents' and infants' behaviors and recorded the session. Parent-infant behaviors were coded from video.

To examine the contingency between parents' teaching and infants' behavior on stairs, we computed odds ratios (ORs) to quantify the likelihood of co-occurrence. ORs lower than 1 indicate that one behavior is less likely to occur in the presence of the other, and ORs higher than 1 indicate that one behavior is more likely to occur in the presence of the other (Bakeman & Quera, 2011). A series of one-sample t-tests compared the average ORs for each behavior combination to an OR of 1 (chance). Results are reported in Table 1. Infants were more likely than chance to back downstairs while parents were verbally encouraging (OR = 3.03, $p < .01$) and while parents were adjusting infants' bodies (OR = 3.68, $p < .05$). But, infants were less likely to back down while parents were modeling a motor behavior (OR = 0.02, $p < .01$).

In natural, everyday settings, newly mobile infants are not alone when navigating and negotiating challenging and potentially risky physical settings of their environment. Parents are typically nearby offering verbal instruction and hands-on assistance as needed. Our findings show that parents tailor their instruction in real-time, relying on verbal information to shape and praise infants' behavior. At other times, parents go as far as modeling the desired behavior. Infants are responsive to parents' teaching particularly when parents offer hands-on assistance and encourage their efforts. But, infants do not seem to benefit from parental modeling perhaps needing to explore the extent of their own abilities to shift into a backing position and execute it successfully on stairs. Further analyses will examine sequences of parent-infant behaviors that predict the backing strategy.

Thematic Poster - New Directions in Face-to-Face Communication (P3-H-514, P3-H-515, P3-H-516)

P3-H-514 - Beyond the Familial: The Development of Emotional Communication with Mothers, Fathers, and Strangers (Salvadori)

Eliala A. Salvadori[1], Cristina Colonnesi[1], Linnea Elsammak[1], Frans J. Oort[1], Daniel S. Messinger[2]

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Preverbal social interactions are characterized by dynamic, multimodal face-to-face communication. Contextual factors, like the familiarity of the interaction partner, and individual predispositions, such as temperament, all contribute in shaping socio-emotional development. Prior research has described infant communication with mothers, and occasionally fathers, while less is known about infant communication patterns with unfamiliar partners. Yet interaction with strangers is a component of social life from infancy onward. Due to their novel nature, interactions with strangers may have the unique potential to elicit aspects of the infant communicative system that would normally remain hidden; hence they may predict later socio-emotional adjustments over and beyond infant-parent interactions. The present longitudinal study was designed to compare differences and similarities in the development of infant emotional communication with mothers, fathers, and strangers, while examining the contribution of temperament.

Fifty-eight families (25 baby girls; 87% Dutch origin) participated in the study at infant age 4 and 8 months (within a range of ± two weeks from the child's target ages). Infants were observed during three separate 2-minute face-to-face interactions at the family's home (with mother, father, and stranger). The order of the interaction partners was fully counterbalanced across families, within the infant gender. The observations were video-recorded using a high-definition 360° Samsung camera, mounted in between the infant and the adult to get a split-screen output displaying both interaction partners simultaneously. Infant communication behaviors were coded microanalytically with The Observer Video Analysis Software (Noldus) to characterize gaze direction and facial expressions (in duration) as well as vocalizations (frequency onset). Each parent reported on infant temperament (i.e., surgency and negative affectivity) at both ages. Overall, findings suggest that infant emotional communication patterns are modulated by individual temperamental differences, and are reproduced in and over time, though at different levels, when interacting with novel partners. Findings complement previous research on the development of infant communication with strangers, and provide new insights into interactions with fathers and the role of temperament in early social interactions.

P3-H-515 - Validating Automatic Facial Expression Analyses and Eye-Tracking Measures for Young Infants with Facial Expressions and Attention in the Face-to-Face/Still-Face (Zaharieva)

Martina Zaharieva[1], Eliala A. Salvadori[1], Daniel S. Messinger[2], Patrick Zimmerman[3], Hans Theuws[3], Roos Rodenburg[1], Ingmar Visser[1], Cristina Colonnesi[1]

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The way infants differ in employing the attention and emotion control mechanisms they acquire over the first year of life has been of primary interest to understanding, predicting, and even enhancing the developmental course of crucial later-life socio-cognitive outcomes such as executive functioning. Introducing automatic measures to study these processes can benefit immensely the reproducibility and replicability of infant research. We describe data from two studies evaluating the relation between automatically and manually derived measures from face-to-face and still-face interactions.

Study 1 compares the performance of an automatic system (Baby FaceReader 9; Noldus, 2021) to manual coding in a pre-existing longitudinal dataset for which the facial expression valence of 52 infants at 4 months (156 videos) and 43 infants at 8 months (129 videos) during a naturalistic face-to-face interaction with their mother, father, and an unfamiliar adult. The Area Under the Curve (AUC) from Signal Detection Theory is used to quantify the degree to which the automatic system distinguishes between manually coded valence categories for each video. The automatic system distinguished beyond chance-level both positive facial expressions from negative and neutral (Mean AUC=0.76, SD=0.13), and negative facial expressions from positive and neutral (Mean AUC=0.71, SD=0.13), see Figure 1. The concordance between automatic and manual classifications for positive but not for negative facial expressions was higher at 8 compared to 4 months of age (b=0.06, t=4.32, p<.001) and improved substantially with video quality (b=0.71, t=3.49, p<.001). We provide a detailed overview on the degree to which (configurations among) individual facial actions map onto manually coded facial expression valence categories, as well as a set of guidelines for improving the quality of infant video data collected 'in the wild' during home visits so to maximize the performance of automatic facial expression analyses. Study 2 investigates the relation between the eye-tracking measures of endogenous attention and micro-coded video measures of emotion and attention regulation during a semi-structured face-to-face interaction with the caregiver: the Still-Face paradigm (Tronick, 1978). We obtained looking time response and peripheral arousal measures of shifting attention, sustaining and recovering focused attention, and information processing from three gaze-contingent eye-tracking protocols in a sample of 49 3- to 4-month-old infants (N male=30; M=125.7 days, SD=12.9). Emotional valence, the display of emotion regulation strategies, and focused attention were coded manually by multiple blind raters (trained until inter-rater reliability of r>.80). Multilevel modeling will be used to assess correlations among the constructs of interest nested within infants. Preliminary results from a subset of 18 infants showed a significant group-level increase in the display of negative affect in response to the caregiver's disengagement from the free-play interaction and during the subsequent re-engagement compared to the baseline. The use of self-distraction during the caregiver's disengagement correlated to shorter sustained attention span, r=-0.91, p<.001. Faster shifting attention correlated marginally with longer focused attention towards the social interaction partner, r=-0.51, p<.10.

P3-H-516 - Automated Measurement of Smiling in Infants and Mothers and Cry-Face Expressions in Infants During the Face-to-Face/Still-Face (Ahn)

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The Face-to-Face/Still-Face (FFSF) assesses infant responses to parent unresponsiveness, an age-appropriate stressor. In the FFSF, parent and infant engage in face-to-face interaction (FF), the parent stops interacting with the infant but gazes at them with a neutral expression (SF), and the parent-infant interaction resumes (RE). The prototypical still-face effect is characterized by infants' reduced positive affect and gaze at the parent and increased negative affect during the SF from the previous FF, along with a partial carry-over effect into the RE episode. Automated facial affect recognition is a burgeoning area of computer vision research but has not been applied to the FFSF. Rarely studied in the FFSF, Duchenne smiles appear to express more intense positive affect than non-Duchenne smiles, while Duchenne cry-faces appear to express more intense negative affect than non-Duchenne cry-faces. The current study investigates whether proportions of Duchenne and non-Duchenne smiles and cry-faces differ across FF, SF, and RE episodes, using computer vision.

Forty 4-month-olds and their mothers completed the FFSF protocol consisting of three 2-minute episodes: FF, SF, and RE. Infant and mother were separately video-recorded, and their recordings synchronized. Baby-FACS (certified) coders coded facial Action Units (AU4, AU6, AU12, AU20) in each video frame. Automated facial affect recognition (AFAR) computer vision software using a fast-cascade regression framework tracked and normalized facial images. Images were input to a convolutional neural network (CNN) that output the presence of the same facial AUs, indexing positive emotional expressions in infants and mothers, and negative emotional expressions in infants. Free-margin kappa between AFAR and FACS was above .63 for all mother and infant AUs over the first 30 seconds of the FF, SF (infant only) and RE for the entire sample, indicating acceptable reliability. Overall proportions of infants' and mothers' Duchenne smiles (AU6+AU12) and non-Duchenne smiles (AU12), and infants' Duchenne cry-faces (AU4+AU6+AU20) and non-Duchenne cry-faces (AU4+AU20) were obtained.

Significant still-face effects emerged from analyses of the objective AFAR computer vision software data. Repeated measures ANOVAs indicated that levels of infant Duchenne and non-Duchenne smiling declined from the FF to the SF and rose in the RE ($ps<.01$). Levels of infant Duchenne and non-Duchenne cry-faces increased significantly from the FF to the SF ($ps<.05$), but did not change significantly between the SF and RE ($ps>.05$; Fig.1A). Mothers demonstrated a decline in smiling from the FF to the SF and a rise from the SF to the RE ($ps<.001$; Fig.1B). The proportion of infant smiling involving eye-constriction (the Duchenne marker) was greater in the RE than in the FF and SF ($ps<.05$; Fig.2A). However, eye-constriction was not differentially associated with infant cry-faces by episode ($ps>.05$). The proportion of mother smiling involving eye-constriction was greater in the FF and RE than in the SF ($ps<.001$; Fig.2B).

Automated CNN-based software (AFAR) yielded the canonical infant still-face effect. This was the first description of Duchenne and non-Duchenne expressions in mother and infant during the FFSF. Finally, eye-constriction was differentially associated with infant and mother smiling, but not infant cry-faces, in the FF, SF, and RE episodes.

P3-I-517 - The Interaction Between Infant Responsiveness and Maternal Depression in Predicting Non-Distress Vocalizations During Maternal Periods of Emotional and Physical Unavailability (Leong)

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Emotionally available mother-infant exchanges set the foundation for developing healthy relationships and self-regulation. Mothers and infants vary in how emotionally available they are; specifically, they vary in receptiveness and responsiveness to their partner's emotional signals and how clearly they signal their own emotions (Biringen et al., 2014). Maternal depression can impede a mother's ability to be emotionally available; as such, periods of emotional unavailability may be less unusual for these infants (Field et al., 2007). Indeed, these infants cry less in response to experimental perturbations which induce maternal emotional unavailability when compared to infants of non-depressed mothers (Field et al., 2007). Research has focused on infant distress cues (e.g., cries) during perturbed interactions. However, non-distress vocalizations are also thought to have important functions. They serve as attentional bids and sustain reciprocal interactions (Weinberg & Tronick, 1994). What remains unknown is whether infant responsiveness and maternal depression shape infant non-distress vocalizations (e.g., babbles, coos) during periods of emotional and physical unavailability. This study examined (1) whether infant responsiveness during normal face-to-face interactions and maternal depression scores would predict non-distress vocalizations during perturbation periods, and (2) whether infants use non-distress vocalizations differently depending on the type of perturbation (i.e., maternal emotional vs. physical unavailability). Forty mothers and their four-month-old infants (20 males) participated in a series of interactions. The Center for Epidemiological Studies Depression Scale was used to measure maternal depression (Radloff, 1977). Participants were video-taped during the Still-Face (SF) Procedure (Tronick et al., 1978) and the Separation (SP) Procedure (Field et al., 1986). The SF comprised (1) a period of unstructured face-to-face play, (2) a perturbation period in which mothers remained unresponsive and expressionless, and (3) a reunion period wherein mothers were free to resume playing. The SP procedure was identical except that during the second period the mother hid behind a screen to induce physical unavailability. Infant responsiveness was captured using the Emotional Availability Scales during the normal interaction periods (Biringen et al., 1988). Infant non-distress vocalizations were observationally and systematically coded in real-time whenever the infant cooed or babbled during the two perturbations ($k = .87$). ANCOVA revealed that infant responsiveness and perturbation type independently predicted infant non-distress vocalizations. Infants with higher levels of responsiveness were more likely to make non-distress vocalizations during the perturbations ($p < .05$). In addition, non-distress vocalizations were more common during the SF perturbation than in the SP perturbation ($p < .05$), suggesting that infants use non-distress vocalizations to elicit attention. Maternal depression was not independently predictive of infant non-distress vocalizations ($p > .05$), however there was a significant interaction between maternal depression scores and infant responsiveness ($p < .01$). Specifically, the effect of infant responsiveness on non-distress vocalizations was non-significant when maternal depression was high. These infants may come to expect periods of maternal unavailability and thus make fewer attempts at re-engaging their mothers. Taken together, infants who are highly responsive to their mother's cues are more likely to try and reinstate reciprocal interactions, but these processes may be disrupted by maternal depression.

P3-I-518 - Examining Pathway by Which High Socioeconomic Risk Undermines Mothers' Supportive Emotion Socialization Toward Their Toddlers (Negi)

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Economic hardship is a stressor related with punitive and unsupportive parenting practices (McLoyd, 1990), but little is known about the process by which it may undermine early parental emotion socialization (Leerkes et al., 2020). Certainly, economic hardship is associated with compromised mental health which is known to undermine parenting (Conger & Conger, 2002). Further, prior research demonstrates that social support plays an important role in protecting and maintaining the psychological health of an individual (Cohen & Wills, 1985) and is important for parents to meet parenting demands because it acts as a direct resource to assist with caregiving, particularly under difficult circumstances (Maguire-Jack & Wang, 2016). Thus, we examined the extent to which the proposed negative association between socio-economic risk and supportive emotion socialization is (a) indirect via maternal depressive symptoms, and (b) buffered by social support. The sample included 259 mothers (128 White, 131 Black) and their infants (52% female). Mothers reported their age, education level, annual family income, and number of household members prenatally. Family income-to-needs ratio was calculated as total family income divided by the poverty threshold for a family that size. A composite score was created for socioeconomic (SES) risk using three indicators: mother's age, education level, and income-to needs ratio which was then reversed so high scores indicate more risk. Mothers reported depressive symptoms at 6 months using the CES-D (Radloff, 1977) and their satisfaction with parenting-related social support (e.g., praise for parenting, help with parenting) (Leerkes & Crockenberg, 2002). Supportive emotional socialization was assessed at 14 months via direct ratings of observed maternal sensitivity during distress-eliciting tasks using Ainsworth et al's (1974) scale and via maternal self-reports on the Coping with Toddlers' Negative Emotions Scale (Spinard et al., 2007) which were standardized and averaged yielding a measure in which high scores indicate more supportive emotion socialization.Hypotheses were tested via a path model using MPLUS; the final model is displayed in Figure 1. SES risk was directly associated with lower supportive emotion socialization. As predicted, SES risk was associated with heightened depressive symptoms however, depressive symptoms were not associated with lower supportive emotion socialization. The indirect effect from SES risk to emotion socialization via depressive symptoms was not statistically significant, b = -.03, SE = .02, 95% CI [-.061, 0.006]. Finally, results showed a marginally significant (p = .067) moderating effect of social support on the association between SES risk and emotion socialization such that the negative effect of SES risk is weaker among mothers with higher social support than among mothers with lower social support (Figure 2). These results suggest social support plays an important role buffering mothers from the negative effect of SES risk on emotion socialization in the early toddler period, a time when children are learning critical lessons about the appropriate expression and control of their negative emotions. Future research should identify which aspects of social support appear to be most protective and to identify other buffers of the association between economic hardship and compromised parenting.

P3-I-519 - Impact of attachment style on the relation between maternal and infant anxiety and trait cortisol levels (Amaral Lavoie)

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Background: Measures of neurobiological reactivity, such as cortisol, are important biomarkers for anxiety outcomes in children (Gunnar, 2001). Infant cortisol has been linked to other predictors of child

anxiety, namely infant behavioral inhibition and parent psychopathology (Kopala-Sibley et al., 2017). There is some suggestion that the quality of the parent-infant relationship, characterized by attachment style, could determine how these factors relate to cortisol (Luijk et al., 2010; Nachmias et al., 1996). Past research has not differentiated between insecure attachment styles (avoidant and resistant). In addition, many studies that investigate risk factors in infancy examine outcomes later in the child's life (e.g., Bittner et al., 2007), overlooking more immediate outcomes that appear within infancy, which could be a sensitive period for child susceptibility to their environment (Slagt et al., 2016). We investigated the potential effect of mother-infant attachment style (secure, avoidant, or resistant) on the relation of both maternal anxiety and infant behavioral inhibition with infant trait cortisol levels. Findings could have important implications for biological markers for anxiety and environmental influences as early as infancy. Methods: Data were collected as part of a longitudinal study investigating the interaction between maternal and child emotional processes. Ninety-eight mothers and their 12-15 month-old infants (43.3% female) participated. Infant saliva samples were collected at the beginning of the laboratory visit, at mid-visit, and at post-visit. Trait cortisol levels (AUCg) were calculated based on these three samples (Pruessner et al., 2003). Behavioral inhibition was measured by an established, standardized laboratory procedure (Fox et al., 2001). Infant attachment style was assessed using the Ainsworth Strange Situation (Ainsworth et al., 1978). Maternal anxiety was measured with the Depression Anxiety Stress Scales (Lovibond & Lovibond, 1995). Results: Multiple regression analyses revealed a significant moderation effect, such that infant attachment style moderated the relation between infant behavioral inhibition and trait cortisol levels (see Table 1). Resistant infants showed a positive relation of behavioral inhibition to trait cortisol levels ($t = 2.77$, $p = .007$), while avoidant infants showed a negative relation ($t = -3.208$, $p = .002$; see Figure 1). No relation between behavioral inhibition and cortisol existed for secure infants. There was no significant moderation effect of attachment style on the relation between maternal anxiety and cortisol. Conclusions: The relation between infant behavioral inhibition and infant trait cortisol level was moderated by attachment style, but no relation was found between maternal anxiety, attachment style, and infant trait cortisol level. These results reinforce the importance of studying the relation between predispositions for anxiety and environmental influences, and their outcomes, as early as infancy, as it could be this relation that is determining how these things are being reflected in biological markers like cortisol. Because cortisol may indicate a child's openness to ongoing environmental influences, understanding early correlates can assist with refining relevant theories.

P3-I-520 - Sex Differences in Temperament During Infancy: An Exploratory Study of IBQ-R Subscales (Bradshaw)

Allison Bradshaw[1], Sooyeon Sung[2], Jed Elison[2], Sarah Patterson[3], Rebecca Grzadzinski[4], Stephen Dager[5], Annette Estes[5], Heather Hazlett[4], Lonnie Zwaigenbaum[6], Jospeh Piven[4], Meghan Swanson[1]

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Background & Objectives Past research on sex differences in infant temperament has yielded mixed results. Studies using the Infant Behavior Questionnaire - Revised (IBQ-R) typically focus on sex differences in the three factors: negative affect, surgency/extraversion, and regulation. Some findings using these factors are fairly consistent; girls score higher in regulation, boys score higher in surgency/extraversion, and there is no difference in negative affect (Garstein & Rothbart, 2003; Dias et

al., 2021). Research is more limited on sex differences across the 14 IBQ-R subscales. However, a meta-analysis including participants aged 3 months to 13 years found that girls are shyer, slower to "warm up", and show more fear; whereas boys are more active with more dynamic emotions (Else-Quest et al., 2006). Investigating sex differences on the IBQ-R subscales would provide more detailed information about the nature of sex differences during infancy. The objective of this exploratory study is to investigate sex differences in infant temperament in typically developing infants. Methods Temperament was assessed when infants were 6 and 12 months old using granular subscale scores from the IBQ-R (Garstein & Rothbart, 2002). This study included data from 151 typically developing infants from the Infant Brain Imaging Study, a multi-site longitudinal study (57% males; 87% white, 4% African American, and 9% two or more races). General linear models were used to determine if male and female infants differed on the 14 IBQ-R subscales. Covariates included data collection site and infant age at questionnaire completion. FDR corrections were used for multiple comparisons; however, full results are presented due to the exploratory nature of this study. Results Parents indicated that girls had higher levels of fear compared to boys at both 6 and 12 months ($F(1, 136) = 9.03$, $p = .003$; $F(1, 121) = 5.75$, $p = .018$, respectively). At 6 months, boys had higher levels of high intensity pleasure indicating that they enjoyed activities that were intense, novel, or complex ($F(1, 136) = 5.49$, $p = .003$). Group differences for sex of the infant were not significant for the remaining subscales. After running FDR tests for multiple corrections, the only significant effect was girls showing more fear than boys at 6 months ($q = .042$). Conclusion These results replicate a previous finding that parents report girls to show more fear than boys (Else-Quest et al., 2006). However, we did not replicate other findings that girls show more regulation or boys show higher activity levels. Our study found significant effects at 6 months that did not replicate at 12 months. Further, studies of children up to 4 years old have found effects for sex differences in temperament traits such as inhibitory control, perceptual sensitivity, activity level, and high-intensity pleasure (Else-Quest et al., 2006; Casalin et al., 2012). Together, this research suggests that sex differences in temperament may not be consistent across development. Future longitudinal studies from infancy into toddlerhood would provide insights into the stability of temperament traits across the first years of life.

P3-I-521 - Maternal Regulation of Infants? Behavioral and Physiological Responses to the Still Face Paradigm (Raby)

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Background: Early experiences within attachment relationships are assumed to shape infants' behavioral and biological responses to stress (Propper & Moore, 2006). In addition, parental behavior in the context of infant distress and non-distress is thought to have unique consequences for infants' development (Leerkes et al., 2009). Objective: The current study tested these ideas using data collected from 108 mother-infant dyads who completed the Still Face Paradigm (SFP; Tronick et al., 1978) when infants were six months old. We hypothesized that supportive parenting in the non-distressing Play episode of the SFP would be associated with infants' overall behavioral and physiological activity during the SFP. We also hypothesized that supportive parenting during the distressing Reunion episode would be associated with infants' responses to the stress of the SFP. Methods: Infants' behaviors during the SFP were coded on a second-by-second basis using the Infant and Caregiver Engagement Phases coding

system (Weinberg & Tronick, 1999). The protest, withdrawal, or negative engagement codes were combined to create a measure of infant distress, whereas the social monitoring and social positive engagement codes were combined to create a measure of infant social engagement. Summary scores for the Play, Still Face, and Reunion episodes were created by calculating the amount of time infants exhibited distress or social engagement during each of those two-minute episodes of the SFP. In addition, infants' heart rates and respiratory sinus arrhythmia levels were continuously assessed during the SFP. Summary scores were created by calculating the average for each of these physiological indices during the Play, Still Face, and Reunion episodes. Maternal parenting quality during the Play and Reunion episodes was rated using five, 5-point scales (maternal sensitivity to non-distress, maternal sensitivity to distress, intrusiveness, positive regard, and detachment). These scales were averaged (reverse-scoring intrusiveness and detachment) to create composite measures of supportive parenting during the non-distressing Play episode and the distressing Reunion episode. Infant age at the time of the SFP, infant biological sex, infant race/ethnicity, and family socioeconomic status were included as covariates for all analyses. Results: Data were analyzed using a series of multilevel models. Results indicated that infants whose mothers were highly supportive during the Play episode of the SFP exhibited high levels of social engagement throughout the SFP (Figure 1), which was consistent with our first hypothesis. Supportive parenting during the Reunion episode, on the other hand, was associated with infants' responses to the stress of the SFP. Specifically, highly supportive care was associated with less pronounced increases in infants' observed distress and heart rates during the SFP, less pronounced decreases in observed social engagement during the SFP, and a partial recovery in RSA levels during the reunion episode (Figure 2). Conclusions: These findings highlight the unique consequences of parental behavior during distressing and non-distressing contexts for infants' behavior and physiological activity. Highly supportive care during the non-distressing interactions appears to facilitate infants' social engagement. In contrast, highly supportive care during distressing contexts may help infants effectively regulate their physiological and behavioral responses to stressful events.

P3-I-522 - Infant regulatory problems (RPs) in the context of mother-infant interaction, maternal experience of RPs and epigenetic correlates of stress regulation (Hámori)

Eszter Hámori[1], Lilla Márkus[1], Flóra Farkas[1], Csaba Barta[2]

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The increasing prevalence of infant regulatory disorders (RD) -sleep, eating and crying disorders - (DC 0-5TM) has drawn attention to the importance of studying the social and biological correlates of these disorders. Epidemiological studies have confirmed that 2-8% of infants beyond 3 months of age experience multiple regulatory problems (RPs) - problems that do not fulfil the level of the clinical disorder. Multiple RPs during the first 5 months are associated with long term attention and stress regulation problems in childhood (Bilgin et al, 2020). Furthermore, neurobiological studies of RDs have already explored that exposure to persistant stress can alter the expression of genes involved in the regulation of stress and attention due to epigenetic modifications. (Conradt et al, 2015). Prenatal, psychosocial and adverse family risk factors can predict multiple RPs (Olmestig et al, 2021). However, relatively few study investigated the prevalence and the correlates of early RPs in low risk families. The present study aimed to explore the prevalence of early regulatory problems (RPs) and their maternal subjective experience in a sample of low-risk 3-6 months old infants. In addition, we also wanted to examine the parent-infant stress regulation together with the stress caused epigenetic alterations. 101

low risk families with healthy full-term 3-6 months old infants participated in the project. Maternal experience of infant RPs were assessed by the Regulatory Problems Survey (Hámori et al. 2017) Mothers filled a list of 12 regulatory problems and marked the degree of percieved severity of those problems. Maternal experience of pregnancy, birth and infant regulation was explored by the Thematic Regulation Interview (Hámori et al, 2017) and were analysed on three dimensions: maternal subjective experience, reflectivity on baby and on herself. Mother-infant stress regulation was assessed in the Face-to-Face-Still-Face paradigm (FFSF, Tronick et al, 1978) and was evaluated accross the three episodes by the Global Coding System of Emotional and Social Regulatory Patterns (Hámori et al, 2020). DNA sampling and epigenetics. We aimed to identify genetic variants and epigenetic alterations, which may be associated with the development of stress regulation patterns. DNA samples were collected from both the infants and their mothers via a non-invasive cheek-swab method. Genetic and epigenetic (DNA methylation) analyses targeted the glucocorticoid receptor due to its key role in stress regulation, as well as a number of genes coding for proteins involved in various neurotransmitter (dopaminergic, serotonergic) pathways. The analysis of results is still in progress and will be provided by the time of the presentation. Results. 90 percent of the mothers have reported more then two infant RPs. Based on the degree of reported difficulties three main factors of infant RPs have emerged: Crying (crying, daytime fussying, asleep) Feeding (brestfeeding, gain in weight, feeding) and Sleep (night fussying, sleep over, belly-ache). Feeding has been reported as the most difficult to cope with, followd by Sleep problems and Crying. The experience of difficult birth and mother-newborn separation after birth predicted maternal reports of more infant Crying an Sleeping problems (R2=.467 R2 Adj=.324 F(7, 26)=3.258 p= .013).More difficulties in feeding and sleeping problems were related to less optimal infant self regulation during the FFSF (χ 2 (2,N =94)=6.791, p<.05). Multiple RPs were related to mother's more disruptions of the communication process (r=-0,319 p= .035) during the regulation episode. Conclusion. Exploration of adaptive vs maladaptive regulation pattern can have clinical significance.

P3-I-524 - What happened? Why is she so sad? Differences in labels and questions during a storybook task about basic and self-conscious emotions (Reschke)

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Emotion knowledge is linked to social competence in the preschool years (Denham et al., 2003). However, less is known about the socialization mechanisms that shape the ontogeny of early emotion understanding. Furthermore, whereas extant research has largely focused on the socialization of so-called "basic emotions" (e.g., happy, sad, angry, scared, disgusted; see Ekman, 1993), less is known about the socialization of self-conscious emotions (e.g., shame, embarrassment, pride, awe, guilt) in infancy. The current study longitudinally examined caregiver-child conversations about basic and self-conscious emotions depicted in a storybook.

Participants: Children (N = 218; Female = 120) and their primary caregivers participated at two time points: (1) at 2-3 years of age; M = 2.45, SD = .25) and (2) 1 year later (M = 3.51, SD = .26).</p>

Procedure: Caregivers were recorded describing to their child 10 wordless images (order randomized) depicting a cartoon child (gender counterbalanced) experiencing an emotion in response to an elicitor (see Figures 1&2). Conversations were transcribed and independently coded to identify the frequency of

caregivers' (1) emotion labels, (2) knowledge questions (e.g., "is she sad?"), and (3) causal questions (e.g., "why does she feel sad?").

Results: Separate generalized mixed linear models were used to analyze mean differences in the frequency of each dependent variable as a function of emotion and time point. Total words spoken by the primary caregiver was included as a covariate to control differences in speaking speed. Distribution and link functions were selected based on best comparative model fit.

For emotion labels there was a significant main effect of emotion, $F(9, 3{,}529) = 218.75$, $p < .001$. Caregivers labeled disgust images ($M = 4.76$, $SE = .14$) significantly more than all other emotions, $ts \geq 20.22$, $ps < .001$.

For knowledge questions, there were significant main effects of emotion, $F(9, 3{,}380) = 12.73$, $p < .001$, and time point, $F(1, 3{,}474) = 20.24$, $p < .001$. Caregivers asked more knowledge questions during Joy ($M = 1.73$, $SE = .10$), Fear ($M = 1.65$, $SE = .09$), Disgust ($M = 1.63$, $SE = .09$), and Awe ($M = 1.56$, $SE = .11$) images than all other emotions, $ts \geq 3.00$, $ps \leq .003$. Overall frequency of knowledge questions decreased significantly from time point 1 ($M = 1.46$, $SE = .07$) to time point 2 ($M = 1.21$, $SE = .06$), $t = -4.55$, $p < .001$.

For causal questions, there were significant main effects of emotion, $F(9, 3{,}361) = 21.44$, $p < .001$, and time point, $F(1, 3{,}487) = 12.61$, $p < .001$. Caregivers asked more causal questions during Guilt ($M = 1.28$, $SE = .08$) images compared to all other emotions, $ts \geq 3.51$, $ps < .001$. Overall number of causal questions increased significantly from time point 1 ($M = .72$, $SE = .04$) to time point 2 ($M = .86$, $SE = .05$), $t = 3.55$, $p < .001$.

Conclusion: Taken together, these results suggest that caregivers label and ask questions about some emotions more than others and that the quantity of questions asked during discussions about emotions increases or decreases with time depending on the quality of questions being asked. Implications for the ontogeny of emotion knowledge in infancy will be discussed.

P3-I-525 - Zooming the way to relationships: Examining grandmothers? and parents? emotional availability during virtual interactions with infants during the COVID pandemic (Barr)

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Relationships have been a focus for understanding developmental cascades in young children. During in-person interactions, emotionally available, responsive partners help infants build relationships (Bornstein & Tamis-LeMonda, 2001). COVID-19 resulted in a fundamental shift in grandparent-grandchild relationships. Because many infants had fewer face-to-face interactions with their grandparents, families turned to video chat to connect (Brown & Greenfield, 2021). While research has demonstrated that video chats can help families maintain existing child-grandparent relationships (McClure et al., 2015; Strouse et al., 2021), less is known about how. Specifically, do grandparents exhibit emotional availability (EA) as indexed by their ability to read infant signals over video chat and provide flexibility and warmth in response to those cues? Similarly, how does parent emotional

availability support grandparent-infant interactions during video chat? Increased family video chat during COVID-19 provides a unique context to examine EA toward infants during video chat. To examine this, between October 2020 and August 2021 we conducted a naturalistic, longitudinal observational study of 49 families. We recorded 3 video chats between grandparents (all grandmothers, M = 62 years), infants (M = 11.6 months, age range: 6-25 months), and parents (2 fathers), supplemented by surveys. Grandmothers and parents were highly-educated and mostly Caucasian, and geographic distance between them ranged from 1 to 2700 miles. To assess interactions, we coded grandmothers' and parents' emotional availability (EA, combining sensitivity and warmth) in 30-second blocks during video chats, as well as infants' emotional valence. During data collection, the COVID-19 context continued to evolve, including the introduction of vaccines which became widely available for older adults in the U.S. from February of 2021 (~midpoint of our data collection period). We ran two growth curve analyses to examine predictors of parent EA and grandparent EA during video chats. Our predictors included the date of video chat centered at February 1 (see Figure 1: grandmother EA, parent EA, and baby valence across time). We also included log-transformed geographic distance between grandparents and the infant-parent pairs and a composite variable of stress and loneliness drawn from parent and grandparent surveys called "overwhelmed." Finally, we included infant age in months, frequency of video chat between the grandmother, infant, and parent, and the EA of the other adult within the same video chat. For grandmothers, we found that higher parent EA predicted higher grandmother EA (Table 1: Model 1). For parents, grandmother EA predicted parent EA, and geographic distance between participants was negatively related to parent EA (Table 2: Model 2). We are currently testing (and will present) whether parent and grandparent EA predict infants' emotional valence and whether this differs as a function of in-person or video chat context. Examining relationships in a digital age requires that researchers expand the study of social interactions to include virtual, real-time formats (e.g., video chat). Here, we find that emotional availability exhibited by parents and grandmothers during video chat, as shown in existing research on in-person interactions, is reciprocal. Therefore, virtual interactions have the potential to support relationship building between infants and remote grandparents.

P3-I-526 - Well-being in children after early mild traumatic brain injury (Roy)

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Introduction: Early mild traumatic brain injuries (mTBI) is an insult to the brain experienced during early childhood (0-5 years) that can cause post-concussive symptoms such as behavioral (e.g., anxiety), physical (e.g., headache), and cognitive (e.g., poor attention) difficulties (Bernard & al., 2017; Dupont & al., 2021). MTBI sustained in childhood can in some cases be associated with reduced quality of life, which may affect children's well-being (Beauchamp & al., 2018; Fineblit & al., 2016; Gornall & al., 2021). Although there is no consistent definition of what constitutes optimal well-being, it can be defined in the context of TBI as the maximization of one's potential (Hawley & Joseph, 2008). Since most children seem to recover well from mTBI (Zemek et al., 2016), assessing their well-being could help identify protective factors related to their recovery. Objective: This study aims to investigate children's evolution regarding their post-injury well-being in domains known to be affected by early mTBI (behavior, cognition, post-concussive symptoms, quality of life). Method: Children (n=78; 52% boys) with early mTBI (Mage at injury = 3.04 years; SD = .95) were evaluated at 6- and 18-months post-injury and compared to typical developing children (n=77; 51% boys). All children (N = 155; Mage = 3.56 years; SD =

.97; 52% boys) were divided into two groups. A higher level of well-being characterized one group, and a lower level of well-being characterized the other group. Higher well-being was defined according to four criteria: 1) Satisfactory cognition, defined by the absence of two scores lower than two standard deviations among seven cognitive tests: Conflict scale, Spin the pots, Delay of gratification, Shape Stroop, Discrepant Desire Task, Desire task, False belief understanding task); 2) Presence of good quality of life, defined by a score > 65.43 on the Pediatric Quality of Life Inventory 4.0; 3) Less than three symptoms reported on the Post-concussive Symptom Interview; 4) Absence of significant behavioral problems, defined by a T score < 65 in terms of internalized and externalized behaviors reported by parents on the Child Behavior Checklist. Results: There were significantly fewer children with all four well-being criteria among the mTBI group 6 months post-concussion (X2 (1, N = 155) = 4.9, p = .032) and 18 months post-concussion (X2 (1, N = 135) = 10.35, p = .001) compared to the typically developing control group. Discussion: This study suggests that early mTBI can impact children's well-being up to 18 months post-concussion. Future studies should seek to identify what environmental, family, injury, and individual factors are associated with greater well-being in order to promote these in an effort to improve outcomes.

P3-I-527 - The Roles of Infant Surgency and Maternal Positive Affect in Predicting Child Internalizing and Externalizing Behaviors (Phillips)

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Internalizing (IBs) and externalizing (EBs) behaviors during childhood predict anxiety and aggression (Hill et al., 2006; Kerr et al., 2007). Child surgency and negative affect, as well as maternal positive affect and intrusiveness have been demonstrated to predict both IBs and EBs (Burt et al., 2013; Gartstein et al., 2012; Kingston et al., 2018). However, much of this work focuses on these associations during toddlerhood only and does not account for how these factors during infancy might predict toddler IBs and EBs. The goal of our study was to assess the roles of these factors during infancy in predicting toddler IBs and EBs. We hypothesized that infant traits would predict toddler IBs and EBs and that maternal behaviors would moderate these associations. Mother-child dyads (N = 207) visited the lab when the children were 10-months and again when they were 36-months. At 10-months, mothers reported on infant surgency (iSUR) and negative affect (iNA) using the IBQ (Rothbart, 1981) and maternal positive affect (mPA) and intrusiveness (mINT) were coded by research assistants during dyad interaction tasks. At 36-months, mothers used the CBCL (Achenbach & Rescorla, 2001) to report toddler IBs and EBs. Two regression models were used to test the hypotheses- one with IBs as the dependent variable and one with EBs as the dependent variable with three steps in each model. Step 1 included iSUR and iNA, step 2 included mPA and mINT, and step 3 included the interaction terms between maternal behaviors and infant traits. For the IB model, steps 1 [F(2, 203) = 7.598, R-squared = 0.70, p < .001] and 3 [F(4, 197) = 4.138, R-squared = 0.148, p = .003] were significant. In step 1, iNA predicted IBs (B = 2.299, p < .001). In step 3, iSUR (B = -1.730, p = .017) and iNA (B = 2.352, p < .001) predicted IBs and the interaction between mPA and iSUR was significant (B = -5.668, p < .001). For the EB model, only step 3 was significant [F(4, 198) = -7640, R-squared = 0.100, p = .002]. We used PROCESS (Hayes, 2021) to probe the interactions and examine the simple slopes, assessing the effects of the moderators at one SD above and below the mean. For the interaction between mPA and iSUR predicting IBs, iSUR moderated the association between mPA and IBs. Specifically, high mPA predicted fewer IBS when iSUR was low (B

= -4.26, p = .0005; Figure 1). For the interaction between mPA and iSUR predicting EBs, mPA moderated the association between iSUR and IBs. Specifically, high iSUR predicted fewer EBs when mPA was high (B = -4.26, p = .0092) and more EBs when mPA was low (B = 4.10, p = .0050). Our results demonstrate that infant and maternal traits play both direct and moderating roles on the development of toddler IBs and EBs. This highlights the importance of assessing child development longitudinally from a biosocial perspective.

P3-I-528 - What about the educational quality in childcare for children under 3 years of age? An in-depth understanding of the Piklerian approach (Proulx)

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The early years of a child's life set the foundation of a human being through the multiple interactions between the child and their environment. In OECD member countries, the need for childcare for children aged 0-3 years is increasing (OECD, 2019), highlighting the importance of children's experiences and the critical role of educational quality in these settings. Educational quality is generally defined with structural quality like regulated variables, process quality like children's experiences, physical environment and activities, and quality of adult-child interactions. Studies that have measured quality in Quebec's Early Childhood Centers have observed acceptable to good levels of quality (Gingras et al., 2015). As for studies on the quality of interactions with children aged 0 to 3 years, they inform a low to average level of quality, whereas the quality of interactions plays an essential role in the child's development (Sabol et al., 2013). However, research have mainly focused on structural and process quality (Bigras et al., 2020), as well as educational quality from a global perspective (Drouin et al., 2004; Gingras et al., 2015), and from a normative quality perspective, which is observable and measurable quality. Other authors indicate the need to describe the quality of orientations (Anders, 2015) and consider another perspective to quality, such as the meaning-making approach (Dahlberg et al., 2012). Quality of orientations refers to "meaning making," i.e. the underlying reasons that can explain this normative quality, and concerns in particular to the knowledge of pedagogical approaches (Anders, 2015) that could be associated with higher levels of educational quality (Lemay et al., 2021). However, the lack of studies on educational quality and pedagogical approaches (Anders, 2015) justifies the study of educational quality in childcare centers that implement a pedagogical approach developed mainly for children aged 0 to 3 years: the Piklerian approach. Thus, a multiple case study will be conducted with six groups of children aged 0-3 years to understand the overall components of educational quality from two perspectives (normative and meaning making) in childcare centers where the Piklerian approach is implemented. First, by describing the characteristics of educational quality (structures, processes, and interactions) in groups of children aged 0-3 years in daycare centers that implement the Piklerian approach, by (2) identifying the meaning that practitioners attribute to the nature of their interactions with children, and then by (3) identifying practitioners' meaning on the organization of children's daily lives that they implement. To measure structural and processual quality from a normative perspective, a questionnaire, the Educational Quality Observation Scale (Bourgon & Lavallée, 2013) and the Classroom Scoring Assessment System (La Paro et al., 2012) will be used. The meaning-making will be collected through semi-directed and self-confrontation interviews. The results of this study could contribute to the improvement of the educational quality by providing a better understanding of the practices generated by the implementation of this emerging approach, the orientations and structure that

underlie them, as well as the interactions that result from them to meet the needs of children aged 0 to 3 years.

P3-I-529 - Does insecure attachment to the partner impair mother-infant bonding via maternal depression? (Sirparanta)

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Introduction: This study is based on the perspective of multiple attachment models, according to which each person develops several relationship-specific attachment models. It focuses on attachment to the partner. Because insecure attachment is a risk factor for perinatal depression and perinatal depression affects the quality of the mother-infant relationship, this study aims to examine whether insecure attachment to the partner impair mother-infant bonding via maternal depression. Method: The Attachment Multiple Model Interview, the Edinburgh Postnatal Depression Scale, and the Postpartum Bonding Questionnaire were administered to 23 postpartum mothers with infants under 6 months of age. The proposed model was tested using Partial Least Squares-Path Modeling analysis (PLS-PM). Results: Results are presented in Graph 1: the intensity of maternal depression mediates the link between the quality of attachment to the partner, measured by the four dimensions of attachment (security, deactivation, hyperactivation, and disorganization), and the risk of problems in the mother-infant bonding. Discussion/Conclusion: The poorer the quality of attachment to the partner, the higher the risk of perinatal depression for the mother and, in turn, the more the infant is exposed to a risk of bonding problems with his/her mother. These results highlight the importance, in treating perinatal maternal depression, of focusing psychotherapy on the relationship with the partner in order to increase attachment security and thus reduce the risk of mother-infant bonding disorders. Keywords: Attachment ; Romantic partner ; Perinatal depression ; Mother-infant bonding disorder.

P3-I-530 - Infants listening preferences: Happy infant-directed speech or ID singing? (Karademir)

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Introduction Infants prefer happy-sounding speech to neutral speech (Sing et al., 2002), and they prefer happy infant-directed (ID) syllables to vocal (humming) lullaby (Corbeil et al., 2013). Although positive vocal affect attracts their interest, differences in affect and familiarity across speech and singing have not been investigated in previous studies. The present study investigates whether infants perceive vocal expression of emotion in music and how familiar language influences on their musical engagement. Method A power analysis using G*Power 3.1. (Faul et al., 2007) showed that a total sample of 24 infants would be needed to detect a minimum effect (d = .25) with 95 % power using an ANOVA repeated within-subjects with alpha at .05. To date, nine 6- to 11-month-old infants (M = 265 days, range = 177 - 348 days, six females) from English-speaking households in London, UK have completed the study, with two infants excluded because of fussy behaviour. A head-turn preference procedure was used to explore their responses to and interests in various stimuli in native and foreign languages. They heard a female voice speaking or singing either lively/joyful or neutral tones in English/French. The study employs a 2 x 2 x 2 repeated measures design with types of stimuli (ID speech/ID singing), affective cues

(happy/neutral), and language (English/French) as independent variables, and infants total looking time to the screen as a dependent variable. For each language infants heard a total of eight trials (four ID speech/four ID singing) with language presented in blocks with order counterbalanced. In a single trial, the infants heard an auditory stimulus while seeing an image (e.g., a checkerboard) displayed on the right or left of the screen (Figure 1). Each piece was played until the infants looked away for two seconds. All of the infants participated in both language conditions, and the entire session was video recorded for subsequent coding of the infants' behavioural responses (such as facial expression) to music. Results The results showed an attentional preference for ID singing regardless of affective cues in both language conditions (Figure 2). A preliminary analysis of variance (ANOVA) was conducted with average looking time (in seconds) as the dependent variable, emotional context (lively/joyful or neutral), types of stimuli (ID speech or ID singing), and which language condition was used (English or French) as within-subject variables. Results from the fully powered sample will be presented at the conference. Discussion The initial findings of the current study point towards a music bias in infancy (Tsang et al., 2017; Nakata & Trehub, 2004); although the infants showed greater attention to a joyful speech in their native language (Singh et al, 2002). This preference might provide support for the fact that happy vocalisations or those with high positive affect, whether speech or singing, play an essential role in regulating infant attention (Corbeil et al., 2013).

P3-I-531 - Intolerance of uncertainty during the COVID-19 pandemic: implications for maternal psychological well-being and early infant outcomes (Conaghan)

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The COVID-19 pandemic has been associated with widespread distress and a heightened incidence of both depression and anxiety (Santomauro et al., 2021). One group faced with an increased risk for distress and psychological deterioration during times of widespread precarity are new-and-expectant mothers (Lam et al., 2004). Psychological research has often investigated factors that may put individuals at further risk of experiencing the deleterious effects of widespread stressful events such as natural disasters and disease outbreaks (Tang et al., 2014). Prior findings have identified both emotional dysregulation and the inability to tolerate uncertain and ambiguous circumstances, or intolerance of uncertainty (IU), as two primary factors that may exacerbate anxiety and depressive symptoms when one is faced with stressful life situations (Del Valle et al., 2020; Moccia et al., 2021). The current investigation explored associations among pregnant women and new mothers' (n=296) self-reported emotion dysregulation, IU, and mental health symptomology during the peak of the 2020 coronavirus outbreak. It was hypothesized that women who reported higher emotional dysregulation and higher IU would also report higher internalizing symptoms throughout the COVID-19 pandemic. Data was acquired remotely through online surveys of new mothers and pregnant women. Preliminary results suggest that both baseline emotional dysregulation and intolerance of uncertainty are positively related to reported symptoms of depression and anxiety (r's range from .55 to .77, p's < .001) throughout the perinatal period. These findings suggest that the inability to emotionally regulate oneself and tolerate uncertain situations are critically associated with pregnant and new mothers' reported symptoms of anxiety and depression in the face of the COVID-19 pandemic. Additional analyses will examine whether participants' elevated dysregulation and IU are related to birth outcomes (such as low birth weight and

birth complications) and early infant development, as measured by the Ages and Stages Questionnaire (ASQ).

P3-I-532 - Longitudinal associations between perceived stress in pregnancy and maternal-fetal bonding (Takács)

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Study's objective Research suggests that the development of maternal-fetal bonding (MFB) is affected by maternal mental health problems, such as depression (Rollè et al., 2020) and anxiety (Göbel et al., 2018). However, although 25% of pregnant women experience some form of psychosocial stress (Yali & Lobel, 1999), little is known about the effects of prenatal stress on MFB. The aim of this study was to assess the associations between stress and MFB measured repeatedly during pregnancy. Methods Women were recruited in collaboration with three gynecological clinics in the Czech Republic, Prague, during their prenatal medical checks. Healthy women (N=101) with singleton pregnancies took part in this study. Women who miscarried were excluded from the study. At each trimester of pregnancy (T1, T2, T3), the participants completed the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1994) and the Maternal Antenatal Attachment Scale (Condon, 2015). Structural equation modelling (path analysis) was used to determine the effects of prenatal stress on MFB. The following covariates were included in the model: maternal age, marital status, education, parity, and planned/unplanned pregnancy. Only variables significantly affecting any of the main variables were included as covariates. Results MFB at T3 was predicted by MFB at T2, which was in turn predicted by MFB at T1. Stress at T3 was predicted by stress at both T1 and T2, stress at T2 was predicted by stress at T1. Concurrent negative associations between MFB and stress were significant at T1 and T2, with higher stress predicting lower MFB, but not at T3. In contrast, we found a significant positive cross-lagged effect of stress at T1 on MFB at T3, with higher stress predicting better MFB. There was no effect of PSS at T2 on MFB at T3. In addition, lower educational status was associated with higher MFB at T2, and primiparity was associated with higher MFB at T3 than multiparity. Conclusions When measured concurrently, MFB and stress are negatively associated, suggesting that higher stress predicts lower MFB. However, stress at the beginning of pregnancy has a long-term effect on MFB, but with the opposite effect: higher stress predicts better MFB. Our results suggest complex associations between stress and MFB, with connections differing according to the timing of maternal stress and the stage of MFB development.

P3-I-533 - Empathic Concern, Respiratory Sinus Arrhythmia, and Physiological Synchrony in 9-month-old Infant-Mother Dyads (Tünte)

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Already in the first two years of life infants can respond to another person's pain with empathic concern. In the present study, we replicated an empathic concern paradigm in which mothers displayed simulations of distress by pretending to hurt either knee or finger while interacting with their child

(Davidov et al. 2021). Infant's behavior was video coded for self-distress, prosocial behavior, inquiry behavior, and concerned affect. We extended video coding of the distress simulation by rating length and intensity of the mother's behavior, and the extent to which the infant had witnessed the event causing the distress. Electrocardiogram was recorded from mother and infants during distress-episodes and neutral play-phase to compute respiratory sinus arrhythmia (RSA) and physiological synchrony, using a sliding window method (Abney et al. 2021). Regarding behavioral data, our preregistered analysis of the whole sample (N = 90) indicates that infants display stronger behaviors for all four scales during the distress-episodes, compared to a neutral play-phase (all $p < .001$). Further, a longer and more intense maternal distress simulation was correlated with concerned affect (N = 74, $r = .55$, $p < .001$) and inquiry behavior (N = 74, $r = .27$, $p = .017$). Whether the infant had witnessed the event causing maternal distress was not correlated to the behavioral scales. Regarding infant RSA, our preliminary analysis (N = 42) indicates no change in infant RSA for distress-episodes, compared to neutral-episodes. Further, regarding physiological-synchrony (N = 42) our preliminary analysis indicates no difference between distress- and neutral-episodes. As we have currently only included part of our sample in the RSA-analysis, it will be highly informative, whether these results hold true in the full sample to be presented at ICIS. In summary, our results replicate previous findings, showing that empathic concern can be measured in 9-month-old infants by video coding reactions to maternal distress simulations. Further, we highlight the importance of length and intensity of the mothers' reaction. At the same time our preliminary analysis of physiological data do not support the notion that RSA and/or RSA-synchrony differ between simulated distress episodes and neutral play.

P3-I-545 - "Are you feeling sad?": The emotion words infants and children hear and say in their natural environments (Ogren)

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Talking about and understanding emotions is important for healthy social development (Izard et al., 2001). However, recent theoretical work has suggested that emotion words may also be crucial for the development of emotion concepts in the first place (Barrett, 2017). Although infants begin to produce emotion words by as early as 18 months (Ridgeway, Waters, & Kuczaj, 1985), much remains unknown regarding what emotion words arise in natural conversations between parents and their infants and young children. In fact, prior research has specifically called for further studies investigating young children's use of emotion words in natural interactions (Bretherton, Fritz, Zahn-Waxler, & Ridgeway, 1986), and parents' labeling of emotions when their infants and young children are present (Hoemann, Xu, & Barrett, 2019). To address this, the present study used transcripts of natural parent-child interactions to address 2 main goals: 1) To determine which aspects of the language environment predict infant and child emotion word production; 2) Distinct from prior work, we also examined differences between mothers and fathers in terms of emotion language production. The present study examined 2,089 transcripts from 180 children across 17 corpora. All children in these transcripts were between 15- and 47-months of age, and transcripts were accessed from the Child Language Data Exchange System (CHILDES; MacWhinney, 2000), a publicly available data set of natural conversational interactions with children. Transcripts were coded for the number of times emotion words were produced by mothers and their children in each transcript. Each speaker's mean length of utterance (MLU) was also calculated as a proxy for linguistic complexity. Results revealed that the proportion of

emotion words produced by infants significantly increased with age (z=7.61, p<.001). For details regarding the frequency with which specific emotion words were produced, see Figure 1. We also found that parent emotion language (z=11.54, p<.001) significantly predicted infant emotion language, but infant MLU (z=-0.39, p=.694) and parent MLU (z=1.03, p=.305) did not. Looking at differences between mothers and fathers, it is important to note that transcripts included mothers substantially more often than fathers (1,987 transcripts versus 830, respectively). However, in transcripts where mothers spoke they provided an average of 2.01 (SD=4.36) emotion words per transcript, which was significantly more (t(2815)=7.98, p<.001) than fathers who provided an average of 0.76 (SD=1.83) emotion words per transcript. Thus, fathers in the analyzed CHILDES transcripts appear to provide different emotional input compared to mothers. These results provide valuable information about the emotion language that infants and young children both hear and produce between 15- and 47-months of age. These findings indicate what specific words infants are likely to produce. They further suggest the importance of parent emotion language for children's learning about emotion words, and suggest potential differences between mothers and fathers in emotion language input. Ultimately, this information may be helpful for informing theories of early emotional development, and potentially for interventions.

P3-J-535 - Predictors of Screen Time Among Brazilian Infants and Young Children During the COVID-19 Pandemic (Campos)

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Pediatrics associations around the world recommend zero screen time for children under 2 years. However, pre-pandemic studies conducted in the US show that exposure begins, on average, at 6 months with 49 minutes/day on screens. The main parental motivations for infants' screen time were to occupy the child while they are performing tasks and for educational purposes. Furthermore, parental stress was also a factor associated with greater infant exposure. During the COVID-19 pandemic, infants' screen time and parents' stress are reported to have grown, including in Brazil. This study aimed to evaluate the predictive role of parental motivations and parental burnout stress on infants' screen time during the pandemic. A sample of 139 parents living in Brazil (n= 72 girls) whose children were aged 0 to 23 months (Mean = 11.6 months SD = 6.52 months) answered the following instruments online (from May-August 2021): 1) Social-demographic Form; 2) Child Screen Time Exposure: adaptation from the Common Sense Media questionnaire (2019); 3) Parental Motivation (PM) for child exposure to screens: adapted from Cingel & Kcrmar (2013), this questionnaire provides information on four scales: a) Parental Needs; b) Educational benefits for the child; c) Child's Desires/ Family Routine d) Child Behavior Control (Adequate reliability, as α = .932); 4) Parental Burnout Stress (PBA, Roskan et al., 2018). Statistical analyses were conducted on Jamovi (1.6.23). Children were first exposed to screens on average at 5.4 months (SD = 3.9) and spent 31.3 minutes (SD = 203) a day on screens. A linear regression model was tested with infants' average daily screen time as outcome and the four PM subscales, the PBA total score, child age, and family income as predictors. Higher scores on the Child's Desires/ Family Routine subscale (p < .001) and lower family incomes: lower than R$1000 (p = .002); R$2000-4000 (p= .016); R$4000-R$6000 (p = .004); R$6000 - R$10000 (p = .002) and higher than R$ 10000 (p = .003) when compared to reference (R$ 1.000 - R$ 2.000 - most common Brazilian family income in 2021) were significant predictors of more screen time. Higher score on the Parental Needs subscale was a marginally significant predictor (p = .067). The model explained 41.0% of children's screen time (R = .679; ΔR2 =

.410; p = .020). Results suggest that screen exposure is not a matter of parents ignoring their pediatrician's recommendations, but a social phenomenon associated with family income - likely the parent's financial means for offering other leisure activities for their children. It also shows that screens were an important part of Brazilian families' routine during the COVID-19 pandemic, supporting initial reports that pointed to an increase in screen time due to the implementation of remote work. Our results may guide future interventions to reduce infants' and young children's screen time in Brazil, by taking the above-mentioned predictors into consideration. Furthermore, future studies should continue to investigate the consequences of screen exposure between 0-23 months on child development.

P3-J-536 - Mechanistic effects of a Family Strengthening Intervention on early child outcomes in Rwanda (Jensen)

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Background: Poverty-related risks known to affect early child development can be targeted in interventions. We present data from a longitudinal cluster-randomized trial (CRT) examining the effectiveness of Sugira Muryango (Strengthen the Family), a father-engaged lay-workers delivered home-visiting intervention for families living in severe poverty with children aged 6-36 months in Rwanda. Results from pre- to post-intervention assessments suggested that Sugira Muryango was associated with increased stimulation and positive parenting, improved caregiver mental health, and reduced family violence including harsh discipline and that children from families receiving Sugira Muryango improved more on gross motor, communication, problem-solving, and personal-social development. Here, we explore the extent to which intervention-related changes in caregiver behaviors mediate the positive effects of Sugira Muryango on children's developmental outcomes. In line with the program's theory of change, we focus on behaviors related to playful caregiving, violent discipline, dietary diversity, caregiver emotion regulation, and caregiver mental wellbeing. Methods: The CRT enrolled 1049 families. Data were collected at baseline, immediately after the intervention, and at a 12 months follow-up. Developmental outcomes were assessed using ASQ-3. Playful learning was assessed using the Family Care Indicators from UNICEF's MICS. Violent discipline was assessed using items from MICS. Dietary Diversity was assessed using USAID items that reflect whether or not the child consumed seven food groups in the past 24 hours. Caregiver emotion dysregulation was assessed using the Difficulties in Emotion Regulation Scale (DERS), and caregiver anxiety and depression were assessed using Hopkins Symptoms Checklist (HSCL-25). We use Structural Equation modeling in to examine the model presented in Figure 1. Analyses included all 1023 caregiver-child dyads. Results: Analyses included all 1023 caregiver-child dyads. The model showed acceptable fit: RMSEA = 0.071; CFI = 0.914; SRMR = 0.060. Results are presented in Table 2. As expected, we found that child development scores at baseline predicted one-year follow-up outcomes and that caregiver behaviors showed significant consistency from baseline to post-intervention. We also found that post-intervention caregiver outcomes were predicted by treatment status except for caregiver depression. Concerning the associations of changes in caregiver behaviors to child outcomes, we found that changes in playful learning activities predicted all four child outcomes namely gross motor, communication, problem-solving, and personal-social development. Changes in dietary diversity predicted all child outcomes, except communication. Indirect effects were estimated for playful learning and dietary diversity. Results show significant indirect effects of the intervention on child outcomes via playful learning activities

(p<0.05), and on gross motor and problem solving via dietary diversity (p<0.05). Conclusions: Understanding mechanisms by which early parenting interventions improve child development is important for the optimization and scale-up of programs to reach vulnerable families. Findings suggest that increased engagement in playful learning and dietary diversity are key mechanisms through which parenting intervention generates positive outcomes.

P3-J-537 - Evidence-based parenting program implemented in public policies: evaluation of a facilitator training at large-scale (Pisani Altafim)

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The literature has highlighted the importance of carrying out parenting programs during the first years of age to prevent violence against children since practices involving violence are less frequent, but may increase in subsequent years. The implementation of large-scale parenting programs with quality and fidelity linked to public policies remains a challenge, especially in low- and middle-income countries. One parenting program implemented in different countries is the ACT-Raising Safe Kids parenting program (American Psychological Association). Although previous studies evaluated the efficacy of program, there is still no study that evaluated a large-scale implementation model linked to public policies. The ACT facilitator training was adapted for an online version during the pandemic, emerging the need to evaluate this training format. The present study aimed to evaluate the effectiveness of the ACT facilitators` training to improve professionals' knowledge on positive parenting to implement the program on a large scale at a state-level, with parents and caregivers of children in early childhood, especially in the first three years of life. The study was carried out in partnership with the state government in line with public policies. Participants were 178 professionals of public services, mainly in the Social Protection and Education areas, from 24 cities of the Ceará State (Northeast, Brazil). The professionals participated in the ACT-Raising Safe Kids facilitator workshop conducted remotely by two Master Trainers and a support team totaling four days and 16 hours (Zoom Platform). From April to December 2021, seven ACT facilitator workshops were held. The participants answered an online-survey via Google Forms, including sociodemographic characteristics and their knowledge to guide parents on positive parenting. The pre- and post-evaluation questionnaire included eight questions on professionals' knowledge of parenting, violence prevention, and child development (3-points Likert scale; yes, in terms, and no). The McNemar test was used to analyze the change from pre- to post-evaluation in the proportion of participants who reported knowledge about each item of the questionnaire (Yes answer). The results (Table 1) showed that, in comparison to the pre-evaluation, there was a statistically significant increase in all the following items of professionals` knowledge to guide parents and caregivers: child development, aggressive behavior, violence consequences for children, violence-related media use, caregivers' behavior in front of their children, anger control, praising children and caregivers' behaviors when children do not behave well or do something wrong. Therefore, after the training, the majority of the professionals considered that the training effectively improved their knowledge of child development, positive parenting, and violence prevention, which was considered an essential point by the facilitators, especially during the pandemic period. The study reinforces the importance of translating science into public policy and demonstrates the need for training professionals dealing directly with the most psychosocial vulnerable families. The study

demonstrates promising results of the professionals' training, which is an important stage of large-scale implementation of an evidence-based parenting program.

P3-J-538 - Effects of harm reduction language on parent reports of infant screen media use during the COVID-19 pandemic (Heller)

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Introduction: An increased number of parents are working full-time from home while simultaneously caring for children during the COVID-19 pandemic (Heggeness, 2020). This dual responsibility is particularly difficult for parents of infants, who are limited in their ability to engage independently in tasks. Infant screen media use may help caregivers balance childcare with working full-time from home. Though current American Academy of Pediatrics (AAP) guidelines discourage screen use in children under two (Chassiakos et al., 2016), parents are not following these guidelines (Rideout, 2016; Trihn et al., 2020) and report feeling guilty for exceeding the recommendations (Dynia et al., 2021; Teichert, 2020; Vanderloo et al., 2020). Using non-judgmental, harm reduction language may help pediatricians access more accurate parental reports of infant screen media use (Heller, 2021). Accurate parental reporting allows pediatricians to work more effectively with parents to reduce infant screen time and seek out developmentally appropriate content. The current study has two goals: 1) Assess if, and to what extent, rates of screen use have increased in children under three during the COVID-19 pandemic; 2) Determine if using harm reduction language results in higher parental reports of infant screen time rates. Method: 150 parents of children between birth to 36 months completed an online survey advertised through Amazon's M*Turk platform. Participants were randomly assigned to one of three groups: Control (read nothing), American Academy of Pediatrics (read current AAP guidelines for infant screen use), or Harm Reduction (read current AAP guidelines for infant screen use + statement noting some experts believe the guidelines are too restrictive). Participants then answered a series of questions about daily infant screen use. Results: Infant screen time was considerably higher in this sample (M=108 minutes) than a representative pre-pandemic sample (M=42 minutes, Rideout 2017). A Welch's ANOVA with Games-Howell corrections revealed a significant difference between groups for parental reports of infant TV/online/streaming content viewing, $F(2, 147)=3.98, p<.05, \eta 2=.052$. Parents in the control group (M=93.5 minutes, SD=95.8) reported significantly more daily viewing of TV/online/streaming content than parents in the harm reduction group (M=50.0 minutes, SD=59.75), $p<.05$. Parental reports of infant viewing of TV/online/streaming content in the AAP group (M=69.0 minutes, SD=69.3) did not significantly differ from the other groups. Conclusions: Infants are viewing approximately one hour more of media content daily than before the pandemic. Pediatric providers should be mindful of the increased screen time rates for this age group and work with parents to ensure infants are provided with adequate opportunities to engage in activities that support healthy development. When discussing infant screen time with parents, referencing restrictive recommendations may result in underreporting. Knowing 1) infant screen time usage during this historical crisis, as well as 2) language that results inaccurate parental reports of screen use, is vital to the pediatric community's efforts to address ramifications of the COVID-19 pandemic on physical, cognitive, and socioemotional infant development.

P3-J-539 - Variation in quality of interactions offered to infants, toddlers and preschoolers in home-based childcares (Lemay)

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Research aims This presentation explores the variation in quality of interactions offered to infants, toddlers and preschoolers in home-based childcare. Relationship to previous research In early childhood education, high quality interactions promote children's development (e.g. Britto et al., 2017). However, little is known about the nature of quality of interactions in home-based childcare (Ang et al., 2016), especially when it comes to infants and toddlers as opposed to preschoolers (Ackerman, 2021; Banghart et al., 2020). What are the variation in quality of interactions in the context of a multiage group? Theoretical and conceptual framework In early childhood education, interactions between educators and children are among the most influential processes for children's development and learning (Cadima et al., 2020; Araujo et al., 2019; Sabol et al., 2013). The Teaching Through Interactions Framework (see Hamre et al., 2013 for a summary), presents the theoretical and empirical rational underlying high-quality interactions. In general, high-quality interactions must be warm, meaningful, sensitive, and stimulating (Hamre and Pianta, 2001; Sokolovic et al., 2021). Some studies indicate that the quality of interactions offered to 0-3-year-olds appears lower there the one offered to groups of children aged 3-5 years (Halle et al., 2012; Lahiti, 2015; Fenech, 2010; Vermeer, 2016), Methodology and methods Drawn from a larger sample of 37 home-based childcares, this study concerns the 8 home-based childcares (Montreal, Canada) attended by infants, toddlers and preschoolers. Interactions in each childcare were videotaped for 3 hours during a single visit in the fall 2019 and were scored using the CLASS tool, versions Infant (Hamre & al., 2014), Toddler (La Paro et al., 2012) and Pre-K (Pianta et al., 2008). Observers completed 6 observation cycles (observing 15 to 20 minutes, scoring 10 minutes), alternating between versions of the tool as recommended by Teachstone (Teachstone, 2020). Ethical considerations At recruitment, providers and families were informed about the project and standard ethical considerations and signed a consent form agreeing to participate. The research assistant had the directive to adapt the camera angle if a child did not want to be filmed. Findings, discussions While datas are still being analyzed, the results will present and compare the CLASS scores obtained with the Infant, Toddler and Pre-K versions of the tool for a better understanding of the variation in the quality of interactions in home-based childcare. Discussion stresses the pros and cons of the observation procedure for observing quality of interactions in multiage groups. We will address how to support children' development, especially infants, through initial and ongoing training of providers. Implications These findings have implications for home-based childcare providers' training, as well as policy, since many monitoring systems to ensure quality and accountability are starting to include home-based childcare.

P3-J-540 - Family environment moderates the harmful impacts of prenatal opioid exposure among adopted children (Speck)

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Prenatal opioid exposure is associated with developmental delays across multiple domains of children's development, including cognitive, psychomotor, and language development (Labella et al., 2021; Lee et al., 2020; Yeoh et al., 2019). However, one of the challenges in this research is disentangling whether this association is due to prenatal opioid exposure or because of associated adversities in the postnatal

environment (e.g., ongoing parental substance use and other correlated risk factors, such as poor parental mental health). Studies of adopted children are a potential solution to this problem because adopted children experience prenatal and postnatal environments provided by different parents. Studies examining the potential effects of polysubstance exposure, including prenatal opioid exposure, on adopted children's cognitive and attention abilities have produced mixed findings. Some indicate that adoption protects against the effects of polysubstance exposure (Ornoy, 2003; Ornoy et al., 1996), and others report that adopted children prenatally exposed to substances exhibit poorer cognitive functioning and greater inattention than children not exposed to substances (Moe, 2002; Nygaard et al., 2015). The first aim of the present study is testing whether prenatal opioid exposure specifically is associated with adopted children's developmental delays. The second aim of the current study is to test whether being placed into highly enriched adoptive family environments reduces the harmful effects of prenatal opioid exposure. Specifically, we evaluated whether family socioeconomic status and indicators of parents' psychosocial risk moderate the association between prenatal opioid exposure and children's developmental delays. To address these aims, a sample of 124 adoptive families was used. On average, children were placed at 1 month (SD = 3 months) and they had approximately 8 months (SD = 4 months) with their adoptive families at the time of the current study. Adoptive parents completed questionnaires regarding how likely their child was exposed to opioids prenatally; the Ages and Stages Questionnaire (ASQ; Squires & Bricker, 2009), which assessed children's development in five domains; the family's socioeconomic status (SES); parental stress (Abdidin, 1983); depressive symptoms (Radloff, 1977); and levels of chaos in the home (Matheny et al., 1995). Results indicated that there was not a significant overall effect of prenatal opioid exposure on children's ASQ scores, and that parents' depressive symptoms and levels of parental stress did not interact with prenatal opioid exposure to predict ASQ scores. However, experiences of chaos and prenatal opioid exposure interacted to predict the ASQ communication subscale as well as the overall ASQ score. For both outcomes, prenatal opioid exposure was associated with poorer ASQ scores only for children in low chaos homes (Figure 1). Additionally, prenatal opioid exposure was associated with poorer fine motor and problem-solving skills only for children in high SES homes (Figure 2). Taken together, these results suggest that children who were prenatally exposed to opioids fail to benefit from the opportunities afforded by high quality family environments.

P3-J-541 - Bringing developmental science to the spotlight: how to make research accessible to parents. (Sander-Montant)

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At what age will my baby talk? Is this size of vocabulary normal? These are the types of questions any parent is bound to ask, and evidence shows that more often than not they will turn to the internet for information (O'Connor & Madge, 2004). Unfortunately, browsing for answers can become frustrating due to the high prevalence of misinformation, and the specialized and technical language that is commonly used in scientific publications. Kotoboo comics (Kotoboo.org) is a project that aims to tackle this problem by bringing language development science closer to those who benefit from it the most.

Parents, caregivers, and early childhood educators appear to be in constant pursuit of up-to-date information about child development (Google Trends, 2020) . However, few studies have looked specifically at what caregivers and non-caregivers information needs are. We know little about what Internet users want to learn about and what they consider the most important in terms of accessing information about language development. Here we attempted to breach this gap and explore a solution to communicate developmental science research more effectively with caregivers, and lay audiences more broadly. We conducted an online survey that asked participants about their interests and behaviors regarding using the internet to search for information about childrens' language development. The survey consisted of 10 questions. This is an ongoing project. At the time of writing the abstract, we have 20 participants (age range: 25-64 years, M=36.85, 14 female and 6 male) of which 13 identify as primary caregivers of at least one child. We plan to have 100 participants. Preliminary survey results show that the majority of participants use the internet to look for information about language development between every other week (27%) and once a month (22%). Furthermore, all the participants think getting the latest advancements in science is helpful. Our results show that the most important features of developmental science communication that participants are looking for are those that are evidence-based, accessible, and concrete (Figure 1). Finally, our study also revealed that respondents are more frequently interested in getting information on three main themes: bilingualism, caregiving strategies, and literacy (Figure 2). We aim to further propose a science communication model that would allow developmental scientists to better communicate their findings with caregivers and other interested parties. Since 2020 we have been running Kotoboo comics, an engaging, barrier-free, evidence-based online platform that explores cutting edge topics in the field of language development. We chose the format of illustrative comics accompanied by short, easy-to-understand texts. To this date we have published over 40 freely available comics on a range of topics from bilingualism to children's screen time to sign language. After a year and a half, our community engagement has grown steadily, to this date, our comics published in English, French, Japanese, Spanish, and Arabic have reached 16,000 views and we have more and more followers on our social network platforms (Instagram, Twitter, and Facebook). Our ultimate goal is to apply our findings to a broader science communication model, bridging the gap between the science that happens in laboratories and the everyday lives of caregivers and educators.

P3-J-542 - The concerns of parents raising multilingual infants and toddlers in Quebec (Quirk)

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Parents raising infants and toddlers with multiple languages in the home frequently express concerns for their children's language development (e.g., Piller & Gerber, 2018). Understanding these concerns is important as they may influence parents' language choices with their children (Braun & Cline, 2010), which - in turn - may influence children's language outcomes (De Houwer, 2007). Yet, research on the topic is limited and largely focused on one type of context: predominantly monolingual societies (e.g., King & Fogle, 2006). The current study addresses this gap with the first large-scale quantitative analysis of parents' concerns regarding their children's multilingual development in a society where multilingualism is the norm: the Canadian province of Quebec. In an online questionnaire, 821 Quebec-

based parents of infants and toddlers (aged 0-4 years) responded to 9 Likert-scale items (from 1 to 5) designed to assess parental concerns regarding their children's multilingual development. Responses were analyzed to investigate 1) the nature of parents' concerns, i.e., if concerns patterned onto different factors; 2) the strength of these concerns; and 3) whether concern strength varied depending on parent and child characteristics. We hypothesized a) that parent concerns comprise two factors: language environment concerns and language outcomes concerns; b) that language environment concerns are stronger than language outcomes concerns; and c) that certain child and parent characteristics are associated with stronger concerns (Figure 1). Exploratory factor analysis with maximum likelihood factoring revealed that parents' concerns did indeed pattern onto two factors - but these were different from those we hypothesized (Table 1). Items that patterned onto Factor 1 centered on children's cognitive difficulties that could result from multilingual exposure, such as confusion and delays, while items loading onto Factor 2 centered on macro-level concerns related to children's language exposure and outcomes, such as parents' ability to support children as well as children's attainment of fluency. Child-centered cognitive concerns (Factor 1) were significantly lower (M=1.7, SD=0.9) than macro-level exposure-outcomes concerns (Factor 2), which were moderate in strength (M=2.3, SD=1.1). The transmission of a heritage language (HLT), i.e. a language other than French or English, the societal languages in Quebec, and acquisition of three or more languages were associated with higher levels of concern for both Factor 1 (HLT: r=.13 p<.001; trilingualism: r=.14, p<.001) and Factor 2 (HLT: r=.14, p<.001; trilingualism: r=.11, p<.01). Parents who held less positive attitudes towards the cognitive advantages that multilingualism confer reported higher levels of concern for both factors (F1: r=0.14, p<.001; F2: r=.09, p<.01). We discuss our findings in terms of their potential for improving support for parents of multilingual infants and toddlers in Quebec as well as their generalizability to other multilingual societies and to predominantly monolingual societies. Lastly, we suggest directions for future research, including an analysis of qualitative data obtained by means of an open-ended item in this questionnaire, which could add further nuance to our knowledge regarding parents' concerns for their children's multilingual development.

P3-J-543 - Automating Participant Recruitment and Research Management (Li)

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The management of developmental research is regarded as more complicated than other fields in psychological and social sciences because it involves complex relations among children, families, research personnel, and research facilities. Extensive interactions among the stakeholders (e.g., participant recruitment and communicating experimenters) often impose significant challenges to the efficiency of research progress. Despite advancements in technology, a great proportion of developmental labs still rely on manual approaches to manage their research activities, which are both inefficient and prone to human errors. Furthermore, popular research management softwares are unable to streamline the entire process of developmental research, from scheduling to managing study activities.

To better understand how labs are recruiting participants and managing research activities, we conducted a survey among developmental labs across the world. Sixty-four labs across 14 countries responded, and we found that 55% of labs spend more than 2 minutes constructing emails to participants and 73% of labs spend more than 4 minutes updating online calendars (Figure 1). These

processes are also prone to human error, with 68% of labs stating that every new research assistant makes more than 2 mistakes per month. The survey also showed that 75% of labs currently do not have methods of evaluating the performance of lab members, and about 73% of labs do not use any automatic approaches in scheduling and managing participants. However, over 86% of labs are willing to try new tools that can facilitate research management.

To overcome the current challenges in managing developmental research, we developed a web-based research management system (https://github.com/naiqixiao/DRDB). It stores information about participants, studies, research personnel, and schedules via industry-recognized database standard (MySQL). Moreover, the system is equipped with advanced algorithms that automate study schedule management and facilitate communication between families and researchers. For instance, the system allows drafting emails and creating Google calendar events to be done within 10 seconds. The system can improve the demographic representativeness of developmental research. By monitoring the demographic distribution of recruited participants, the system can assist researchers to improve the representativeness of study samples.

In addition to the functions directly facilitating research management, the system is developed for improving lab training effectiveness. The system has a "Training Mode" to facilitate training for new researchers. The built-in performance tracking subsystem provides objective performance reports for performance evaluations. By improving the efficiency of participant management, the system allows researchers to allocate more time for research activities.

As an open-source software, the system will be shared among developmental research communities. It will not only greatly benefit developmental research around the world, but will also help improve the equity, diversity, and inclusion among research participants.

P3-J-544 - Does the assessment of infant development vary with the educational background of the observer? (Pauen)

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MONDEY ("Milestones of Normal Development in Early Years") is an observational tool for caregivers of young children (0-3 years), developed in Germany (Pauen, 2011), but also available in other languages, including English. The developmental status of a given child is assessed by asking adults who see the child on a regular basis (e.g., parents, daycare teachers) to evaluate how many milestones a given child has already achieved. Milestones refer to simple behaviors, observable in everyday situations. Each well-defined milestone (total number: 111) is assigned to one of eight developmental dimensions (gross-, and fine motor-, perceptual/memory-, mental-, language-, social-, emotional-, and self-regulation development). Previous findings reveal that MONDEY has very good construct validity (Pauen et al., 2012), and inter-rater reliability (Heilig & Pauen, 2013). Heilig and Pauen (2013) found that parents report more milestones to be achieved at a given age than professional caregivers. Whether these group differences result from differences in the educational background of the observer (higher for parents than professional caregivers in the given sample) still needs to be clarified. Whereas studies using standardized tests to monitor infant development suggest that children of parents with a higher education reach higher scores (e.g., Tella et al., 2018), evidence referring to observational tools for

parents is still sparse. To fill this gap, we refer to data from a socially diverse sample of parents taking part in an ongoing longitudinal study (Bremen Initiative to Foster Early Childhood Development, BRISE; Schuette et al., 2020). So far, N = 94 complete data sets of the first wave are available for parental education, and MONDEY assessments at infants' age of 3-4 months (T1), 6-9 months (T2), and 12-15 months (T3). Using Casmin classification we split parents into Group HE (higher education: 2c-3b; N = 53) and Group LE (lower education: 1a-2b; N = 41). T-test comparisons of MONDEY z-scores revealed no significant group differences at any measurement point (see Table 1). These findings suggest that the educational background of the observer has no effect on parental MONDEY assessments - at least for infants up to one year of age. Alternatively, infants of parents from the LE group may actually be less developed than infants from HE parents (see Tella et al., 2018), but LE parents compensate for this disadvantage by granting their child more milestones than he/she has actually achieved. Future studies should compare MONDEY data with data from a standardized developmental test applied by an experimenter to clarify this issue.