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Abstract Proceedings



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Poster Session 1

A-Motor and Sensorimotor Processes

P1-A-1: Mothers talk about infant actions: How verbs correspond to infants' real-time behavior

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Verbs are notoriously difficult to learn. To learn a verb, infants must attend to continuously unfolding events, extract shared meaning among them, and connect that meaning to a word. Despite this mapping problem, infants learn hundreds of verbs by age two. How do they accomplish the verb-mapping challenge? As a start, verb learning does not occur in a vacuum. Language unfolds during the back-and-forth exchanges between infants and their caregivers. We propose that reciprocal connections between infants' actions and language inputs help infants decipher verb meanings (e.g., as an infant stacks blocks, mother asks, "Are you building a tower?"). We conducted the first naturalistic, home-based study of real-time connections between mothers' action verb usage and infants' concurrent motor actions.

We video-recorded 32 mother-infant dyads (16 13-month-olds, 16 18-month-olds) for two hours at home. From the videos, we identified each action verb mothers used to specify a manual action (e.g., press, shake) or whole-body action (e.g., bring, go). Then, we coded whether infants displayed a manual and/or whole-body action in the 3 seconds preceding or 3 seconds following the verb utterance. We further specified whether infants' actions showed precise correspondence (e.g., mother says "stack the blocks", and infant does so), partial correspondence (e.g., mother says "stack the blocks", and infant bangs blocks or stacks different object), or no correspondence (e.g., infant throws ball).

Mothers averaged 68.4 utterances per hour that contained manual (M = 39.1, SD = 22.6) or whole-body verbs (M = 29.3, SD = 13.3). Mothers' verb usage increased with infant age: 18-month-olds heard nearly double the action verbs per hour (M = 93.0, SD = 29.9) than did 13-month-olds (M = 51.9, SD = 30.21); $F(1, 13) = 8.687, p = 0.011$.

Mothers' use of manual and whole-body verbs aligned with the two types of infant actions at both ages (Figure 1). When mothers used manual verbs, infants performed more manual actions than whole-body actions, $F(1,13) = 29.277, p < 0.001$. Conversely, when mothers used whole-body verbs, infants performed more whole-body actions than manual actions, $F(1,13) = 49.74, p < 0.0001$. Thus, manual verbs tended to co-occur with manual actions, and whole-body verbs tended to co-occur with whole-body actions.

For both verb types, mothers' verbs highly corresponded with infants' behaviors. Verbs and actions showed precise correspondence more than half the time (Figure 2). Indeed, precise correspondence between verb and action was more frequent than partial or no correspondence, $F(1, 13) = 23.17, p < 0.001$.

The correspondence between infant action and mother verb use suggests reciprocal, bidirectional influences between infants' moment-to-moment behaviors and their language experiences. Infants continually interact with objects and spaces in their environment, and as they do, mothers offer words for infants' ongoing behaviors. At the same time, mothers' verb use may spur new actions in infants, thus shaping infants' interactions with the objects and spaces of their worlds.



P1-A-2: Shaping environments: Parental choices for activities and toys and later motor development and object play

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In recent decades, motor development is increasingly recognized as an important factor facilitating development in other domains (e.g., Libertus & Violi, 2016). Moreover, children show large variation in their motor development that might partially be attributed to environmental factors. This environment, the physical and social context children grow in, is mostly shaped by caregivers. Previous work has shown large differences in the way caregivers shape children's environments and suggests that these differences might have consequences for children's motor development and skills (Adolph, Karasik, & Tamis Lemonda, 2010; van Schaik, Oudgenoeg-Paz, & Atun-Einy, 2018). However, evidence for a longitudinal relation between parental choices for activities and materials and motor development is still scarce. In the current study, we investigated whether the activities parents did with their children and the materials they provided them with, at the age of 9 months, predicted children's motor development and object play cross-sectionally and longitudinally. Children were followed from age 9 months up to age 20 months. The study included 30 Dutch children. At age 9 months, parents filled in the Affordances in the Home Environment for Motor Development questionnaire (Caçola, Gabbard, Montebelo, & Santos, 2015) reporting on aspects of the home environment that are considered important for motor development. Moreover, parents reported the frequency of engaging in activities that are thought to elicit or limit movement (e.g., putting the child in baby bouncer or allowing the child to freely move on the floor). Children's motor skills were measured using parental reports about the age of attainment of major motor milestones (e.g., unsupported sitting, crawling) and by observing children's object play at 9, 12, 16, and 20 months. Results reveal that certain activities and toys are consistently related to the attainment of major motor milestones. The frequency of engaging in activities that enable more movement is related to earlier attainment of crawling and walking ($\beta=-.40$; $\beta=-.35$). Playing more with puzzles at age 9 months is also related to earlier attainment of independent sitting ($r=-.45$), crawling ($r=-.53$) and walking ($r=-.31$). On the contrary, playing more with pop-up toys is related to later attainment of crawling ($r=.33$) and walking ($r=.41$) and playing more frequently with balls is related to later sitting ($r=.37$). Moreover, use of puzzles, pop-up toys and balls were all related to more complex object exploration (i.e., making more combinations) at ages 12 and 20 months (r values range from .36 to .45). No significant cross-sectional relations were found. The results suggest that activities and toys that enable more movement are related to earlier self-locomotion attainment, whereas more stationary toys are related to later attainment of self-locomotion. Moreover, the use of toys that explicitly elicit (spatial) manipulation (such as puzzles and balls) predicts more complex object exploration longitudinally. These results demonstrate how caregivers' choices, early in the infant's life, ultimately cascade and contribute to developmental motor outcomes. In the presentation the meaning of the findings as well as the types of toys and activities that were not related to motor outcomes will further be discussed.

P1-A-3: Is the effect of infant massage different based on gender?



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Objective: This study examined the impact of gender on the effects of infant massage through statistical analysis of the Preterm infant studies database of Dr. Tiffany Field. Variables for head circumference, days in the NICU and weight gain were analyzed. This study addressed the following research questions: 1. Does change in head circumference during the NICU period differ by the type of massage received (massage, massage with oil, no massage), by the gender of the infant, or by an interaction of the two factors? 2. Does the number of days spent in the NICU before release depend on the type of massage received (massage, massage with oil, no massage), by the gender of the infant, or by an interaction of the two factors? 3. Does weight gain during the NICU period differ by the type of massage received (massage, massage with oil, no massage), by the gender of the infant, or by an interaction of the two factors? **Method:** The method of inquiry used for this study was quantitative research, specifically secondary data analysis. Multiple linear regression analyses were also completed and reviewed. **Results:** Evidence supported the research question that gender influenced the number of days spent in the NICU for premature infants who received massage. There was insufficient evidence to conclude that massage influenced weight gain or head circumference for premature infants based on gender. Results of multiple regression analyses were nonsignificant but trending toward significance. **Conclusion:** Overall, no significant differences in the effect of massage were found according to gender. Further research is needed to determine the exact cause(s) of differences between infant boys and girls. Once these determinants are identified, further research on the effects of infant massage when combined with these determinants can be explored.

P1-A-4: If you only believe: Longitudinal relations between parental beliefs about motor development and child motor skills

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Early motor skills, show considerable variability in terms of timing, sequence (order), and form. This variability is often ascribed to culture, as culture is expected to shape beliefs, practices, settings and indirectly influences child outcome (Adolph, Karasik, & Tamis-LeMonda, 2010; Super & Harkness, 2015). However, clear longitudinal evidence of these relations is lacking. Previous work has shown distinctive cultural models for Dutch and Israeli parents in their beliefs about infant motor development. Israeli parents valued stimulation and obtaining motor milestones in the 'correct' order more, while Dutch parents emphasized allowing infants to follow their own developmental pace (van Schaik, Oudgenoeg-Paz, & Atun-Einy, 2018). It remains unclear to what extent these differences are related to children's actual motor development. This study, therefore, examines the longitudinal relations between parental beliefs and child motor skills in the Netherlands and Israel. Participants included 85 parents of Dutch (N=43) and Israeli (N=42) infants. Parents filled in the Parental Beliefs about Motor Development questionnaire (Atun-Einy, Oudgenoeg-Paz, & van Schaik, 2017) during the third trimester of pregnancy and when the children were two months old. At age 10 months motor development was assessed using the Alberta Infant Motor Scale (AIMS; Piper & Darrah, 1994) and parents reported which motor milestones were obtained. A MANOVA showed that Israeli



children scored higher on the AIMS as a whole and on the prone, sit and stand subscales ($F(4,72)=2.95, p=.026, \eta^2=.14$). The fourth subscale, supine, showed a ceiling effect and was therefore not separately analyzed. Univariate tests showed that the difference was significant on all subscales and effects sizes were medium to large (η^2 range from .07 to .13). Furthermore, partial correlations show that parental beliefs at two months, but not during pregnancy, predict motor skills at 10 months. Specifically, parents who attribute more importance to obtaining advice on motor development have children with more advanced motor skills at 10 months ($r=.19$) and parents who attribute more importance to allowing the child to follow its own pace have children who score lower on the AIMS at age 10 months ($r=-.23$). Moreover, parental reports about motor milestones showed that the infants of parents who attribute greater importance to obtaining advice about motor development and reaching motor milestones in the 'correct' order at age two months more often engage in hands and knees crawl at age 10 months (both r values = .25). On the contrary, parents who attribute more importance to allowing the children to follow their own pace are less likely to have children who attained crawling on hands and knees at 10 months ($r=-.32$). Taken together, the results show that cross-cultural differences seen in motor development can, at least partially, be explained by differences in parental beliefs about motor development. The findings emphasize that parental beliefs should be considered within the constellation of factors affecting motor development. Furthermore, beliefs held after child birth seem more important for child outcomes than anticipatory beliefs held prior to child-birth.

P1-A-5: Parent-child interactions in the first six months and their relation to motor development

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Introduction: Before infants can transition among positions and gather toys on their own, early positioning and play opportunities are reliant on parents. These opportunities provided by parents can shape infants' future motor and cognitive development (Lobo & Galloway, 2008, 2012). The goals of the current study were to: 1) characterize typical parent-child interaction (PCI) in the first 6 months; and 2) determine whether there are relations between PCI and infants' motor development. Methods: Fifteen typically developing infants (2-6 months old; $M=3.3\pm 1.3$; 5 males) were assessed once at home while their parents engaged them in their typical daily activities for 40-60 minutes. PCI was video-recorded and experimenters used Datavyu to code: 1) infants' body position (supine, reclined, upright, inclined, prone); 2) infant's location (floor, held, container); 3) level of physical support from the parent (head, upper trunk, lower trunk, arm, none); 4) presence of toys (within or out-of-reach, not present); and 5) engagement in face-to-face interaction. Data were normalized. Infants' motor ability was assessed using the Alberta Infant Motor Scale (AIMS). Pearson bivariate correlation analysis was used to relate PCI and AIMS measures. Results: With age, infants spent more time in prone ($t(13)=.66, p=.008$) and inclined ($t(13)=.80, p<.0001$); parents provided less support at the head ($t(13)=-.76, p=.001$) and more at the upper trunk ($t(13)=.68, p=.006$) or arms ($t(13)=.73, p=.002$), with no change in support at the lower trunk ($t(13)=.27, p=.333$). When held, infants were typically upright, inclined, or reclined ($t(13)=.66, p=.007$) and were less likely to be presented with toys ($t(13)=-.87, p<.0001$) within reach or grasp ($t(13)=-.78, p=.001$) or face-to-face interaction with the parent ($t(13)=-.56, p=.030$). In contrast, when on the floor,



infants typically were not physically supported by parents ($t(13)=-.81, p<.0001$) and had more opportunities to play with toys ($t(13)=.96, p<.0001$) presented within reach or within grasp ($t(13)=.86, p<.0001$), and engage in face-to-face interaction with the parent ($t(13)=.59, p=.020$). In general, face-to-face interaction was associated with the presence of a toy ($t(13)=.68, p=.005$) with the toy presented within the infant's reach or grasp ($t(13)=.56, p=.029$). Infants' motor outcomes correlated negatively with support at the head ($t(13)=-.77, p=.001$) and positively with support at the upper trunk ($t(13)=.77, p=.001$) or arms ($t(13)=.66, p=.007$); however, when we controlled for age, these relations were no longer significant. Conclusions: The results suggest that: 1) PCI changes across the first half year of life as parents place infants more often in prone and provide them less physical support at the head; 2) infants are provided more opportunities for face-to-face engagement and object play when positioned on the floor rather than held; and 3) providing physical support at infants' heads is negatively related to infants' motor ability while providing support lower, at the trunk or through the arms, is positively related. Future research should aim to determine causal relations between PCI and infants' motor outcomes while controlling for infants' age. These results can be used to optimize developmental outcomes for infants, especially those at risk for delays.

P1-A-6: Prematurity effects on parental beliefs about motor development: a cross-cultural comparison

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Parents of infants born preterm often have more worries about their infant's motor development as preterm birth (i.e. before 37 weeks gestational age) predicts more motor difficulties or delays (e.g., de Kieviet, Piek, Aarnoudse-Moens, Oosterlaan, 2009). Early interventions, in which parents play a central role, therefore often target motor skills (Orton, Spittle, Doyle, Anderson, & Boyd, 2009). Empirical work suggests that prematurity affects parental perceptions of the infant and parental practices such as choice of toys, and parent-infant interaction (Stern, Karraker, McIntosh, Moritzen, & Olexa, 2006). However, little is known about parental beliefs regarding motor development among these parents. Moreover, cultural differences were found between Israeli and Dutch parents of term-born infants in their beliefs about motor development, such that Israeli parents emphasize the stimulation and importance of motor development whereas Dutch parents stress children's own pace and natural process. Given all these differences, the current study investigates differences in parental beliefs about motor development between parents of preterm and term-born children in the Netherlands and Israel, and explores the relation between beliefs, background characteristics and the level of medical risk caused by the preterm birth. Parents of preterm born children (75 Dutch and 111 Israeli) filled in the Parental Beliefs about Motor Development questionnaire (Atun-Einy, Oudgenoeg-Paz, & van Schaik, 2017) when infants were 1 to 7.5 months old (corrected age). The samples were equally spread across background variables such as SES, gestational age and medical risk level. MANOVA using culture and prematurity as independent variables showed a large main effect of culture, $F(6,563)=41.46, p <.001, \eta^2=.31$, and smaller main effect of prematurity, $F(6,563)=7.91, p < .001, \eta^2=.08$. Israeli parents score higher on the importance of: motor development, stimulation of motor development, seeking advice and the order of motor development. Dutch parents stress that children should follow their own pace. Parents of preterm born children score higher on the importance of: stimulating motor



development, seeking advice and the order of motor development. Additionally, a trimmed SEM model relating background characteristics and the medical risk fitted the data well, $\chi^2(48)=36.85$, $p=.879$, $RMSEA<.001$. This model showed that except the belief in motor development being a natural development all beliefs were mainly related to culture, β ranged from .30 to .46. The importance of stimulation was also related to gender, $\beta=.22$, and negatively related to the corrected age, $\beta=-.16$, and birth weight, $\beta=-.24$. The importance of seeking advice was also positively related to attending physical therapy, $\beta=.18$, and negatively related to birth weight, $\beta=-.14$. Furthermore, addressing importance to the order of motor development was related to attending physical therapy, $\beta.15$. The findings show a prematurity effect on parental beliefs. However, this effect is smaller than the cultural effect, which is line with previous work on parents of term-born infants. This relation could not be explained directly by risk variables related to prematurity which could be explained by the notion that besides risk, the feeling of vulnerability of parents possibly more directly affects their beliefs and practices regarding stimulation of development.

P1-A-7: The motor coordination of vocal production in late infancy

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Vocal production is a complex motor pattern requiring the coordination of several 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 exhibit concomitant delays in language development (Malas et al, 2017). How typically developing infants coordinate their entire body to produce a vocalization is not well understood.

The present study demonstrates substantial developmental changes in the temporal properties of body 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. All sounds uttered by the child were considered to be a vocalization and were included in the present study. The onsets and offsets of vocalizations were manually coded with a minimum inter-vocalization-interval of 300 milliseconds and were grouped into three categories: "speech", "speech-like", "not speech." Across development, the proportion of speech and speech-like vocalizations increase (Figure 1).

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 each age group, and for each sensor, the median rotational speed was calculated 4 seconds before the onset of a vocalization until 4 seconds after. A bootstrapped significance test indicated during which periods of time rotational velocity was different from chance. Similar changes in rotational velocity are observed for the head and hands (Figure 2). For most age levels, infants start to move before a vocalization even begins. 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.

Vocal production in infants may be the incidental result of "overflowing" motor activity (Thelen 1991, Addamo et al., 2007), however the motor coordination necessary to produce a vocalization may be indicative of general motor maturation (Fagan & Iverson, 2004, Locke et al., 1995). Alternatively, the increasing precision of producing a vocalization may be related to the intention to produce a sound. Recent neurophysiological evidence from nonhuman primates demonstrates the decision to produce a vocalization occurs more than a second before vocal onset (Gavrilov et al., 2017) and that, to produce a vocalization, related muscles activate well in advance (West and Larson, 1993). The present findings are consistent with the nonhuman primate literature and a first step in understanding the motor coordination of infant vocal production in naturalistic environments.

P1-A-8: Online reach correction in 6- and 11-month-old infants

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While infants become successful in reaching for objects from about 5 months of age (von Hofsten, 1979), it is debated whether this early control is guided in an online fashion (e.g., Ashmead et al., 1993). Here, we take a model-based approach to investigate whether infants integrate visual information about target object position in the online control of their reaching movements.

We set-up an experiment with 6- and 11-month-old infants, who reached for a toy while the position of their hand was tracked using an infra-red reflective marker (see Figure 1). Reaches were split in baseline-trials, in which the toy maintained the same position throughout the reach, and perturbation trials, in which the toy was displaced left- or rightward while the infant was reaching for it. To test whether infants are able to correct their movements online, we described the reach trajectories using an autoregression model, adapted from Saunders and Knill (2003). In this model, the position of the hand on time step t was expressed as a time-dependent linear combination of its position on time steps $t-4$ to $t-1$, plus a time-dependent offset. We restricted this model to the duration of a single movement unit, defined as the part of the reach trajectory between two local minima in hand speed around the time of perturbation. For each age group, the coefficients of this autoregression model were fitted to half of the baseline-trials. Subsequently, the model was compared to the other half of the baseline-trials, as well as the leftward and rightward perturbation trials. A deflection from the model in the direction of the perturbation would be evidence for online-correction of the reach, which should be absent in the baseline-trials.

Thus far, data of 33 infants have been collected (final sample will be 20 infants per age group). Figure 2 presents the results of preliminary analysis of the first 20 infants tested, showing the average deflection of the measured hand trajectory from the model for the three conditions, for each age group. These results suggest that infants at 11 months make clear adjustments in their reach in order to correct for the toy perturbation. This correction, which appears to occur around 0.4 s after the toy was displaced, was virtually absent in the 6-month-olds.

These tentative results suggest that, although infants learn to use visual feedback about target location to control their reach in an online fashion in their first year, this ability is not yet manifest at 6 months. However, these results does not exclude the possibility that reaches are corrected



across rather than within movement units. We plan to address this possibility in further analysis which we would like to present at the conference together with the current within movement unit analysis.

P1-A-9: Early trajectories of motor skills in infant siblings of children with autism spectrum disorder

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Autism spectrum disorder (ASD) is characterized by differences in social communication and social interaction, and the presence of repetitive or restricted interests and behaviour. Although delays in motor development are not core features of ASD, recent work studying infants who are the siblings of children with ASD suggest that early delays in motor skills may be associated with other areas of development at 36 months, including the probability of receiving an ASD diagnosis (LeBarton & Landa, 2019), ASD symptom severity score (Iverson et al., 2019), and expressive language skills (Choi et al., 2018). While these studies demonstrate the longitudinal effect of motor delays observed at single time points, there is considerable interest in determining how patterns of motor trajectories over the first three years of life relate to later developmental outcomes in this disorder. Such investigations have the potential to improve our current understanding of mechanisms underlying the emergence of ASD symptoms. We investigated early trajectories of motor development in a cohort consisting of 536 infant siblings of children diagnosed with ASD and 187 controls with no family history of ASD. Infant siblings are typically referred to as high-risk (HR) since about 20% of siblings receive ASD diagnoses (Ozonoff et al., 2011). Data for the current study were drawn from the Canadian Infant Sibling Study - a prospective multi-site study of HR infants (Zwaigenbaum et al., 2005). We evaluated separate trajectories of fine and gross motor development over the first three years of life using group-based trajectory modeling (GBTM). GBTM divides a heterogeneous cohort into distinct groups based on their patterns of motor development across time. We then assessed how group membership was related to expressive language, receptive language (Mullen Scales of Early Learning), ASD symptom severity (Autism Diagnostic Observation Schedule), and the presence of an ASD diagnosis at 36 months. Our analysis of fine motor development revealed four separate groups (Figure 1) characterised by varying degrees of inclining trajectories. Fine motor group membership was significantly related to diagnostic category at 36 months (chi-squared, $p < .001$). Significant differences were seen across fine motor trajectory groups for expressive language (Kruskal-Wallis, $p < .001$), receptive language (Kruskal-Wallis, $p < .001$), and symptom severity (Kruskal-Wallis, $p < .001$) at 36 months. Similar results were seen for gross motor scores, analysis of which also revealed four trajectory groups (Figure 2). Gross motor trajectories were characterized by three groups that exhibited stable inclining trajectories and a fourth group in which development slowed between 12 and 24 months. Gross motor group membership was significantly related to diagnostic category at 36 months (chi-squared, $p < .01$). Significant differences were seen across gross motor trajectory groups for expressive language (Kruskal-



Wallis, $p < .001$), receptive language ($p < .001$), and ASD symptom severity (Kruskal-Wallis, $p < 0.05$) at 36 months. Taken together, these results demonstrate associations between early patterns of motor delays and multiple important developmental features. These findings support that motor delays may have cascading effects on language development and suggest that interventions addressing early motor delays may have benefits across several areas of development.

P1-A-11: The Early Motor Questionnaire (EMQ): An exploration of item structure by age

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Parental report measures can provide valuable information on infants' development. The Early Motor Questionnaire (EMQ) is a parent report measure of early motor development covering gross motor skills, fine motor skills, and perception-action integration skills for ages two to 24 months and includes 128 items. Unlike other motor assessments, the EMQ does not assume that motor skills are achieved in stages. Rather, the EMQ takes an individual differences approach that allows children to succeed in one set of skills but show delays in another. Consequently, it has been identified as a potential instrument for use in a clinical setting as an assessment of motor delay (Kjølbye, Drivsholm, Ertmann, Lykke, & Køster-Rasmussen, 2018). The EMQ also has the potential for practical applications in clinical settings. Parents spend on average 20 minutes in waiting rooms to see their pediatrician, and the EMQ requires approximately 17 minutes to complete. Thus, this measure could be used as a more sensitive inventory of motor ability in pediatric settings, replacing more blunt assessments that are limited to only the largest motor milestones. However, little is known about the average score of gross motor, fine motor, and perception action skills children receive on this measure at each age, and how much variation from the mean can be seen both from average scores and in item-by-item performance at each age. The current project aims to address this knowledge gap by using over 650 parent-completed EMQ samples (data collection ongoing) from multiple sites to analyze child scores on each item. Specifically, results will enable us to state the average range of performance of typically developing children for gross motor, fine motor, and perception-action development. Preliminary data suggests linear distribution of infant motor development across age from birth to age 24 months, which provide the baseline for calculating mean scores and variation from the mean at each age (see Figure 1). Exploring this information at the item-level of each subscale of the EMQ will increase understanding of the behavior of the measure, allowing for future development of a short-form questionnaire using key variables identified in a large sample. Since the EMQ is available for free and has been translated into several languages, increasing the usability and interpretability of this measure is likely to increase its use in developmental research. Applications of the EMQ include quantifying the effectiveness of motor interventions, and examining the relation between motor development and other domains.

P1-A-12: Infants' motor learning ability assessed: Adaptation to coriolis forces in reaching



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Acquiring novel motor skills like swimming is much harder at a later age. This suggests that motor learning ability changes with age. Measuring and quantifying infants' motor learning ability has thus far been hard if not impossible due to the lack of age-appropriate tools to measure learning in the lab. To overcome this methodological hurdle, we constructed a room that can rotate in the horizontal plane, hereafter called carousel. Reaches inside the carousel will initially deviate in the direction of transient Coriolis forces generated by the motion of the arm relative to the rotating carousel. Adults quickly learn to compensate for these non-contact forces, showing straight reach trajectories after approximately four reaches in a carousel (Lackner & Dizio, 1994). This swift learning in adults makes a carousel a promising tool to study motor learning in infancy.
The current study aimed to uncover whether the rate of motor learning increases in infant development. Do infants adapt their reaches to Coriolis forces and do older infants need fewer trials to fully adapt? To address this question, 9- and 15-month-olds were invited to the carousel lab (n = 7 per age group thus far, final sample will be 20 per group). Infants seated in the center of the carousel were encouraged to reach for objects which were offered one-by-one by the experimenter. Infra-red reflective markers attached to the infant's hands enabled tracking their hand movements at 100 Hz. Rotation direction (clockwise, CW, or counterclockwise CCW) was counterbalanced between participants.
To test whether reaches were affected by the rotation, the maximum lateral deviation (MLD) from a straight line trajectory was calculated per reach and subsequently averaged per infant. CW rotation should lead to leftward, and CCW rotation to rightward deviations. Preliminary results indicate that rotation direction had a marginally significant effect on the MLD ($F(1,10) = 3.996, p = .074$), which did not interact with age ($F(1,10) = 1.085, p = .322$). Reaches during CCW rotation significantly deviated to the right ($t(5) = -3.246, p = .019$), whereas reaches during CW rotation did not deviate systematically ($t(6) = 1.082, p = .328$, see Fig. 1). MLDs that decrease over trials would signal learning. Therefore, an exponential function was fit to the MLDs per infant: $MLD(\text{trial}) = a \cdot \exp(-\text{trial}/\tau) + b$. If learning is present, the reciprocal of the time constant (τ) should be larger than zero. Across participants, the reciprocal of τ was close to zero, indicating no motor learning, though visual inspection of the data (Fig.2) suggests that some of the 15-month-olds might be able to learn to compensate for the Coriolis forces within the experiment. The full sample will be presented at the conference.
In sum, we found preliminary evidence that infants' reaches can successfully be perturbed by the Coriolis force that arises when arm moves while the body rotates. However, we did not find clear evidence in the current preliminary data that at group-level 9- or 15-month-olds are able learn to compensate for these perturbations within the timescale of an experiment.

P1-A-13: I choose where to look: Eye movements in the first years of life

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We constantly alternate saccades and fixations to actively explore our visual environment and interact with it. Saccades are rapid eye movements that bring visual stimuli that attract our



attention and/or are relevant to our goals to the high-resolution fovea of the retina. During fixations, the selected information is properly extracted and processed, and the following saccade is programmed. Saccade generation relies thus on two key processes: where to go and when to go, which are measured by saccade amplitude and saccade latency, respectively. Saccade amplitude is the distance travelled by the saccade between starting eye position and landing eye position, and determines saccade accuracy. Saccade latency is the time between stimulus presentation and saccade triggering. Most of our daily saccades are voluntarily generated, that is based on an endogenous decision depending on our goals and motivations (e.g. reading, face processing...). Saccades can also be reactive when directed toward a novel visual stimulus in our environment. From birth eye movements support infants' motor, social and cognitive development, from reaching and grabbing an object, responding to a smile, to reading their first words. Because eye movements provide a unique window into cognitive and socio-cognitive processes during development, eye-tracking techniques have met a great success in various studies in developmental psychology. Surprisingly, very little attention is paid to the basic characteristics and early development of oculomotor control. Studies usually use the adult model to analyse and interpret children eye movement behavior and thereby make inferences about the underlying cognitive processes. Here, we examined latency and amplitude of saccades in infants and toddlers. We previously showed that immature reactive saccade (RS) performance in 7-42 month-old children improve with age (for latency) and across trials (for accuracy), suggesting differential effects of brain development and experience. While RS are easily elicited notably in preverbal children, voluntary saccades (VS) are generally initiated following an instruction to look toward a preexisting stimulus, or toward complex visual scenes. Moreover, RS and VS are controlled by partially separate neural networks, which undergo specific anatomical changes during child development. We recently adapted our protocol (Alahyane et al., 2016) to elicit VS without verbal instruction in 43 9- to 40-month-old children compared to adults. To prompt a decision, two identical peripheral stimuli appeared simultaneously at 10° eccentricity from a fixation point (140 trials). Preliminary results showed that infants and toddlers were able to select and direct their gaze toward one target without any explicit task instruction, and that they generated VS with slower latency (M=453ms, SD=104ms) than adults (M=212ms, SD=41ms). Saccade latency decreased as age increased, suggesting developmental improvements in saccade control. Compared to RS (M=238ms, SD=38ms), VS in children had longer latency but also higher accuracy (M=9.37°, SD=0.49° vs. M=8°, SD=0.57°); VS were almost as accurate as adults' (M=9.63°, SD=0.62°), suggesting a benefit from additional time for better saccade accuracy. Characterizing early development of saccade control lays the groundwork for a better understanding of typical and atypical development of cognitive and socio-cognitive processes at both theoretical and methodological levels.

P1-A-14: Sensorimotor coordination in infants with hearing loss

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Infants develop their cognition by perceiving and acting on their environment. One of the most important milestones in infancy is the successful development of sensorimotor abilities, such as achieving predictive control of actions and coordinating behavior with other objects and people (von Hofsten, 2019). In the current study, we investigated the sensorimotor skills of



infants with congenital hearing loss, before cochlear implantation (i.e., before receiving access to sound). In previous work, we showed that hearing loss affects infants' visual processing, suggesting that early deafness has widespread consequences on general cognitive development. However, the role of auditory experiences and the impact of hearing loss on sensorimotor development is still unknown. To address this question, we used head-mounted eye-tracking to conduct microanalyses of deaf infants' sensorimotor coordination during a naturalistic parent-child interaction. There is some evidence for motor delays in deaf children, based on standardized assessments, but when these delays emerge is unknown. Other studies have shown that hearing loss affects the interactions between hearing parents and their deaf children, but whether sensorimotor skills contribute to this is unknown. In the current study, we used head-mounted eye-tracking to investigate sensorimotor coordination in deaf infants while they engaged in a naturalistic, interactive task with their parent. Method. Nine infant-parent dyads participated in this study. Infant participants had a mean age of 10.95 months (range = 8.12-14.93; SD = 3.31). Data were analyzed from the first of three visits, as this study is part of a longitudinal project following infants up to twelve months following cochlear implantation. All infants were tested prior to receiving their cochlear implants, and therefore had no access to sound. Infants and parents completed a joint task in which they placed coins into a piggy bank, which was positioned in such a way that infants were required to coordinate their actions with their parent to achieve the goal (i.e., they could not complete it on their own; Figure 1). Both dyad members wore head-mounted eye-trackers, which capture their eye movements and field of view. Additional scene cameras recorded motor actions from a third-person perspective. Data Analyses. Recordings from the head-mounted eye-trackers were calibrated offline and exported into a series of single frames. Infant gaze and manual actions were coded frame-by-frame by two trained coders to determine, for every frame, where infants were looking and what they were doing with their hands. To investigate sensorimotor coordination, we examined (1) infants' anticipatory gaze for their own reaching actions and the actions of their parents, and (2) infants' hand-eye coordination, defined as moments in which infants were looking at and holding the same object. We will present preliminary findings from our initial analyses of the data collected thus far, and highlight the potential of this novel approach to garner new insights into the sensorimotor abilities of infants with hearing loss.

P1-A-15: Children use communicative signals to segment action sequences

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Humans are cultural learners and engage in cultural learning already from infancy. An important question remains whether and why children learn better in pedagogical interactions with adults, compared to observational learning. It is possible that child-directed interactions are particularly suitable for teaching purposes, because they support the segmentation and chunking of actions into appropriate units. When children learn about an action, they need to be able to identify its beginning and end, and each constituent unit of the action. One source that might be particularly suitable to segment and chunk events might be parents' use of communicative signals parents use direct gaze particularly at event boundaries (Brand, Hollenbeck, & Kominsky, 2013; Brand, Shallcross, Sabatos, & Massie, 2007). In the current study, we investigated whether communicative signals help 18-month-olds segment an action



sequence, thereby changing which parts they imitate. We adapted a study by Carpenter, Call, and Tomasello (2005) in which an experimenter was hopping or sliding an animal into a house. Toddlers predominantly imitated the outcome (i.e. putting animal into house) but not manner (hop/slide). We hypothesised that addressing toddlers communicatively (communicatively ("Wow!" and direct gaze to the toddler--boundary marked communicatively) or non-communicatively (short "Hmm.", gaze onto table--boundary marked control) after the hopping/sliding, but before the animal entered the house, makes them encode manner and outcome separately, increasing their manner imitation. As a baseline, we presented the "Wow" after putting the animal into the house (boundary unmarked). Using a mixed effects analysis, the model with the Action Type (Hop, Slide) and Marker (Baseline, Marked--Communicative, Marked--Control), was significantly better ($\chi^2(3) = 13.05, p = .005$) than the Marker-only model, which in turn was significantly better than the null model ($\chi^2(3) = 6.39, p = .04$). Subsetting by Action Type shows that toddlers are more likely to imitate sliding with a communicatively marked boundary (M = 40%, 95%CI = 24%, 57%, $\beta = 1.51, z = 2.42, p = .02$) compared to the baseline (M = 12%, 95%CI = 5%, 27%), but not for the marked--control condition (M = 13%, 95%CI = 5%, 30%, $\beta = 0.13, z = 0.18, p = .85$). However, for the hopping action no such effect is observed and neither the communicatively marked condition (M = 42%, 95%CI = 27%, 59%, $\beta = -0.39, z = -0.63, p = .53$), nor the marked--control condition (M = 27%, 95%CI = 14%, 45%, $\beta = -1.21, z = -1.76, p = .08$) is significantly different to the baseline (M = 50%, 95%CI = 33%, 67%). We found different effects of boundary marking for the two actions we investigated. For the salient hopping action, marking the boundary between the action manner and outcome did not increase already high levels of imitation. For the less salient sliding action, marking the event boundary communicatively increased imitation considerably, an effect absent for the control marker. Our results suggest that children may use communicative signals as boundary markers, but only for action sequences that are not easily segmented on their own.

P1-A-16: Asymmetrical upper extremity movements in infants with and without neonatal stroke

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Purpose: Hemiplegic cerebral palsy (CP) is often the result of a neonatal stroke. Just like an adult with a stroke, infants have motor impairments and neglect on one side of their body resulting in asymmetries. These pathological asymmetries are subtle and hard to identify in infancy. One reason is that infants who are typically developing and do not have neonatal stroke also show lateralities. The purpose of this study is to measure the quantity and quality of arm movements with using kinematics in infants with and without neonatal stroke. We hypothesized that diagnosis, age, and affected side are significant predictors of common measures of upper extremity coordination such as movement frequency, movement speed, and movement length. Methods: N=11 full-term infants, 5 TD, 6 with NS participated in this 10-visit longitudinal study from 8 weeks of age to 28 weeks of age. Passive reflective markers were placed on both hands. A 10-camera VICON motion capture system recorded movements of the markers at 120 Hz during a reaching paradigm. Infants were presented with a colorful toy at midline and shoulder height for 30-second trials while seated in an infant chair with trunk and head support. The paradigm included trials where both hands were free and where each hand was free while the other hand was gently constrained. A diagnosis of CP was confirmed



by 18 months for half of the infants with NS. Results: Multiple linear regression models were created using backwards selection to determine significant predictors of the dependent variables. Constraint, diagnosis, and their interaction were significant predictors of movement frequency, with the infants moving significantly more in the constraint trials and infants with CP moving the least overall ($F(5,149)=5.99, p=.000$). For movement length, age and the interaction between age and diagnosis were significant predictors, with infants moving significantly longer distances as they got older, infants with CP moving the shortest distances, and infants with TD the longest ($F(11,143)=6.45, p=.000$). For movement speed, infants with NS and no CP and infants with CP both moved significantly slower than infants with TD, and all infants moved significantly faster at 5 and 6 months than they did at 3 months ($F(5,146)=7.91, p=.000$). Some of these data and conclusions have been presented elsewhere. Conclusions: Infants moved more frequently with constraint, and infants with NS with and without CP moved less frequently than infants with TD, with a greater decrease in the constraint trials. Contrary to our hypothesis, constraint was not a significant predictor of movement speed or length. Infants with NS with and without CP were moving slower and shorter distances than infants with TD, and all infants increased their speed and length of movement with age, as predicted. This is a preliminary study with important findings. Constraint, in real time, may be effective in increasing the movement frequency of an affected arm in infants with NS with or without CP. Other interventions are likely necessary to improve movement quality in the affected arm for functional use.

B-Developmental Neuroscience

P1-B-17: Using mu power to study 18-month-olds' context-dependent action processing: The case of verbal cues

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According to behavioral research, infants can infer others' intentions from behavioral or verbal cues. Patzwald and Elsner (2019) showed that infants also integrate these social cues based on their coherence, because here, 18-month-olds imitated actions that were congruent with an adult's verbal action intention more often than incongruent actions. Yet, the electrophysiological underpinnings of the integration of social cues in infancy have received comparably little attention. Past research suggests that the neural mirroring system is involved in processing another's goal-directed actions already in infancy, and that it may be sensitive not only to bottom-up perceptual information but also to top-down processes, for instance triggered by the action context. Adapting Patzwald and Elsner's paradigm, we investigated in an EEG-study whether infants show differential patterns of motor activation that is, of central mu power (6-9 Hz, over C3, C4), towards perceptually identical action stimuli, which would point towards an integration of the coherence of goal-related verbal cues and subsequent goal-directed behavior. In a within-subjects design, 18-month-olds ($N=38$) watched videos of an adult performing the same out of two potential actions on a novel object. Depending on condition, she preceded her action demonstration with a verbally announced action intention that either matched (congruent; e.g., "up" and upward movement) or mismatched



(incongruent; e.g., "down" and upward movement) this action demonstration (Figure 1). Depending on what the precise cognitive process underlying infants' cue integration may be, it is conceivable to expect reduced central mu power (i.e., enhanced motor activation) for either the congruent action (indicating the covert preparation of selective imitation; Filippi et al., 2016; Frey & Gerry, 2006), or the incongruent action (indicating the need for updating predictions about how an action may unfold; Kilner et al., 2007; Stapel et al., 2020). Because same-aged infants in Patzwald and Elsner's (2019) study preferentially imitated the congruent over the incongruent action, and because past research demonstrated a positive relation between infant motor activation during observation of another's goal-directed action and their subsequent tendency to imitate (Filippi et al., 2016), we expected reduced central mu power for congruent relative to incongruent actions. Analyses confirmed this hypothesis over C4 (Figure 2). This reduced mu power for the action when it matched the verbal cue, relative to a mismatch, was related to infants' receptive action-related language skills. We conclude that mirroring mechanisms are influenced by the coherence of social cues, and that development in related social-cognitive abilities is related to this process.

P1-B-18: Relation of motor competence and neural mirroring of motorically familiar and unfamiliar means-end actions in 10-month-olds

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Action production and perception lead to overlapping neural motor activation (neural mirroring) which is suggested to serve as a basis for action understanding (Hunnius & Bekkering, 2014). It is further proposed that own action experience influences perception of others' actions (Woodward & Gerson, 2014). Recent evidence shows that neural mirroring is tightly associated with actions that infants have experience with and for motor skills in which they are competent in (van Elk et al., 2008; Cannon et al., 2016). Others suggest that neural mirroring is not restricted to actions in one's own motor repertoire but extends even to non-executable actions (Southgate & Begus, 2013). At the intersection of motorically familiar and non-executable actions are novel actions that infants have not performed before, like tool-use actions. Southgate and Begus (2013) found that infants show neural mirroring to novel actions using a claw tool as well as to familiar grasping actions, while Cannon et al., (2014) found that adults who had more active motor experience using a tool showed stronger mirroring compared to novices. With these findings in mind, we asked: Do infants differ in mirroring dependent on the motorical familiarity of the observed action? Is there a relation between mirroring and motor competence of that action? We examined infants' neural mirroring during perception of means-end actions of grasps (motorically familiar) and tool-use actions (motorically unfamiliar), and how infants' own motor competence in production of these actions relates to their neural mirroring. In a within-subjects design, we first showed 10-month-old infants ($n=17$, $m=9m20days$) videos of someone grasping a toy or pulling a cane to retrieve a toy (Figure 1). This observation phase was followed by an execution phase, where we examined infants' own production of grasps and tool-use actions (Figure 1). As indicator of neural mirroring, we analyzed the power of the alpha frequency band (6-9Hz) over central electrodes during observation of grasping and cane actions relative to baseline (i.e. a person without movement). Results show mu ERD indexing motor activity during perception of both



familiar and unfamiliar means-end actions compared to baseline ($t(16)=-9.5$, $p < .001$; $t(16)=-13.7$, $p < .001$, respectively); we found no evidence for a difference between 10-month-old infants' neural mirroring of familiar and unfamiliar actions ($BF_{10}=1.67$; Figure 2). Regarding the relation between neural and behavioral measures, we found that infants' competence in execution of the action (grasp or cane use) was associated with stronger action mirroring during observation of the corresponding action ($r=.45$, $p=.08$; $r=-.53$, $p=.04$, respectively; Figure 2). These findings suggest that the neural motor system supports the perception of actions, though infants' neural mirroring was not restricted to motorically familiar actions, and neural mirroring is stronger for the actions that infants are competent in. We are currently following this up with a sample of 12 to 13-month-old infants to investigate age-related differences in the link between mirroring and motor competence. We are also measuring a full scope of motor development to explore the functional link between the aspects of motor skills that facilitate action understanding.

P1-B-19: Infants acquire novel actions through a neural processes in their motor cortex

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Social learning is integral to human development and the transmission of cultural knowledge and skills. From early on, human infants acquire novel actions through observation and imitation. While several works have looked at the neural mechanisms underlying goal-directed-reaching actions, the neural mechanisms that underlie infants' acquisition of novel transitive actions (i.e., actions performed with an object) are not well understood. Here, we assessed 10- and 20-month-olds' ($n = 42$; $n = 36$) electroencephalogram (EEG) during the observation of novel transitive actions, followed by an assessment of the imitation behavior in 20-month-olds (Figure 1). This allowed us to examine (1) the neural processes during action observation in 10- and 20-month-olds and (2) whether these processes predict the subsequent imitation behavior in 20-month-olds. In addition, we assessed the effect of different communicative signals on infants' neural processing and action learning. This is, some of the actions were presented after a communicative ("Hey, look here", gaze contact, pointing, high pitch voice) or a non-communicative ("Hmm, I will have a look", no gaze contact, pointing at the chin, low pitch voice) introduction by the model. Our results revealed an increase in the 7 – 10 Hz rhythm in the motor cortex (C3, C4; see Figure 2A) during action observation predicted the action imitation in 20-month-olds (Figure 2D). Furthermore, 10-month-olds, who did not yet reliably imitate others' actions, showed very similar neural activity during action observation (Figure 2A). Communicative signals did neither affect infants' neural activity during action observation nor their subsequent imitation behavior. Noteworthy, former studies reported a decrease in the infants' 6 - 9 Hz neural activity, for example, when infants observed goal-directed reaching actions. The present study differs from most previous studies in critical ways. First, we showed infants' transitive actions, and, second, we applied a trial-based subsequent memory design. Communicative signals did not affect infants' neural processing and imitation rates. In our view, these findings do not put in question that communication may facilitate social learning, but suggest that infants generally have a high proclivity to imitate others, which is not strongly



reliant on communicative signals. In conclusion, our findings constitute direct evidence that infants acquire novel transitive actions from others through a neural code in their motor cortex – a key mechanism that underlies early human brain development and cultural learning.

P1-B-20: Parent attitudes to remote in-home monitoring technologies for infant research

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Introduction: Our current understanding of infant neurocognitive development is primarily generated from results produced in university babylabs^{1,2}. Babylab settings often lack ecological validity, generalisability and scalability^{2,3}. Remote in-home infant monitoring may be key to improving these shortcomings of babylab-based investigations. Wearable technologies^{4,5} (e.g. bodysuits⁶, electrode stickers⁷ or wrist/ankle bands⁸ containing sensors), video and audio recording and/or smartphone questionnaires are examples of technologies that could be utilized. The deployment of such technology needs to be acceptable and practical, require little training and should not intrude on the family's privacy or disrupt their daily routine. To aid the responsible development of these technologies, we aimed to investigate stakeholders' requirements and acceptability. Methods: We conducted a survey with 410 parents on opinion of remote in-home monitoring technologies for infant research. Multiple choice and open field questions focused on the practicality, privacy and transparency of technologies such as infant-friendly wearable devices, video/audio recording and smartphone apps. Results: Wearable devices containing sensors such as bodysuit and wrist/ankle bands were viewed more favourably over traditional electrode sensors. Parents were more likely to accept video and audio recording in the home if data was anonymised (through automated processing) at point of collection. Stakeholders were more open to international data sharing for anonymous data and wanted to directly view their child's sleep, video and audio data. Discussion: Taken together, our results indicate generally positive attitudes to remote in-home monitoring technologies for infant research but highlights specific considerations such as safety and privacy that must be taken into account when developing future studies. References: 1.Ballieux, H. et al. Feasibility of Undertaking Off-Site Infant Eye-Tracking Assessments of Neuro-Cognitive Functioning in Early-Intervention Centres. *Infant Child Dev.* (2016). 2.Bronfenbrenner, U. Toward an experimental ecology of human development. *Am. Psychol.* (2006). 3.Schmuckler, M. A. What is Ecological Validity? A Dimensional Analysis. *Infancy* (2001). 4.Ajami, S. & Teimouri, F. Features and application of wearable biosensors in medical care. *Journal of Research in Medical Sciences* (2015). 5.Patel, S., Park, H., Bonato, P., Chan, L. & Rodgers, M. A review of wearable sensors and systems with application in rehabilitation. *Journal of NeuroEngineering and Rehabilitation* (2012). 6.Rogers, E., Polygerinos, P., Walsh, C. & Goldfield, E. Smart and Connected Actuated Mobile and Sensing Suit to Encourage Motion in Developmentally Delayed Infants 1. *J. Med. Device.* (2015). 7.Curtindale, L. M., Bahrick, L. E., Lickliter, R. & Colombo, J. Effects of multimodal synchrony on infant attention and heart rate during events with social and nonsocial stimuli. *J. Exp. Child Psychol.* (2019). 8.Singh, M. & Patterson, D. J. Involuntary gesture recognition for predicting cerebral palsy in high-risk infants. in *Proceedings - International Symposium on Wearable Computers, ISWC* (2010).



P1-B-21: Neural responses to touch in naturalistic mother-infant interactions

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Caregiver touch and physical proximity play a vital role for infant's growth and development (Field, 2002). The potential benefits range from interpersonal emotion regulation to establishing a secure attachment relationship between caregiver and infant (Feldman et al., 2009; Beebe et al., 2010). Still, little is known about the neurophysiological mechanism underlying touch and proximity in naturalistic caregiver-child interactions. In human adults gentle stroking has been shown to activate C-tactile fibers specifically, which are unmyelinated peripheral nerve fibers (Löken et al., 2009). These fibers preferentially respond to stroking with medium velocity, which is associated with pleasant touch and affiliative bonding. In a previous study, cortical activation in infant's inferior frontal gyrus did not differentiate between affective and non-affective touch (Pirazzoli et al., 2019). The authors assume that the standardized application of touch through an experimenter's hand might have attenuated infant's response and further social signals might be needed for infants to be able to distinguish affective touch from other forms of touch. Here, we examined infant's neural response to various forms of touch in a naturalistic mother-infant interaction. In the present study, 4-6-month-old infants and mothers were tested in a naturalistic free play condition without toys for five minutes. During the interaction, functional near-infrared spectroscopy (fNIRS) was assessed in 22 measurement channels located over the inferior frontal gyrus, lateral and medial prefrontal cortex bilaterally in both mother and infant. fNIRS signal was preprocessed using the homer2 toolbox in MATLAB and brain activation patterns were derived using the general linear model approach established in the SPM12 toolbox. Touch was micro-coded frame by frame and the interaction segmented into moments of active touch (e.g. stroking, poking, kissing), passive touch (static touch, holding), functional touch (e.g. adjusting the infants' clothes), infant touching the mother and no touch. Interrater reliability was moderate to high and ranged between kappa=0.71-0.89. The duration of each touch category was used in further statistical analyses. Preliminary results (n=27, 15 females, average age 4;11 months, 148.1 days) from linear mixed effects modelling reveal an interaction effect of active touch and region of interest, $F(4,7.42)=11.42$, $p=.003$ (as depicted in Figure 1) and an interaction effect of passive touch and region of interest, $F(4,7.42)=4.51$, $p=.04$. Looking further into our regions of interest, we find higher activation in the inferior frontal gyrus and medial prefrontal cortex to be related to longer durations of active and passive forms of touch. Functional touch, however, had no significant effect on infant cortical activation patterns, $p=.29$. Accordingly, infants seem to show adult-like cortical responses to longer durations of maternal affective touch, but not to non-affective touch during mother-infant interactions. The results will be discussed concerning the role of naturalistic interactions in providing multisensory stimulation to guide infant's neural processing of affective forms of touch.

P1-B-22: Limbic white matter structural integrity prospectively predicts negative emotionality in infants: A preliminary study



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Rapid development of the human brain in the first years of life establishes important brain-behavior relationships that set the stage for future health. Little is known about how early alterations in white matter microstructure relate to clinically relevant behaviors such as emotional dysregulation. Thus, our goal was to examine white matter structural integrity within key limbic (i.e., uncinate fasciculus and cingulum) and association (i.e., forceps minor) bundles in 3-month-old infants and determine their prospective relationships to behaviors encompassing negative emotionality (NE) at 9 months. Mothers (age 19-24) and their 3-month-old infants were recruited from the longitudinal Pittsburgh Girls Study. At 3 months, diffusion weighted imaging (DWI) was performed on a 3T scanner (Siemens Skyra, 32-channel coil) during natural, non-sedated sleep. DWI data were acquired using a multishell scheme and manually realigned, motion and eddy current corrected, and reconstructed in native space using generalized Q-sampling imaging (GQI). Tractography was performed for each tract within each infant (n=20). Measures of structural integrity, quantitative anisotropy (QA) and normalized QA (NQA), and tract volume were extracted from each tract from each individual and averaged across hemispheres (for cingulum and uncinate). At 9 months, NE was elicited using two Laboratory Assessment of Temperament (Lab-TAB) tasks, Gentle Arm Restraint (two 30-sec trials) and Toy Retraction (three 15-sec trials), which elicit anger/frustration. Infant NE was coded using time-sampled ratings on 5-point scales. Nine white matter tract variables (QA, NQA and volume from each tract) were included in an elastic net regression, along with the infant's cohort, sex, age at time of scan, age at time of behavioral assessment, socioeconomic status (SES), and the mother's Edinburgh Postnatal Depression Scale (EPDS) scores at 3 and 9 months. The outcome variable was a NE composite score (averaged facial distress and vocal distress from both tasks and struggle from the gentle arm restraint). Uncinate NQA (-.155), uncinate volume (.088), sex (.049, greater NE in females), EPDS (3 months, -.026), SES (.010), cingulum NQA (-.010) and neonatal age at 3 months (.003) were all selected by the elastic net as predicting NE at 9 months. Of these, uncinate NQA was most predictive, indicating that greater uncinate structural integrity was associated with less NE. When entered into a standard hierarchical regression, with sociodemographics in step 1 and neural predictors in step 2, step 1 accounted for 69.6% of the variance, while step 2 accounted for an additional 17.3% of the variance (86.9% total; $F=5.307$, $p=.006$). Of the neural predictors, uncinate volume was the most robust predictor of NE (St. Beta=.420, $p=.017$). Cingulum NQA was also a robust predictor (St. Beta=-.370, $p=.290$), although non-significant. Our findings revealed prospective brain-behavior relationships in infants, demonstrating that greater uncinate structural integrity predicted less NE, while greater uncinate volume predicted greater NE. These findings may provide insights into the optimal development of uncinate microstructure (e.g., greater myelination and less dispersion) allowing greater emotion regulation capacity. Understanding such brain-behavior relationships may contribute to early identification of risk or intervention for behavioral and mental health problems later in life.

P1-B-23: The relationship between neonatal brain volumes and childhood cognitive outcome in Down Syndrome



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Background: Recent evidence has shown that brain abnormalities found in people with Down Syndrome (DS), such as reduced brain volume, are present antenatally, and can appear as early as 25 weeks of gestation (Patkee et al., 2019). It is also well established that cognitive development in infants and children with DS is delayed relative to their typically developing peers, and that there are wide individual differences in cognitive abilities within this population (Karmiloff-Smith et al., 2016). Aims: This project is the first attempt to link early structural brain imaging in the neonatal period with subsequent neurodevelopmental outcomes in DS. The aim is to determine whether identifying markers of early brain growth can predict subsequent cognitive outcome. Methods: Neonates were recruited with ethical approval at the Centre of the Developing Brain at St. Thomas' Hospital, London, UK. Magnetic resonance imaging (MRI) was performed on a 3T scanner on DS (n=10, 32-45 weeks postmenstrual age (PMA)), and typically developing (TD) neonates (n=50; 32-45 weeks PMA). 3D reconstructions were obtained and different regional brain volumes (e.g. cortex, cerebellum, amygdala, hippocampus and thalamus) were produced using an optimised automatic neonatal brain segmentation algorithm (Makropoulos, et al., 2018). Neuropsychological assessments were then performed at Birkbeck College, UK on these infants with DS, at age 6 months to 5 years. The Mullen Scales of Early Learning (Mullen, 1989) was used to assess measures of Fine Motor (FM), Gross Motor (GM), Visual Reception (VR), Receptive Language (RL) and Expressive Language (EL). Results and Conclusion: Data collection is ongoing, but preliminary Bayesian analyses provide suggestive evidence supporting a relationship between cortical volume and all Mullen scales (FM, GM, VR, RL and EL) (B10= 4.71-9.5), and a positive correlation between cerebellar volumes and motor scores(B10= 3.42-5.70). Further analyses examining the relationship between subcortical grey matter regions and cognitive outcome will be performed.

P1-B-24: A proof-of-principle study of DNA methylation in infants with an older sibling with Autism Spectrum Disorder

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Background Preliminary evidence suggests that changes in DNA methylation contribute to the etiology of Autism Spectrum Disorder (ASD, LaSalle et al., 2016). However, data is primarily derived from post-mortem brain samples or peripheral tissue from adults. Deep-phenotyped longitudinal infant cohorts are essential to understand how epigenetic modifications relate to early developmental trajectories and emergence of ASD symptoms. We present a proof-of-principle study designed to evaluate the potential of prospective epigenetic studies of infant



siblings of children with ASD. Methods Illumina genome-wide 450K DNA methylation data from buccal swabs was generated for 63 male infants at multiple time-points from 8 months to 2 years of age (total N=107 samples). 11 of those infants received a diagnosis of ASD at 3 years. With a series of analyses, we characterized DNA methylation signatures associated with five phenotypes of interest: case-control status for ASD and case-control status for atypical development at 3 years (categorical outcomes), continuous measure of parent-reported adaptive skills at 3 years (dimensional outcome), and two infant phenotypes: face looking time in a face-popout eye-tracking task (Gliga et al., 2009) and neural response to faces, i.e. amplitude of the Nc event-related component in a face/non-face paradigm (Elsabbagh et al., 2009). Results We found suggestive evidence that probes associated with our phenotypes of interest using a "discovery" threshold of $p < 5 \times 10^{-5}$ have been previously identified as mechanisms involved in ASD emergence. Mapping networks of co-methylated probes associated with neural correlates of social attention implicated enrichment of pathways involved in brain development. Longitudinal modelling found covariation between phenotypic traits and DNA methylation levels in the proximity of genes previously associated with cognitive development. For example, GFOD1 showed an age-specific change of association with face looking between 8 and 15 months ($b = -0.008$, $p = 0.003$, False Discovery Rate-adjusted p -value = 0.08) and has been previously associated with ADHD (Figure 1). TRPM5, whose mutations are linked to ASD (Neale et al., 2012), showed significant change in direction of the association between DNAm levels and adaptive skills at 15 months ($b = -0.003$, $p = 0.002$, FDR = 0.03, Figure 2). Larger samples and more complete datasets are needed to verify generalizability of these results. Discussion Our study demonstrated that the investigation of mechanisms underpinning ASD emergence might benefit from incorporating epigenetic analysis into prospective longitudinal studies of infant siblings of children with ASD. Effects observed from epigenome-wide association analyses suggest that examining DNA methylation profiles in age-homogeneous samples obtained as part of infant-sibling designs allows for the detection of meaningful signals with smaller samples than previously estimated. We observed that DNA methylation levels in networks of sites in the genome that are associated with neural correlates of social attention at 8 months are regulated by genes involved in brain development and ASD. Moreover, significant changes in the association between DNA methylation and behavioral phenotypes were observed between 8 and 15 months. In conclusion, assessment of DNA methylation profiles at multiple time-points in infant-sibling designs is a promising avenue to comprehend developmental origins and mechanisms of ASD.

P1-B-25: Prediction and the frontoparietal attention network in the infant brain: An fNIRS study with 6-month-olds

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Infants gather information and form internal representations by allocating attention based on predictions they form in the noisy world. In support of the theorized interaction between attention and prediction (Pearce & Hall, 1980), previous research has found prediction-related frontoparietal attention network engagement in adults (Kastner et al., 1999). However, despite much behavioral evidence for infants' attentional capabilities (for a review, see Colombo, Kapa, & Curtindale, 2010) and the interaction between attention and prediction in infancy (Kirkham, 2007; Tummeltshammer et al., 2014), there is insufficient research on the attention network



engagement while infants engage in predictions. Considering that infants exhibit weak frontoparietal connectivity (myelination: Deoni et al., 2014; functional connectivity: Danmaraju et al., 2014), infant attention network may differ from adult attention network. Therefore, we aimed to explore how prediction modulates neural responses in the infant frontoparietal network. Using functional near-infrared spectroscopy (fNIRS), we analyzed the hemodynamic responses in the frontal and parietal lobes as 6-month-old infants ($n=30$) watched videos of predictable sequences (consistent temporal pattern of A-A-A-B) or unpredictable sequences (inconsistent temporal pattern of D-C-C-C, C-D-C-C, and C-C-D-C). Based on the previously found mismatch response in the infant frontal lobe in response to unpredictable sequences (Basirat et al., 2014), frontoparietal engagement associated with endogenous attention in adults (Corbetta, 1998), and neural activation modulated by predictability (Jaffe-Dax et al., in prep; Emberson et al., 2015), we hypothesized that frontal and parietal lobe activity and functional connectivity in the infant brain differ between predictable and unpredictable sequences, reflecting a differential engagement of this attentional network depending on the predictability of events. In support of our hypotheses, the results showed that the frontal lobe activity ($t(29) = -3.3463$, $p = 0.0011$) and parietal lobe activity ($t(29) = -1.9742$, $p = 0.0290$) were significantly greater during unpredictable sequences compared to predictable sequences. In addition, the right frontoparietal functional connectivity was significantly greater ($p = 0.0228$) in response to unpredictable sequences ($r = 0.42$) compared to predictable sequences ($r = 0.26$), though we find no corresponding effects on the left. Taken together, our results reveal that the frontoparietal attention network is differentially engaged as infants employ, learn from, and process predictable and unpredictable sequences. The direction of this effect (stronger neural engagement during unpredictable sequences) has been found in many previous infant studies, and suggest that this frontoparietal attention network may be more involved with prediction testing and prediction error processing than with prediction generation. In conclusion, infant frontoparietal attention network is active while infants engage in predictions, in support of the Pearce and Hall's theory of the interaction between attention and prediction. Given the importance of attention and prediction on learning, our research sheds light on the mechanisms that support development in infancy, a pivotal period of development in human life.

P1-B-26: Investigating the application of unsupervised deep neural networks as a model for infants' visual brain development

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To understand the development of the infant brain and mind in the first year of life, it would be valuable to have computational models of the learning process. In adults, deep neural networks (DNNs), which have revolutionised artificial intelligence, are currently the best available computational models for a number of brain systems. For example, functional magnetic resonance imaging (fMRI) has been used to measure the response in the ventral visual stream to pictures of objects and DNNs trained for image recognition can predict the fMRI response to a novel stimulus. So, DNNs provide a computational model of the adult brain, but can they also model infant learning?. An issue here is that the DNNs tested against the brain so far learn how to categorize images through supervised learning, in which both the image and its respective label are provided during training. This is not a good model of infant learning, as



infants have extremely impoverished access to labels. An alternative potential training strategy for DNNs is unsupervised learning, in which images are categorized through clustering without any labels. However, the effectiveness of unsupervised DNNs in modelling adult brain representations remains yet untested. The present study aims to test whether the activation patterns within a state-of-the-art unsupervised DNN correlates with brain neural activation patterns similarly to supervised networks. One unsupervised and one supervised network were exposed to two sets of images and the representational structure of their activation patterns were compared to that of fMRI neural patterns in early visual cortex (EVC) and inferior temporal (IT) cortex. The analyses were then repeated on the untrained networks. Results show that the supervised and unsupervised DNNs were similarly correlated with adults' brain representations. Furthermore, while lower and upper layers of the untrained networks all behaved in the same way representing mainly perceptual features of the input images, in the trained networks the behaviour of lower and upper layers dissociated. Specifically, lower layers better correlated with EVC, where the activations largely reflect perceptual properties, while upper layers better correlated with IT, whose activations are more entangled in semantic properties. The similarities between the supervised and unsupervised network suggest that it is possible to replace supervised learning with unsupervised learning without losing the parallel with the brain activations. Moreover, the way representations develop within the network before and after training suggest a hypothesis regarding the order in which brain representations develop during learning. Specifically, rather than undergoing a sequential development where earlier visual areas are active earlier than IT, at birth the whole visual system could be active, but mainly representing perceptual characteristics. Later on, after learning takes place the representations in the visual system would then differentiate and higher visual areas such as IT start incorporating semantic information in their activation patterns. This hypothesis leads to the testable prediction that soon after birth infants would categorize images based on their perceptual similarities whereas after some months, a semantic-based categorisation would be favoured. We will test this prediction in an upcoming MRI study.

P1-B-27: Development of white matter fibre density and morphology between 7 and 13 years following very preterm birth

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Objectives: Very preterm (VP) birth places infants at risk of brain injuries and neurodevelopmental delays. Fixel-based analysis (FBA), a recent diffusion magnetic resonance imaging (MRI) analysis method, enables more specific inference on brain white matter structural properties than previous methods. Using FBA, we aimed to build on current knowledge on the effect of VP birth and associated perinatal risk factors on white matter microstructural and morphological development during childhood. Methods: Diffusion images were acquired for VP (born <30 weeks' gestation) and full-term (FT, born ≥37 weeks' gestation) children at two ages: mean (SD) 7.6 (0.2) years (n = 138 VP and 32 FT children) and 13.3 (0.4) years (n = 130 VP and 45 FT children). 103 VP and 21 FT children had images at both ages



for longitudinal analysis. Images were processed using the FBA pipeline with MRtrix3 software. We compared FBA metrics (fibre density (FD), fibre cross-section (FC) and a combination of these properties (FDC)) between VP and FT groups cross-sectionally at each age, and longitudinally between ages. We also examined associations between perinatal risk factors and cross-sectional and longitudinal FBA metrics in the VP group. Results: Compared with FT children, VP children had significantly lower FD, FC and FDC throughout the white matter at ages 7 and 13 years (Figure 1). These FC and FDC differences were no longer significant after adjusting for intracranial volume. VP children also had slower development of FDC in commissural and motor fibre tracts between ages 7 and 13 years compared with FT children, even after adjusting for intracranial volume (Figure 2). Within VP children, earlier gestational age at birth, lower birth weight z-score, and neonatal brain abnormalities were significantly associated with lower FD, FC and FDC throughout the white matter at ages 7 and 13 years. Neonatal brain abnormalities were additionally associated with a reduced rate of development of FDC in the corpus callosum and superior corona radiata between ages 7 and 13 years (data not shown). Conclusions: VP birth and concomitant perinatal risk factors are associated with delayed or disrupted white matter microstructural and morphological development in childhood. These findings provide a more comprehensive understanding of white matter development following VP birth compared with previous studies, and may help to explain the neurodevelopmental delays documented in the VP population.

P1-B-28: Neural noise associates with vigilance to threat in the first year of life

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Infants are thought to exhibit an orienting advantage toward threat-relevant stimuli, such as angry faces (LoBue & DeLoache, 2010; Nakagawa & Sukigara, 2019). Surprisingly little is known, however, about how this advantage may be influenced by neural information processing. Excessive "neural noise" may decrease an infant's ability to rapidly detect threat by decoupling neuronal synchronization mechanisms that may facilitate efficient engagement of attentional resources. Neural noise can be indexed via the slope of the electroencephalogram (EEG) power spectrum ("1/f slope"), with a flatter slope reflecting a higher rate of random neuronal activity relative to the phase of a carrier oscillation. In the present study, we examined whether more neural noise--a flatter 1/f slope--was related to slower and more variable detection of angry faces at 8-months of age. Families were drawn from a multisite study examining temperament across the first two years of life. Eye-tracking trials were initiated when an infant fixated at the center of a 17" screen (100ms). A face stimulus (angry, happy, or neutral) then appeared in the corner of the screen and remained until the infant fixated for 100ms. Average latency to fixate the faces was measured. Sufficient vigilance data (≥ 30 trials) were available for 114 infants ($M_{\text{trials}} = 58.39$, $SD = 14.98$, range = 30 - 88, $n_{\text{excluded}} = 44$). Vigilance data were transformed to correct for skewness (Figure 1). EEG was recorded at 32 active electrode sites during a 4-minute baseline task. Power at each frequency was calculated via Fast Fourier Transformation. 1/f slopes were estimated via OLS regression, with log-transformed power regressed on log-transformed frequency (2-25Hz excluding 6-9Hz) for each participant at the central midline site (Cz) (Voytek et al., 2015). Sufficient EEG data (≥ 30 seconds) were available for 122 infants. Two extreme 1/f slopes were removed. We



did not find a main effect of emotion condition for either speed or variability ($p > .09$). Bivariate associations between 1/f slopes and vigilance are presented in Figure 2. We examined two path analyses using lavaan in R v3.6.1 to utilize FIML for missing data. We found that flatter 1/f slopes were associated with slower detection of angry ($\beta = .38, p < .001$) and, to a lesser degree, happy ($\beta = .21, p = .07$) faces. Latency to detect neutral faces was unrelated to neural noise ($\beta = .09, p = .43$). We also found that flatter 1/f slopes were related to more variable detection of angry faces ($\beta = .23, p = .02$). Variability in detecting happy or neutral faces was unrelated to noise ($\beta = .06 - .13$). Delayed detection of threat-relevant stimuli may thwart adaptive responding to potentially threatening environmental cues (LoBue, 2013). We found that 8-month-olds with more neural noise were slower and more variable in their detection of emotional cues, particularly anger. Our findings suggest that disrupted information processing in the brain (via more neural noise) may hinder an infant's orienting advantage towards threat-relevant cues, with implications for cognitive and behavioral responding.

P1-B-29: Neighborhood racial demographics shape infants' neural responses to people of different races

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The propensity to divide the social world into "us" versus "them" emerges early in life: By 6 months, infants preferentially orient to people from their own racial or linguistic group (ingroup) than to people from different groups (outgroup) (Kelly et al., 2007; Kinzler, Dupoux, & Spelke, 2007). By 18 months, infants prefer ingroup over outgroup members as social partners and selectively learn from and imitate ingroup individuals (Buttelmann, Zmyj, Daum, & Carpenter, 2013, Howard, Henderson, Carrazza, & Woodward, 2015). This tendency to prefer ingroup over outgroup is modulated by experience. For example, infants' preferences for same race over other race faces are reduced by exposure to other race faces in the lab (Sangrigoli & de Schonen, 2004), family (Sangrigoli et al., 2005), and community (Bar-Haim, Ziv, Lamy, & Hodes, 2006). However, the neural and psychological mechanisms that give rise to these behaviors are not yet known. We investigated the effect of exposure to racial diversity on neural correlates of attentional, mirroring and affective processing in infants, as indexed by frontal theta synchronization, mu suppression and frontal alpha asymmetry respectively, to shed light on the mechanisms that give rise to lower preference for outgroup individuals. We aggregated EEG data from 48 7- to 12-month-old white infants across three studies. In all studies, infants observed either white (ingroup; $n=21$) or Asian (outgroup; $n=27$) female experimenters who after a still period (introduction period) proceeded to grasp a toy (action period). Baseline-corrected frontal theta (3-5 Hz averaged across Fp1 and Fp2), baseline-corrected mu suppression (6-9 Hz averaged across C3 and C4), and frontal alpha asymmetry ($\ln F4$ minus $\ln F3$ in 6-9 Hz) were extracted from these periods. These neural markers were examined in relation to infants' neighborhood racial demographics extracted from US census based on zip code. There were no main effects of experimenter's racial group on any neural markers ($p > .052$). However, there were significant interactions between experimenter's racial group and proportion of outgroup (nonwhite) population in infants' zip code on frontal theta (introduction: $=4.257, p=.048$; action: $=5.904, p=.014$) and mu suppression (action: $=-4.906,$



$p=.022$); but not in frontal alpha asymmetry ($ps>.956$). See Figure 1. When observing a racial outgroup experimenter, infants from neighborhoods with larger outgroup populations showed greater frontal theta (introduction: $=3.463$, $p=.031$; action: $=4.167$, $p=.024$) and mu suppression (action: $=-3.007$, $p=.020$) than infants from neighborhoods with smaller outgroup populations. See Figure 2. In contrast, when observing a racial ingroup experimenter, infants' neighborhood racial demographics did not relate to frontal theta or mu suppression ($ps>.272$). In sum, infants from more racially diverse neighborhoods showed greater attention to and stronger neural mirroring of, but not greater approach motivation to, a person of a different race than infants from less racially diverse neighborhoods. These findings suggest that when infants from racially homogenous neighborhoods view people from different races, they pay less attention and are less engaged in the other's actions, but, unlike adults, they do not show evidence of a negative affective response.

P1-B-30: Do infants learn foreign words from a robot? An ERP study

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Over the last decade, the incorporation of robotics in the educational process has become an important research area, and Human-robot interaction (HRI) could be the basis of a new educational framework. Previous research has demonstrated that a robot could be a pedagogical agent for toddlers and/or children, however, it is not well investigated whether a robot providing plenty of social cues could help infants to learn. Then, we tested whether infants were able to learn foreign vocabulary with a robot providing rich social cues by measuring an event-related brain potential (ERP) component known as the N400. Participants were 12 healthy, full-term 9-month-old infants. The brain electric activity of the participants was recorded at 61 scalp locations (HydroCel Geodesic Sensor Net, EGI). The experiment consisted of two phases: the storytelling phase and the test phase. During the storytelling phase, a small humanoid robot Nao (Softbank Robotics) was talking "the 3 little pigs" story in French, which was a foreign language for participants, as gazing and/or pointing at simultaneously presented visual stimuli depicting the story on a monitor located behind Nao. Following the storytelling phase, the test phase began, and infants took a word recognition test (Figure 1). We set three conditions: a) Target words in French (loup = wolf/cochon = pig), b) Non-Target aurally close pseudowords (zoup/nochon) and c) Distractors which were novel words in French (souris = mouse and chien = dog). Two target words (wolf and pig) were selected because Nao repeated frequently (about more than 20 times) in the story. After the recordings, we focused on the picture and word onset-locked ERP (N400) at the central site and compared the amplitudes among the conditions. As results, we observed the N400 like component at a right central channel (C4) and found that the amplitudes were more negative for Non-Target and Distractor than for Target words condition (Figure 2). The N400 component is interpreted as a sign of associative word understanding, therefore, the results suggest that 9-month-olds were able to learn the association of visual stimuli and target words during the communicative robotic storytelling. With the advance of technology, the potential of robot teachers will increase.



P1-B-31: Representing difference: Determining 6-month-old infants' abilities to learn random sequences of syllables

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Introduction. In order to acquire grammar, infants need to extract regularities from the linguistic input. From birth, infants can detect certain structural regularities in speech, notably immediate repetitions (Gervain et al. 2008, 2012). Using near-infrared spectroscopy (NIRS), Gervain and colleagues showed that newborns show an advantage -- stronger neural activation -- for syllable sequences that contain adjacent repetitions (e.g. ABB: mubaba) over random syllable sequences (e.g. ABC: mubage). By contrast, at 6 months, infants' neural activation to both types of sequences is equally strong (Radulescu et al. in preparation). Such a pattern would result if 6-month-olds failed to discriminate between the two sequence types or alternatively, if they -- unlike newborns -- were representing the ABC sequences as strongly as ABBs. Infants begin to learn their first word forms at 6 months of age. To achieve this feat, they need to be able to process sequences of different syllables. This milestone in acquisition thus gives plausibility to the latter interpretation. To confirm this hypothesis, it is essential to demonstrate the 6-month-old infants discriminate the ABB and ABC sequences. Methodology. In the present study, we used the alternating/non-alternating design to test 6-month-old French-learning infants' ability to discriminate ABB vs. ABC sequences, using a paradigm similar to Gervain et al. (2012; Figure 1). Non-alternating blocks (x6) contained sequences of a single type, i.e. all sequences within a block have either an ABB (x3) or an ABC (x3) structure. Alternating blocks contained sequences of both types, presented in strict alternation (ABC-ABB [x3] or ABB-ABC [x3]). If infants discriminate the ABB and ABC blocks, we predict different neural activation in alternating and non-alternating blocks. Results. We recorded infants' brain activity in the frontal, temporal and parietal areas using NIRS, while they listened to the blocks. Although data collection is ongoing, preliminary analysis of 11 participants reveals canonically shaped hemodynamic responses for both conditions (Figure 2), and differences in activation between alternating and non-alternating (with an advantage for the alternating blocks in the temporal region, Channels 3, and an advantage for non-alternating blocks in the frontal region, Channels 2, 10, 16). If confirmed, these results provide the earliest evidence that young infants explicitly represent difference in speech. This research has hence important implications for language development -- particularly for word learning -- as well as for infants' general ability to represent relationships predicated on sameness and difference (Hochmann et al. 2016).

P1-B-33: Investigating the relationship between brain function and parent-infant interaction in infants at-risk for autism

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The search for the identification of early risk markers of Autism Spectrum Disorders (ASD) has drawn much of attention in research. Early emerging behavioural signs of ASD begin at around 12 months of age, but brain function measures have been able to identify potential risk markers



before that time (Elsabbagh et al., 2012; Lloyd-Fox et al., 2017). Subtle brain function differences are thought to become exacerbated by atypical interactions with developing brain systems and the child's caregiving environment, leading to atypical development (Elsabbagh & Johnson, 2010). However, research linking brain function and parent-child interaction (PCI) in the context of ASD has been limited. On this basis, this study explored associations between brain function and quality of PCI in 57 eight-month old infants with high ASD likelihood by correlating Event-Related Potential responses (ERPs) to eye gaze directed toward versus away from the infant and aspects of unstructured PCI (parent sensitive responsiveness and infant attentiveness). Findings suggest links between the two measures, driven by infants with no ASD outcome. Although no relationship was found between sensitive responsiveness and ERP measures, high infant attentiveness was related to greater P400 response difference to eye gaze shifts. Exploratory analysis with other PCI items revealed similar patterns of association while further analysis including gender showed that the relationships were driven by female infants. These exploratory findings offer significant insights into the developmental mechanisms contributing to ASD outcome and the potential of combining brain function measures and naturalistic interactions in assessing risk or clinical diagnosis in early childhood.

P1-B-34: Neural indicators of articulator-specific sensorimotor influences on infant speech perception

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Speech perception is multisensory from early in life. Pre-lingual infants match visual and auditory speech for both native (Patterson & Werker, 2003) and non-native (Danielson et al., 2017) speech suggesting that infants are sensitive to audio-visual speech without specific experience. Sensorimotor input also conveys speech-relevant information to the perceiver. Behavioural evidence shows that at 6- months of age, when the native phonological system is still being established, sensorimotor information influences speech perception in an articulator-specific manner (Bruderer et al., 2015; Choi et al., 2019). These studies suggest a potential link between speech perception and speech production systems that precedes active babbling. To further probe the relation between speech perception and production systems early on in ontogeny, the current study examines the neural dynamics underlying phonetic perception with and without articulator-specific oral-motor influences. We tested 3-4 months-old English-exposed infants, an age at which infants discriminate native and non-native phonetic distinctions (Werker & Tees, 1984; Peña, Werker & Dehaene-Lambertz, 2012). Infants heard sequences of four syllables, while their neural responses were measured using electroencephalography (EEG). In this event-related-potential (ERP) design, trials in which a single syllable is repeated (Standards) were compared against trials whereby the last syllable showed a phonetic category change following repetition (Deviants). Previous studies have shown that a mismatch response (MMR) between the standard trials and the deviant trials is elicited when infants perceptually distinguish phones that crosses the categorical boundary (Dehaene-Lambertz & Dehaene, 1994). In the auditory-only experiment, we tested discrimination of both English bilabial /ba/ vs. alveolar /da/, and non-native dental /da/ vs. retroflex /Da/. We identified a robust MMR for both distinctions in a cluster of left-anterior-sensors 450-710ms following the critical stimulus onset. In the auditory-motor experiment,



infants participated in the same EEG task while their tongue-tip movement was restricted with a teething-toy. We hypothesized that if there is a specificity in the relationship between oral-motor articulator influence and speech perception, then the tongue-tip movement restriction would selectively influence the MMR for phonetic category change across dental to retroflex, but not across bilabial to alveolar. We observed an MMR from 290-500ms in a cluster of left-central-posterior sensors only for the /ba/ and /da/ category change, demonstrating that restricting infants' tongue-tip movement selectively diminished the MMR for the alveolar /da/ - retroflex /Da/ phonetic contrast. These findings extend the previously reported behavioural results, providing electrophysiological evidence for articulator specific auditory-sensorimotor integration in pre-lingual infants. This work further suggests speech production system may inform and potentially guide speech perception prior to the onset of meaningful speech production.

P1-B-35: Social transmission of risk: Caregiver and infant cortisol mediate the effects of socioeconomic risk on self-regulation

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Exposure to environments of early-life stress, such as low socioeconomic status and poverty, can shape the development of infant stress physiology and self-regulation skills. Research indicates chronic exposure to the stress hormone cortisol is one likely mechanism by which environmental risk may impact developing self-regulation. However, more research is needed to better understand the processes and pathways linking early-life adversity to infant cortisol and subsequent self-regulation. In particular, given the importance of the caregiver in regulating infant development, the caregiver is likely a primary pathway through which environmental stress may be transmitted to the child. Thus, the purpose of the present study was to investigate the potential social transmission of early-life socioeconomic risk from parent to infant via stress physiology, and its effects on toddler self-regulation. Data come from a large, longitudinal sample (N=1,292) of children and families living in low-income non-urban areas in the United States. Families were visited in their homes at child ages 7, 15, 24, and 36 months. At 7 months, mothers reported socioeconomic and demographic information. At 7, 15, and 24 months, saliva samples were collected from mothers and infants and assayed for cortisol as an index of chronic resting physiological stress. At 36 months, the mother and her child participated in a 10-min semi-structured puzzle task, in which the dyad was asked to complete three puzzles of increasing difficulty. Interactions were video-recorded and later coded for child self-regulation behaviors, which included measures of persistence, enthusiasm/agency, and compliance. We used structural equation modeling to examine whether the longitudinal association between early-life socioeconomic risk and later self-regulation was serially mediated by mother's and infant's chronic cortisol exposure, respectively. We constructed latent variables of socioeconomic risk, maternal and infant cortisol, and child self-regulation. We first established that early-life socioeconomic risk was negatively associated with toddler self-regulation at 36-months, and positively associated with mother and child cortisol. Next, we confirmed that our measurement and structural models fit the data well. Results from mediation analyses revealed that cumulative infant cortisol partially mediated the association between socioeconomic risk and self-regulation, but only through maternal cortisol (see Figure 1). Importantly, this effect was present over and above the



indirect path from socioeconomic risk through infant cortisol to infant self-regulation independent of maternal cortisol. Further, these effects were observed while controlling for multiple relevant covariates including ethnicity, gender, age, and parenting behavior. These results suggest that maternal cortisol may be a distinct indirect pathway through which socioeconomic adversity relates to infant cortisol and early self-regulation. Our study also highlights the importance of investigating both caregiver and child stress physiology together. Broadly, our findings provide support for the idea that the negative effects of environmental risk on early self-regulation may be partially transmitted from mother to child via stress physiology.

C-Perception

P1-C-36: How different conditions contribute to familiar size knowledge of common objects in 7- and 12-Month-Olds

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When we see a familiar object or a picture of the same object, we not only recognize it, but also activate our knowledge about its typical physical size that is its familiar size automatically. We learn the familiar sizes of objects through our various encounters with them, but when do we start to have stable mental representations of the familiar size of common objects? So far, existing studies have demonstrated that infants at 7 months show knowledge of the familiar size of human faces and bodies. Regarding objects it has only been shown that 7-month-olds were able to remember the familiar size of novel, but not common objects for a short period. We investigated in two studies whether and under which conditions infants show familiar size knowledge of common objects. In Study 1, we tested infants' familiar size knowledge by using real common objects presented out of reach. In Study 2, we examined infants' familiar size knowledge by presenting the same real common objects within reach. As we also wanted to investigate whether infants' familiar size knowledge is affected by stimulus format, in Study 2, we also presented the common objects as pictures. In both studies we used real sippy cups and pacifiers as common objects in three different sizes: familiar size, larger and smaller than familiar size (novel sizes). In Study 2, we also used matched pictures of the named objects in the same three sizes. Our dependent variable was infants' average looking durations towards familiar- and novel-sized objects. In Study 1, 65 7- and 12-month-olds ($n_{7\text{-month-olds}}=33$) viewed pairs of a familiar-sized object and one of the novel-sized placed out of infants' reach for 10s. Whereas the 7-month-olds looked equally long at familiar- or novel-sized objects, 12-month-olds showed a strong looking preference for the novel-sized objects, $t(31) = -3.75$, $p = .002$, $d_{\text{cohen}} = -.65$. In Study 2, 135 7- and 12-month-olds were randomly assigned to a real-objects-group ($n=67$) and a pictures-group ($n=68$). Infants viewed familiar- and novel-sized real objects or matched pictures, but now within reach for 20s. Infants were also allowed to interact with the objects and pictures. In the real-objects-group, infants of both ages preferred to look at the novel-sized objects longer than at the familiar-sized, $t(66) = -3.63$, $p = .002$, $d_{\text{cohen}} = -.56$. However, infants of both ages showed no looking preference towards familiar- or novel-sized objects in the pictures-group, $t(67) = .37$, $p = 1.00$. Our results show that 12-month-olds can successfully discriminate novel from familiar sizes, both when real common



objects are placed out and within reach. In contrast, 7-month-olds show familiar size knowledge of these objects only when objects are presented within reach. The possibility to interact with the objects might help 7-month-olds to activate their familiar size knowledge. For the pictures, infants of both ages did not differentiate between familiar and novel sizes. Taken together, from 7 months on, infants exhibit familiar size knowledge of common real objects, but this knowledge does not generalize to pictorial representations of these objects.

P1-C-37: Consonant production and early word-form processing are linked at 14 months of age

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Speech perception and production are linked in adults (Skipper et al., 2017), which raises questions about the development and function of this neurocognitive link. Pioneering studies have highlighted a precocious influence of sensorimotor information on speech perception (Yeung & Werker, 2013; Bruderer et al., 2015; Choi et al., 2019). Furthermore, infants' perceptual processing has been shown to evolve in correspondence with the emergence of production as, at this stage, infants display a perceptual advantage for the speech sounds they can produce versus those they cannot yet produce. This mechanism has been documented in non-word recognition (DePaolis et al., 2010), audiovisual matching (Vilain et al., 2019) and word-learning (Majorano et al., 2019). While the direction(-s) of the perception/production coupling still has to be fully understood (Nazzi & Gonzalez-Gomez, 2012), the shared conclusion is that production and perception develop in tandem. We explored whether similar patterns exist for familiar word-form processing. The set of consonants that each infant produced was collected through a detailed parental questionnaire and the groups were median-split into high- and low-Producers. Differently from DePaolis et al. (2010), our stimuli were not selected based on individual production, but along the broader distinction between easy-to-articulate (early-acquired) vs difficult-to-articulate (late-acquired) consonants. Using HPP, two groups of healthy, typically-developing French-learning monolinguals (11- and 14-month-olds, N = 32 each) heard two lists, each containing 10 familiar words composed of easy- vs difficult-to-articulate consonants. No familiarization phase was included. Word frequency, vowel context and syllabic length were varied within but balanced across lists. All words were spoken in mild IDS by a French-native female speaker. The familiarity of the words used (cf. Poltrock & Nazzi, 2015) was verified for each participant through a parental interview. Only a minority of the participants were not familiar with all the words (25% at 11 months, Mean Unfamiliar Words = 4.5; 31% at 14, MUW = 3). These subjects belonged mostly to the low-Producers groups (6 out of 7 at 11 months; 7 out of 10 at 14). At 11 months, an ANOVA on orientation times with Producer (high- versus low-Producer) and List (easy- versus difficult-to-articulate consonants) revealed a main effect of Producer ($F = 6.7$; $p = .01$; $\eta^2 = .18$), with longer orientation times in high producers. This signals an association between perception and production abilities whose underlying reasons need further clarification. At 14 months, no main effect was found, but the Producer x List interaction was significant ($F = 8.1$; $p = .008$; $\eta^2 = .21$), due to high-Producers' longer orientation times towards the lists containing difficult-to-articulate consonants ($p = .005$). This is consistent with the fact that these infants were starting to produce the difficult-to-articulate sounds. Conversely, the lack of Producer x List interaction at 11 months is consistent with the fact that fricatives were overall not produced in



this cohort. This study is the first investigation, to the authors' knowledge, to test the speech perception/production association with real familiar words. Our results agree with previous literature, describing a gradual emergence of this connection.

P1-C-38: Brief exposure to other-race faces promotes perceptual discrimination and social learning from other-race adults in 9-month-olds

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Months-long exposure to specific sensory input shapes the early development of perceptual and cognitive capacities. For example, speech and face discrimination become specialized after 6 to 9 months of predominant exposure to own-race faces and native speech sounds (Werker & Maurer, 2014). Similarly, cognitive processing by infants, such as social learning, also favors mostly familiar stimuli (e.g., own-race faces, Xiao et al., 2018). These experience-based developmental changes can be altered in infants by prolonged experience with novel stimuli (e.g., other-race faces) over weeks or months (e.g., Anzures et al., 2012; Heron-Delaney et al., 2011; Scott & Monesson, 2009). However, it is unclear whether brief exposure to novel experience would be sufficient to recover biased perceptual and cognitive capacities. The answer to this question would help us better understand the nature of experience-based early cognitive development. The current study investigated how a 4-min exposure to other-race African faces facilitates perceptual and cognitive processing of African faces. We examined the effects of brief exposure in Asian 9-month-olds, who had no African face experience prior their participation. Two between-subject exposure conditions were included: Other-race exposure condition, where infants watched a video of two African females talking to them; and Own-race exposure condition, which showed two Asian females. In Experiment 1, we examined the effect of the brief exposure on discriminating African faces with a familiarization-VPC (visual paired comparison) task. We found a significant novelty preference (55.63%, $SD = 7.35\%$, $n = 17$, one-sample t-test, $p = .006$) in the Other-race condition, but no significant visual preference was observed in the Own-race condition (52.98%, $SD = 6.75\%$, $n = 17$, one-sample t-test, $p = .088$). These results suggest that a brief exposure to African faces boosted infants' perceptual discrimination of African faces (Figure 1). In Experiment 2, we focused on how the African face individuation modulated the tendency of Asian 9-month-olds to learn from African adults. Prior studies have indicated that infants do not follow the gaze of other-race adults, but only if the adults were just partially reliable (Xiao et al., 2018). Here, we tested whether exposure can induce infants to learn from another African adult, who was only partially reliable. Using the gaze-following task in Xiao et al. (2018), we indexed gaze-following in infants with proportional looking time to the gazed-at location. As shown in Figure 2, infants who were exposed to other-race videos ($n = 21$) showed significant gaze-following (46.31%, one-sample t-test, $p = .022$). By contrast, another group of infants ($n = 21$) who watched a 4-min video of two Asian females failed to exhibit such gaze-following (37.95%, one-sample t-test, $p = .122$). Together, these findings demonstrate that a brief exposure to African faces can augment perceptual discrimination of African faces and social learning from African adults in Asian infants, who (without that experience) were unable to discriminate African faces or learn from unreliable African adults. The findings suggest that plasticity still remains in the perceptual and cognitive systems of infants even with 9 months experiencing predominantly own-race faces.



P1-C-39: Tracking dynamic infant attention to audiovisual synchrony and asynchrony

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Integrating redundant information from multiple senses is an important perceptual ability. Numerous studies have investigated the conditions under which infants match congruent audiovisual speech in the first year of life (e.g. Kubicek et al., 2014; Kuhl & Meltzoff, 1982; Patterson & Werker, 2003). Fewer studies have examined sensitivity to audiovisual congruence in non-speech stimuli, and there is substantial ambiguity in reports of infant preference when synchronous and asynchronous videos are presented side by side concurrent with a non-speech auditory stimulus (e.g. Spelke, 1979; Gerson et al., 2015). One possible explanation is that infant interest shifts across a trial - for example, an auditory scene analysis explanation might predict that infants' attention may initially be drawn toward a synchronous display, and subsequently shift to an asynchronous display. Examinations of infants' shifting attention across trials are necessary to investigate this explanation. We used eye-tracking to examine the time course of infant attention to audiovisual synchrony at the trial level. In two experiments, we examined 8- to 12-month-old infants' interest in synchronous and asynchronous displays. Infants were seated facing a single screen with two videos presented side by side. Each video depicted a finger tapping on a surface of a table while a series of sine tones played. The auditory stream was synchronous with one of the two finger tapping videos. Infants' gaze to the synchronous and asynchronous videos was recorded using an eye tracker (Eyelink 1000+). In Experiments 1A and 1B, the audio and video were presented at an isochronous rate, either 430 or 600 taps/beats per minute. Experiments 1A and 1B were identical, except that Experiment 1A included 16 trials of 25 seconds, and 1B included 48 trials of 8 seconds. In both experiments (N = 21 and 18, respectively), infants preferred to look at the asynchronous video (p 's < .001), and this preference was apparent across the length of the trial. In Experiment 2, we examine whether preference for asynchrony persists when stimuli are presented in a complex rhythmic pattern (syncopated) rather than the simple isochronous pattern presented in Experiments 1A and 1B. Testing is currently underway. Results will elucidate infants' understanding of multisensory integration, and begin to resolve inconsistencies in the literature between infant audiovisual perception in the speech domain and beyond.

P1-C-40: Development of face pareidolia in objects in 3- to 6-month-old infants

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Humans can see illusory faces in objects, a phenomenon called face pareidolia that probably find roots in our expertise in face processing (Ichikawa, Kanazawa, & Yamaguchi, 2011). Infants have been recently shown to present a sensitivity to facelike stimuli (Kato & Mugitani, 2015), and the perception of "faces in objects" is thought of to emerge around the end of the



first year of life along with the development of holistic processing (Kobayashi et al., 2012). So far, previous studies inferred the perception of pareidolia in infants using spontaneous visual preferences, based on the rationale that if infants see faces in objects they should look longer at these objects compared to other non-facelike objects. While such visual biases can indicate differential processing between these objects, null preferences as found in younger infants (i.e., 6-month-olds, Kobayashi et al., 2012) are inherently ambiguous, and cannot be taken as indication of an absence of perception of pareidolia. Procedures typically used to examine category formation (e.g., familiarization/novelty reaction, Quinn, 2011) could turn out to be more sensitive to uncover a differential processing between facelike and non-facelike objects. In the current study, we investigated category formation in 3-to 6-month-old infants for facelike and non-facelike object exemplars from the same taxonomic category. If facelike objects are seen as faces, they should not be categorized as a member of the category from which the facelike object taxonomically belongs, despite high visual similarity with the other non-facelike exemplars of the category. Forty 3-month-olds and twenty-five 6-month-olds were first familiarized with exemplars from one object category (e.g., trees, eggs, etc.) presented two by two per trial in four 15-s trials. During the test phase, infants were presented with a novel exemplar from the familiarized category paired with a facelike exemplar from the same category (two 10-s trials). Images were presented either upright or upside-down since picture-plane inversion is known to impair face(like) perception (Rossion, 2008) while low-level properties are the same in both orientations. Thus, each infant completed two conditions (i.e., upright vs. inverted stimuli, using different object categories for the two conditions). Initial findings showed that both 3- and 6-month-old infants looked more at the facelike object in the test phase in upright but not in inverted orientation. In other words, in upright, but not inverted orientation, infants formed a category of object that excludes a novel exemplar of the same category when this exemplar possessed facelike properties. This effect was however qualified by a significant sex*orientation ($F[1,61] = 4.66, p = .03, \text{partial } \eta^2 = .07$) indicating that only female infants looked longer at upright facelike objects after being familiarized with object from the same category (Figure 1). This result is consistent with previous reports of differential processing of social stimuli in male and female infants (Alexander, Hawkins, Wilcox, & Hirshkowitz, 2016; Alexander & Wilcox, 2012; Proverbio, 2017), which have also been reported in nonhuman infant primates (Simpson et al., 2016). Overall, these findings suggest that face pareidolia emerges earlier than previously thought, at least in female infants.

P1-C-41: No preference for the walking action configuration in locomotor infants

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Our ability to understand and respond to the actions of others is a distinctive aspect of human social cognition. Observing others is a primary source of dynamic information about actions produced by the self therefore infants must be able to select and receive an ample exposure to such relevant information. A basic but critical aspect when perceiving and identifying human motion in a point-light-display is to be able to integrate the information contained in the individual motion of the dots into a global motion configuration of a person in action. To test the ability of 3, 5, and 7 months old of perceiving and preferring the global motion configuration of a person walking in a point-light-walker (PLW), a preferential looking procedure was created



contrasting a coherent PLW with a spatially scrambled PLW (Lisboa, Basso, Santos, & Pereira, under review). Results showed that 3-month-olds spent more time looking at the coherent PLW, but 5 and 7 months showed no preference (Lisboa et al., under review). Three months old preferences might be explained by the ability of these infants to process local configural information in PLWs, such as the ability to process the local motion of the limbs, present only in the coherent display (Bertenthal, 1993). Moreover, motion from an articulated limb seems to represent an appropriate stimulus to explore at 3 months - for instance, hands motion appear to be crucial as infants at this age stare at their hands, and begin to bring their hands to mouth. However, the decline in preference in older infants was unexpected (Bertenthal, 1993). One hypothesis is that 5-7 months infants are still not able to globally process configural relations in PLWs and consequently they do not prefer the coherent stimulus; this ability might emerge later in development; in particular, with the on-set of locomotion. The onset of locomotion is one of the major life transitions in early development, involving a pervasive set of changes in perception, attention, and social development (Bertenthal & Campos, 1990). In the current experiment, we investigated preferences for a coherent PLW vs. scrambled PLW in older 9 (N = 17, n = 12, mean age = 289 days) and 12 (N = 37, n = 27, mean age = 388.1 days) months old. We speculate that a preference for the coherent motion of a person walking (when contrasted with a scrambled display) might be narrowly linked to the experience of autonomous locomotion in crawling (9 months) and experienced crawling infants (12 months). Infants in both age groups participated in a cross sectional preferential looking experiment where a coherent PLW was presented simultaneously with a scrambled PLW. Left and right presentations were counterbalanced across trials and infants participated in a total of 12 trials of 15 seconds each. To analyze if there was a preference for coherent PLW, we compared the mean proportion of looking at the coherent PLW to chance level (.50); a proportion of looking at the coherent PLW of .5 indicates no preference. Results showed no preference for either stimulus both at 9, $t(11) = 2.01$, $p = .07$ and at 12 months of age $t(26) = .06$, $p = .95$. The two age groups also did not statistically differ from each other $t(37) = 1.05$, $p = .21$. These results replicate the previous study with 5 and 7 months old (Lisboa et al., under review). A preference for the coherent PLW might emerge with the onset of walking in 14-17 months old infants in a perception-action link.

P1-C-42: Infant associations of infant- and adult-directed speech

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Across cultures, infants are addressed in infant-directed speech (hereafter, IDS), for which adults modify their speech commonly used with other adults, also known as adult-directed speech (hereafter, ADS; Ferguson, 1964). While numerous studies report preferences for IDS over ADS, it remains unclear whether infants attend to IDS because they already associate this register as speech specifically directed at them. Using an eye-tracking task, 6-month-old infants (N=41) were presented with two female speakers using IDS or ADS towards a curtain. The addressee was subsequently revealed to be matching the speech register (e.g., IDS and infant) or mismatching (e.g., ADS and infant). We measured infants' pupil diameter in response to the reveal of the addressee with the assumption that larger pupil diameters represent an index of infants' violation of expectation. We also measured infants' pupil diameter during IDS and ADS exposure to assess infants' preferences in terms of internal arousal. In line with



previous findings, we expected larger pupils in response to IDS compared to ADS. Our results revealed that infants' pupil diameter was in fact significantly larger for the mismatching compared to the matching condition during the expectation phase, $t(40)=2.51$, $p=0.016$ (Figure 1), with 27 out of 41 infants showing this pattern of response. In addition, baseline-corrected pupil diameter was significantly larger for IDS compared to ADS, $t(30)=2.36$, $p=0.025$ (Figure 2), with 22 out of 31 infants showing this pattern of response. Ongoing data collection with 13-month-olds will further shed some light onto the development of infants' response to and infants' associations of IDS and ADS. Taken together, the current study suggests that infants as young as 6-months already associate ADS with adults and IDS with young children. In addition, IDS seems to induce greater infant arousal compared to ADS, even if it is just overheard. Thus, the current findings underline the attentional salience of IDS and, in addition, provide first evidence that infants may attend to IDS because they are already sensitive to the fact that this speech register is exclusively addressed towards them.

P1-C-43: Counting sheep: Perceptual narrowing of other-species faces in infant fMRI

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Infants are challenged with learning the faces in their environment without prior knowledge of who or what will be relevant. To solve this challenge, infants begin as perceptual generalists (Scott et al., 2007). In the domain of face perception, this allows them to discriminate between individuals from other races (Kelly et al., 2007) and other species (Pascalis et al., 2002; Simpson et al., 2011). By the end of the first year, however, infants become more sensitive to own-race human faces and lose other-race and other-species sensitivity. This can be prevented through training on other species faces (Pascalis et al., 2005; Scott & Monesson, 2009) or by living with pets (Hurley & Oakes, 2018). Perceptual narrowing highlights the adaptability of infant perception, and yet little is known about the underlying mechanisms. What is changing in the infant brain to support increased expertise for human faces and reduced sensitivity to other kinds of faces? Here we explore the role of repetition suppression in perceptual narrowing. When adults view the same stimulus repetitively, either in immediate succession or after lag, selective parts of visual cortex show reduced fMRI activity compared to when multiple different stimuli are viewed (Grill-Spector et al., 2006). In the case of faces, when the identity of a face is repeated (vs. changed), regardless of surface changes such as viewpoint, repetition suppression is observed in the fusiform gyrus (Winston et al., 2004; Rotshtein et al., 2005). Such repetition suppression in face-selective visual cortex is related to the perceptual discriminability of human adult faces, including in children (Natu et al., 2016). To test the relationship between repetition suppression and perceptual narrowing in infants, we are collecting fMRI data while infants and adults view short sequential blocks of human faces, sheep faces, and natural scenes. Within the face categories, half of the blocks consisted of the same identity presented multiple times in a row (Repeat) and the other half consisted of multiple identities each presented once (Novel). To the extent that a brain region is sensitive to human or sheep facial identity, fMRI activity should be attenuated for Repeat versus Novel blocks in face-selective visual areas. We hypothesized that infants younger than 9 months (with broad behavioral discrimination abilities) would show repetition suppression for both humans and sheep, whereas infants older than 12 months and adults (with narrower behavioral



discrimination abilities) might show stronger repetition suppression for humans but none for sheep. Based on a partial sample of four participants in each age group who had sufficient data, there was repetition suppression for human faces in a fusiform region of interest in infants older than 12 months but not younger than 9 months. This is consistent with the emergence of perceptual expertise for human face identification. However, surprisingly, the older (but not younger) infants also exhibited repetition suppression for sheep faces. We are evaluating a broader network of face-selective regions, including the superior temporal sulcus and amygdala, to explore why (potentially) preserved other-species neural discrimination in certain regions does not translate into behavioral discrimination.

D-Communication 1 (speech perception, phonology and word-level processes)

P1-D-44: Brief exposure to talker background information facilitates infants' accented word recognition

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Speech is a highly variable signal. Factors such as the speaker's speech rate, vocal range, and accent cause the pronunciation of words to vary tremendously across utterances. Although such variability has been proposed to greatly complicate spoken language processing (Houston & Jusczyk, 2000; Singh et al., 2008), both adult and child listeners are nonetheless able to overcome this challenge. For instance, listeners readily adapt to an unfamiliar accent as a function of prior exposure to the speaker (e.g., Bradlow & Bent, 2008; Clarke & Garrett, 2004; Schmale et al., 2012; White & Aslin, 2011). It is unclear, however, whether accent accommodation is simply triggered by increasing listeners' tolerance (potentially by expanding the acceptability criteria of word pronunciations; cf. Schmale et al., 2015) or whether experience with the specific talker or accent is necessary. If the former explanation at least in part explains infants' ability to adapt to accented speakers, then presenting children with contextual information about the talker's foreign background (which has previously been shown to generate inferences about the speaker's regional origin; Weatherhead et al., 2016) should similarly result in infant accent adaptation. To address this question, we tested native English-learning 20- to 30-month olds ($M = 24.13$; $N = 47$ to date) on their recognition of familiar words in either a native (regionally dominant) or an unfamiliar (Indian) accent. Children's eye movements were video-recorded while they completed a Preferential Looking task: Two images appeared side-by-side on a screen while sentences containing a target word unfolded (e.g., "Hey! Look at the flower! Do you see the flower?"). Crucially, this test phase was preceded by a brief video clip introducing the talker's background as being either local or foreign (including details regarding where the speaker lives and her daily habits, narrated by a second talker). If talker background information allows children to better cope with unfamiliar accents, then infants listening to the Indian-accented speaker should recognize words more accurately in the foreign than in the local background condition. By contrast, infants listening to the native-accented speaker are expected to either (i) recognize words more accurately when the speaker background information is geared towards the local speaker, or (ii) recognize the target items equally well in both conditions (if listening to native-accented



speech is less difficult than listening to foreign-accented speech). In line with our predictions, a bootstrapped cluster-based permutation analysis (based on Maris & Van Oostenveld, 2007) revealed a potential divergence between the two speaker background conditions for infants presented with the Indian accent ($p=.07$, see Figure 1a). This suggests that information about the talker's foreign background potentially facilitates accented word recognition. By contrast, no effect of talker background was detected for infants presented with the native accent (see Figure 1b). Taken together, these results tentatively show that providing infants with background information about the talker can facilitate the recognition of familiar words in an unfamiliar accent. Thus, infants not only rely on prior experience with a speaker, but might also make use of contextual information to better cope with a speaker's accent.

P1-D-45: Toddlers raised in multi-dialectal families learn words better in accented speech than those raised in monodialectal families

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Many infants grow up in multi-accented environments, whereby language input is substantially variable and rich. For instance, in Oslo, 30% of population speak Norwegian as their second language, and among the remaining 70% of speakers, ~30% use a different dialect than the one spoken in Oslo area. Hence, many infants growing up in Oslo are naturally exposed to accent variation, which provides rich but inconsistent language input. For example, the word 'farm' gård, is realized differently depending on the speaker's dialect; with a trill or tap /r/ - /go:r/ - in Eastern dialect and uvular /R/ - /go:R/ - in Western dialect. In addition to differences in sounds pronunciation, differences in the use of lexical tones between Norwegian dialects offer a challenging task for Norwegian infants exposed to dialects. Previous research, in English-learning infants, has shown that multi-accented input at home affects the establishment of stable word representations (Durrant et al., 2015; Buckler et al., 2017). Yet, brief exposure to multiple accents enabled 18-month-old English-learning infants growing up in mono-accented families to recognize words spoken in an unfamiliar accent, suggesting that multi-accented variability may support novel accents understanding (Potter & Saffran, 2017). To address this conundrum, the current study examined whether 28-month-old Norwegian toddlers learn words better when produced in a single dialect or in multiple dialects, and assessed whether toddler's background (mono-dialectal vs. bi-dialectal family) modulates the effect. We designed an audio-visual storybook 'Krokko og Grynte på fisketur" and embedded four novel pseudowords into the story, each referring to a novel object. Three native Norwegian speakers (living in Oslo and speaking Oslo dialect), whose native dialects were Eastern, Western and Northern, recorded the story twice: in Oslo dialect and in their respective native dialect. The story was divided into three parts and two audio narration conditions were created. In both conditions, each part of the story was presented in a different voice; yet, in the control condition, speakers spoke in Oslo dialect, whereas in the experimental condition, speakers spoke in different dialects. Average phrase length, voice pitch and variation, were matched between conditions. Thirty 28-month-old Norwegian toddlers were exposed to the audio-visual book twice per day for a week; half of them were assigned to the control and the other half to the experimental condition. Toddlers' age, gender and vocabulary size were matched between groups. After the 1st, 5th and 9th exposure, toddlers were assessed on their novel word comprehension in a tablet-based 4-forced-choice identification task. Generalized mixed-effect



regression analyses revealed a significant effect of session ($\chi^2=17.5$, $p<.001$), indicating that more book exposure resulted in better novel word recognition. Yet, there was no effect of condition or a condition by session interaction, suggesting that both groups showed similar progress in word learning; hence dialectal variability does not hinder word learning. Yet, in the experimental group, toddlers exposed to dialects at home showed significantly larger improvements than toddlers growing up in a uniformly-accented families (Cohen's $d=1.39$, $p=.021$, $BF_{10}=6.11$), suggesting that dialectal input at home benefits learning in multi-dialectal environments.

P1-D-46: Japanese-learning infants' discrimination of Japanese and Thai stop contrasts

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Languages of the world differ in their inventory of stop consonants. English and Japanese, for example, have voiced and voiceless stops (e.g., /b/-/p/), while Thai has 3-way contrasts among pre-voiced, voiceless, and aspirated (/b/-/p/-/ph/). A primary cue for voicing contrast is the difference in voice onset time (VOT). In Japanese, however, cues for voiced stops is going through a generational change. While older generation produce them with pre-voicing, younger speakers, especially female speakers tend to produce them without pre-voicing (Takada 2011). Consequently, Japanese infants are exposed to /b/ and /p/ tokens with mixed VOTs. What are the implications of the changes for infants who are learning Japanese stop contrasts? It has been widely believed that sensitivity to stop VOT appears relatively early, and English-learning infants are capable of discriminating native stop contrasts before 6 months (Burns et al. 2007). Yet, early development of stop contrast in Japanese has not been studied. Can Japanese-learning infants perceive their native stop contrast as early as English-learning infants? To address these questions, Japanese infants' sensitivity to Japanese stop contrast was tested utilizing habituation-dishabituation paradigm. In Experiment 1, Japanese 5- and 9-month old infants were tested on Japanese stop contrast at word initial stage; /be/-/pe/. Results showed that neither group showed a sign of discrimination. It seems that the discriminability of the Japanese voicing contrast is acquired later in the perceptual development. This "later" discrimination in Japanese could be attributed to the input; the voicing contrast in the initial position was not salient enough. Thus stops in intervocalic position (/ebe/-/epe/) were further tested in Experiment 2, where [b] was fully voiced. The results showed that perceptual cues in intervocalic stops are rich enough for 5-month-olds to discriminate the contrast. To compare Japanese infants' sensitivity to non-native stop contrasts, Japanese 5-month olds were also tested with Thai /bee/-/pee/ contrast (Experiment 3) and /pee/-/phee/ contrasts (Experiment 4) as well. Unlike Korean counterparts who were able to discriminate Thai /bee/-/pee/ contrast (paper 2 in the symposium), Japanese infants showed no sign of discriminating it. This was despite the fact that Thai /b/ is fully voiced, and the VOT difference between /b/ and /p/ was as large as 70 ms. In contrast, Japanese 5-month olds were able to discriminate Thai /pee/ and /phee/ contrast, although they showed a directionality effect: discrimination only when infants were habituated with /pee/ and tested on /phee/. This is contrast to Thai (paper 1) or Korean 4-6 month olds (paper 2) were unable to discriminate it, despite the fact that the VOT difference was approximately 50 ms and it crossed 30 ms boundary, which is similar to English /b/ and /p/. The comparison of Thai, Korean and Japanese 4-6 month olds showed that infants'



discrimination of stop contrasts are influenced by their native language at an earlier age than previously assumed, before they are 6-months of age. Nor the age when infants begin to discriminate these contrasts cannot be attributed to the acoustic nature of the contrast per se.

P1-D-47: Discrimination of native and non-native three-way stops by Korean infants

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Many languages utilize a two-way distinction of consonants (e.g. /b/ versus /p/) while languages like Korean and Thai have three-way contrasts. However, they also differ because Thai stops include pre-voiced as well as voiceless and voiceless aspirated categories (e.g., /b/-/p/-/ph/) but Korean stop categories are all voiceless (e.g. /p*-/p/-/ph/, fortis-lenis-aspirated, respectively). Additionally, two of the three categories (lenis and aspirated) in Korean have undergone a diachronic sound change where voice onset time (VOT) is no longer utilized as a primary acoustic parameter (Bang et al., 2018). According to prior studies, infants are initially sensitive to language-general VOT boundaries (± 30 ms) for stops (Hoonhorst et al., 2009) and show a perceptual narrowing pattern (Werker & Tees, 1984). The present study examined Korean infants' discrimination of the stop categories with sound change (i.e., lenis versus aspirated). Also, Korean adults and infants were tested on non-native Thai three-way contrasts that still rely on VOT as its primary cue for distinction. Using a visual habituation-dishabituation paradigm, three age groups of Korean-learning infants were tested on a lenis-aspirated (/pu-/phu/) stop pair: 4- to 6-month-olds (n=32), 7 to 9-month-olds (n=31), and 10- to 12-month-olds (n=29). The significant interaction effect among the age group, habituation stimulus, and the trial order indicated that Korean children were not able to reliably distinguish the stop pair early on and they became able to discriminate them after 10 to 12 months. This was in line with the enhancement pattern of speech perception development rather than perceptual narrowing. Two additional groups of 25 4- to 6-month-old infants were tested on two Thai stop pairs (all produced with mid-tones): a voiceless-voiceless aspirated (/pe-/phe/) and a pre-voiced-voiceless (/be-/pe/) pair, respectively. Korean 4- to 6-month-olds were not able to reliably discriminate the voiceless-voiceless aspirated pair, although they distinguished pre-voiced-voiceless pair. Twenty-one Korean adults also completed a categorical same/different (AX) discrimination task on the Thai stop pairs. For each trial, the subjects heard a pair of stop contrasts and then judged whether they were the "same" or "different". The accuracy for /pe-/phe/ distinction reached 98.73% and 92.38% for /be-/pe/ pair, indicating that Korean adults easily discriminated these pairs. However, they discriminated /pe/ from the pre-voiced, /be/, only 36.51% of the time, showing great difficulty with pre-voiced and voiced pairs. Korean adults could discriminate the Thai categories that are similar to Korean ones in terms of VOT; yet they were unable to distinguish the categories that their native language does not support, pre-voiced versus voiced ones. Interestingly, Korean infants showed a very different pattern from those of adults as they only discriminated the non-native categories. Korean 4- to 6-month-olds could not distinguish both the native and the non-native stop categories that are distinguished by a positive VOT. As for native stop categories, they began emerging toward the end of their first year of life, suggesting that they require infants to accumulate a sufficient

amount of input. These, taken together, present additional cases that support the enhancement pattern of speech perception development.

P1-D-48: Discrimination of /p/-/ph/ stop contrast in early speech perception of Thai infants

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Voice onset time (VOT) is one of the main acoustic cues in the production of stop consonants. Voicing stop contrasts can be analyzed in terms of VOT values within three broad categories: 'negative VOT' for voiced stops, 'near zero VOT' for voiceless unaspirated stops, and 'positive VOT' for voiceless aspirated stops. Since VOT boundaries are temporal features, they are not absolute, and perhaps should be defined on a language-by-language basis (Cho & Ladefoged, 1999). Acoustic studies of Thai three-way stop contrasts (voiced: /b/ /d/, voiceless unaspirated: /p/ /t/ /k/, and voiceless aspirated: /ph/ /th/ /kh/) were carried out quite extensively. Recently, it has been reported that the voicing contrasts, in terms of VOT values (of young Thai mothers), remained relatively unchanged from those reported 50+ years ago (Onsuwan et al., 2019). Studies investigating VOT perception in Thai adults confirmed that VOT was a robust perceptual cue for Thai stops (Gandour & Dardarananda, 1982), but no studies have tested Thai infants or looked at how their VOT perceptual categories develop. On the other hand, a set of studies investigating discrimination of non-native VOT contrasts of English-learning infants generally found that infants as young as 1 month old showed sensitivities for stop discrimination along both the negative and positive VOT (Eimas et al., 1971; Aslin et al., 1981). Notably, those studies used a synthesized labial stop consonant-vowel syllable. The present study examined the development of Thai-learning infants' discrimination of one of the stop contrasts /p/-/ph/. With Thai language having positive VOT contrasts for three places of articulation, and using naturally produced stimuli, results from the Thai-learning infants were expected to give a clearer picture of how these contrasts developed or got adjusted during their early speech perception. Thai-learning infants in three age groups (N = 24 × 3): 4 to 6, 8 to 10, and 11 to 13 months of age completed the visual habituation-dishabituation paradigm (Stager & Werker, 1997). There were two test phases: /pee/ and /phee/ sets. Each infant started with a habituation phase (either a /pee/ or /phee/ set), then the first test phase (either the "same trial" (as habituation) or a "switch trial" (from habituation)), followed by the remaining test. Therefore, there were four experimental conditions. Naturally produced stimuli, /pee/ and /phee/ (mid tone) were nonsense words. Ten instances of /pee/ and those of /phee/ were selected from a recording of a female native speaker of Thai and normalized for intensity (Table 1). In a separate experiment, native Thai adults could discriminate the stimuli reliably. The results showed that 4- to 6- and 8 to 10-month-old Thai infants showed no sign of discrimination, while 11- to 13-month-olds did. There was a significant directionality effect. They discriminated the contrast when they were habituated with /phee/ and tested with /pee/, but not vice versa (Figure 1). Contrary to previous findings, our results showed that Thai infants' discrimination of their native /p/-/ph/ contrast developed gradually and suggested that some, if not all, stop distinctions must be achieved through the linguistic environment.



P1-D-49: Predictors of positive parent-toddler shared tablet experiences

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Background: Although parent-child joint engagement with digital media is recommended, prior work suggests this may be challenging to accomplish with tablets. No studies have examined modifiable factors such as body or tablet position, or individual factors which may contribute to positive shared experiences over tablets. Objective: Building on previously published results, we will examine differences in parent-toddler interactions over enhanced tablet, basic tablet, and print books, and predictors of positive tablet experiences including: parent-toddler body position, tablet/book position, child, and parent characteristics. Methods: Prior work used observational coding methods to assess parent-child interaction in each condition with a sample of 37 parent-toddler dyads, finding more frequent control behaviors (child closing book, parent/child pivots, pushing the other's hand away) in the tablet compared with print (Figure 1). In the current study, we use similar methods in a larger sample and focus on the positive shared tablet experience. 72 parent-toddler dyads were videorecorded in a counterbalanced, crossover, within-subjects comparison of an enhanced tablet, basic tablet, and print book. Parents completed questionnaires on demographics, home media environment, Early Childhood Behavior Questionnaire-Very Short Form, a validated, reliable 36-item measure of child temperament, and Self-Efficacy Parenting Tasks Index, a 36-item validated, reliable measure of parent self-efficacy. Behavioral coding of dyadic interaction is underway. Parent-toddler verbalizations are coded in 10-second intervals. Eye gaze is coded in 5-second intervals (eye contact with each other, joint attention over book, joint attention over other object, no joint attention), Cohen's kappa = 0.76. Parent-child body position is coded in 5-second intervals (cuddling, child in lap, seated next to each other, running after the child, parent seated/child running, facing each other), Cohen's kappa = 0.83. Tablet/book position is coded in 10-second intervals (parent possession, child possession, shared, not using), Cohen's kappa = 0.87. Poisson regression will compare each outcome by book format. Summation of: parent-toddler verbalizations, eye contact, joint attention will create a "positive shared tablet/book experience" variable (proportion of time dyad is in this state). We will create interaction terms for child characteristics (e.g.: temperament), parent characteristics (e.g.: self-efficacy), body position, and tablet/book position and run moderation analyses examining whether positive shared tablet/book experience varies by book format. Results: Data have been collected from 72 dyads. Parents were 33.0 y (SD 4.3), 93% mothers, 69% had a 4-year college degree, 86% married. Children were 30.2 mo (SD 3.7), 40% boys, 84% white non-Hispanic, 5% black non-Hispanic. Coding is in-process for parent-toddler verbalizations, body position, and tablet/book position, with anticipated completion February 2020. Coding is completed for eye gaze. Univariate/bivariate analyses are expected March 2020. Multivariate/moderation analyses are expected May 2020. Conclusions: Our pilot study suggested parents and toddlers had more difficulties engaging in shared tablet experiences. This current work will build upon this by identifying possible behavioral modifications (body position/tablet possession) and individual predictors facilitating positive shared tablet experiences.



P1-D-50: Paying attention to structural differences in vocabulary knowledge

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Although researchers have long known that differences in the size of infants' vocabularies relate to their language learning and processing skills, relatively little attention has been paid to differences in the structure of infants' vocabularies. When the structure of vocabulary knowledge was previously examined, it was generally in terms of group averages. For example, on average, most typically developing (TD) infants have vocabularies dominated by names for categories organized by similarity in shape and develop a bias to attend to shape (i.e., the shape bias). Recent evidence has suggested, however, that there are individual differences in these vocabulary regularities that have consequences for infants' learning. Some TD infants have vocabularies dominated by names for categories organized by material and develop a bias to attend to material (i.e., the material bias). In this talk, we ask how individual differences in vocabulary structure can help us better understand infants with language delays and difficulties, particularly late talking (LT) infants. LT infants are those who fall significantly behind in productive vocabulary for their age. As a group, LT are less likely than their TD peers to show a shape bias, though there is a lot of heterogeneity in their developmental trajectories. Some LT eventually "catch-up" to their TD peers, but many others continue to be delayed. In two studies, we use vocabulary structure and the shape bias as tools for exploring this heterogeneity. In study one, we examined the relationship between vocabulary structure (via the MCDI) and infants' attention to shape versus material during novel noun generalization in a sample of 66 16-30 month olds (half LT). We found that LT infants were less likely to generalize novel names by shape, $X^2(1)=11.40$, $p=.0007$. We also found a significant interaction between group and the shape-based nouns in an infant's vocabulary $X^2(1)=4.66$, $p=.031$, such that the more shape-based nouns TD infants knew, the more likely they were to attend to shape. In study two we examined how LT's vocabulary structure related to whether or not they eventually caught up to a more typical vocabulary size. Participants were 899 infants contributing MCDI scores at 2 time points to Wordbank (www.wordbank.stanford.edu). On average, infants were 16 months old at time 1 and 27 months at time 2. At time 1, there were 605 TD and 294 LT. Of these, 97 LT continued to be LT at time 2, and 173 LT now had typical vocabularies. We compared the vocabulary structure of these two LT groups at time 1. Controlling for total vocabulary size, LT infants who caught up tended to know more shape-based nouns at time 1 than those who stayed LT, $X^2(1)=9.37$, $p=.002$. However, even those who caught up had fewer shape-based nouns in their vocabulary than those who were TD at time 1, $X^2(1)=106.3$, $p<.00001$. Together, these studies bring new insight into sources of LT strengths and difficulties and are an important first step towards understanding the heterogeneity of this population.

P1-D-51: Taking parent personality into account in child language development

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The personality of a parent or caregiver predicts many aspects of their child's development. For instance, parent personality predicts a child's general social, developmental, and behavioral outcomes (Kochanska, Clark, & Goldman, 1997; Prinzie et al., 2004), and the parent's own cognitions and behaviors regarding parenting (Bornstein, Hahn, & Haynes, 2011; Prinzie, et al., 2009). However, despite the established influence of parental personality traits on social and behavioral aspects of childhood development, research examining the influence of parent personality on children's early language development is virtually non-existent. This gap in the literature is especially noteworthy because parenting behaviors' play a key role in language development during infancy - a critical time period for language development in which vocabulary exponentially increases, word combinations begin, sentence length increases, and grammatical/syntactical knowledge emerges. During this time, successful language growth is also highly dependent upon the experiences and environments of the child, which are directly influenced by the characteristic traits of the parent and child (i.e. parental personality and child temperament). The current study provides an initial examination of links of parental personality with multiple aspects of child language development and expands upon previous research on links between child temperament and child language development. A total of 460 parents of infants 16- to 30-months-old completed online assessments of their child's language milestones, the child's expressive vocabulary (MCDI-WS; Fenson et al., 1994), child's temperament (ECBQ; Putnam, Gartstein, & Rothbart, 2006) and their own Big Five personality traits (BFI; John & Srivastava, 1999). The results replicates and expands upon existing research on child temperament and language - Replicating past research, a child's effortful control ($r=.28$, $p<.001$) and surgency ($r=.16$, $p<.001$) were positively associated, and negative affect negatively associated ($r=-.14$, $p<.001$) with vocabulary. Regression analyses demonstrated these temperament domains explained an additional 9% of the variance in language over age. In addition, we controlled for the fact that parents reported both their child's temperament and language ability (a criticism of prior literature) by controlling for parental personality. After which, only effortful control remained significant ($r=.22$, $p<.001$). Similar results are found for other aspects of language development. Parental agreeableness ($r=.17^{**}$), conscientiousness ($r=.18^{**}$), and openness ($r=.18^{**}$) were associated with multiple aspects of infant language abilities - vocabulary size, vocabulary growth, and MLU. Regression analyses demonstrated parental personality traits explained an additional 4% of the variance in language over age. Most importantly, parent and child traits impact a child's language abilities above and beyond well-known predictors of language, such as age, gender, and family history of language disorders. Consistent with prior work, children's temperament predicted their vocabulary and novel word learning. Notably, however, multiple facets of a parent's personality predicted a child's language skills above and beyond traditional predictors of language. That is, traditional sources of variability, such as chronological age and gender, do not go far enough to capture a complete picture of infant language development.

P1-D-52: Twelve-month-old's phonological knowledge of word forms constrains new mappings

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By the end of the first year, English learning infants have established an awareness of what constitutes acceptable and unacceptable word forms for novel objects in their native language.



That is, 12-month-olds will accept content-like but not function-like words as labels for novel objects (MacKenzie, Curtin & Graham, 2012). In the following experiments, we evaluate whether the phonological properties that characterize content and function words constrains the mechanism that associates novel words and objects. Unlike most content words, function words in English tend to have the following syllable forms: CV, VC, or V. In this series of experiments, we examined whether 12-month-olds are sensitive to the differences in syllable forms across word forms. That is, will infants of this age map objects to novel words that are more akin to function-like words in English? To address this question, we tested 101 infants using the Switch procedure (Werker, Cohen, Lloyd, Casasola & Stager, 1998) in four experiments. Experiment 1 presented infants with two word-object pairings (one CV word and one VC word) until they habituated. In the test phase, infants were presented with two trials: a same and a switch trial. During the same trial, infants were presented with a familiar word-object pairing (e.g.: ku/Object A) heard during the habituation phase. During the switch trial, infants were presented with a familiar object and word but with the familiar pairing violated (e.g., ku/Object B). Experiment 2 presented the same word-object pairings in sentence context to highlight the intended grammatical class of the label (Look at the uk). Experiment 3 presented infants with two words that had an initial consonant and a long vowel (ku:, fl:) to determine if this made words sound more content-like, and thus more acceptable as a label. Experiment 4 presented infants with two words that had an initial long vowel and a consonant (uk:, lf:), providing a nice contrast to Experiment 3 and allowing us to separate out the effects of an onset and vowel length. All stimuli were recorded in adult-directed speech to make the words sound more like typical English function words. A reliable difference in listening times to the two test trials indicates discrimination. Results showed that infants did not form word-object associations between novel CV or VC words and a novel object in any of the experiments (p 's > 0.5). This suggests that infants have a sophisticated understanding of what is and is not an acceptable label by 12 months and that prior experience with their native language may constrain their learning of novel labels. However, experience must play a role because at some point infants have to realize that CV: (e.g. shoe) is a legal object label. This research provides us with insights into infants' word learning abilities and demonstrates how knowledge of lexical forms impacts subsequent mappings.

P1-D-53: Raising a bilingual infant: Parents' beliefs and concerns

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Parents' approaches to and experiences of raising bilingual infants vary immensely from family to family. Understanding parents' beliefs and concerns can guide research and knowledge dissemination to answer parents' most important questions about raising infants with more than one language. While there has been extensive research investigating the beliefs and concerns of parents raising school-aged children (see De Houwer, 1999), few studies have looked at the parents of bilingual infants. Our study addresses this gap, comparing the experiences of Montreal parents raising a bilingual infant in two different language contexts: those raising infants with two majority-languages, and those raising infants with a majority and a heritage language. Parents living in Montreal, Quebec, raising their first child under the age of three ($n = 27$, unique families = 20) took part in one of nine focus groups (mean duration =



42 m), where they discussed their language practices, beliefs, worries and needs for resources relating to raising their infant bilingually. Montreal served as an ideal setting to study bilingual parenting: French and English are the official languages and have approximately the same prestige and social status, yet speaking another language is also very common. Using thematic analysis, we explored if and how French-English-bilingual parents (n = 9) differed in their experience compared to parents raising a bilingual infant with at least one heritage language (n = 11). French-English bilingual parents were generally optimistic about their ability to support their infant's bilingual development, and expressed few concerns. In contrast, heritage language parents expressed numerous concerns: they worried that the infant may never learn the heritage language, they felt exposure to the heritage language outside of the home was lacking, they worried they might be burdening their infant with too many languages, they were concerned about possible language delays, and they thought that language mixing could later hinder their child's school performance. Further, only heritage language parents were concerned about family disharmony stemming from their infants later refusing to speak the heritage language. Lastly, all parents wanted more information about bilingual parenting. French-English parents wanted more bilingual-specific information. All parents wanted more bilingual materials, such as bilingual books. Heritage language parents, however, did not feel they had adequate resources even in the heritage language itself, and wanted materials in this language. Overall, our results highlight that parents of bilingual infants within the same urban context - where bilingualism is positively viewed - can have vastly different beliefs and concerns depending on the perceived community support for the languages they wish to transmit. These findings could help extend De Houwer's (2015) theory of harmonious bilingual development to infancy which, to date, considers risk factors on interactions with a verbal child. We argue that disharmony can be present even before a child can speak with their parents, in part due to limited language support in the community. Within the same community, it is clear that to best support parents, education and resources should be tailored to support different bilingual families.

P1-D-54: Face or book: Does focus of attention during shared book reading predict word learning performance in toddlers?

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Reading picture books with toddlers is a common activity which provides rich cues for language learning: shared book reading fosters vocabulary growth and general language development (e.g., O'Farrelly et al., 2018). However, to date little is known how children use the rich input provided by natural reading for word learning. The current study monitored toddlers' attention during picture book reading and subsequently assessed how well toddlers recognized a novel word-object pair that had been embedded in the story. A speaker presented 2- to 4-year-olds with a story book containing a novel character and a novel label in a one-to-one reading setting, leading to a natural cross-situational word learning situation. Toddlers' eye gaze was continuously tracked throughout reading using eye tracking glasses to assess how much time toddlers spent looking at the book vs. the speaker's face. Subsequently, toddlers' learning of the novel word-object association was assessed in a preferential looking task (cf. Fernald et al., 2008). Toddlers were presented with 32 trials in which two pictures were shown side by side and one was labelled. The increase in proportion



of target looking (PTL) after naming served as measure of word recognition. Trials included familiar trials, labelling a familiar object, and critical test trials presenting the novel object and label. Novel target object and label were either both correct, the label was mispronounced or the object was misshaped. Reduced target looking in mispronounced and misshaped trials (as compared to correct trials) was taken as an indicator for detailed phonological and referential encoding of the novel word. We hypothesized that attention to the book and the novel referent presented therein predicts toddlers' encoding of referential information of the to-be-learned word because detailed encoding of the referent most likely requires attention to it. We further hypothesized that attention to the speaker and articulatory information from her mouth predicts encoding of phonological information of the to-be-learned word as visual speech information might help to decode the auditory signal. Preliminary data from 29 toddlers (planned sample size = 48; age range 24-54 months) indicate a robust increase in PTL for familiar words ($t(28)=3.241$, $p=.003$), but no evidence of novel word learning (correct trials: $t(28)=1.256$, $p=.219$, mispronounced trials: $t(28)=.331$, $p=.743$, misshaped trials: $t(28)=.541$, $p=.593$). This suggests that even though the label elicited more looks towards the target picture in familiar and correct trials, word learning in a natural book reading context was challenging for this age group. Indeed, word recognition in correct trials strongly correlated with age ($r=.456$, $p=.013$). Interestingly, there were remarkable individual differences in attention during reading that might modulate learning: while children showed relatively high rates of interest (mean looking time to speaker or book: 64.3%, range 9-92%, SD 21.1), in general they do not attend much to the speaker's face (mean 6.8%, range 0-21%, SD 6.3). As predicted, there was a trend for a correlation between toddlers' attention to the face and word recognition in mispronounced trials ($r=.283$, $p=.075$) and between toddlers' general attention and word recognition in misshaped trials ($r=.291$, $p=.075$).

P1-D-55: Word comprehension, word production and gesture use in the second year of life

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Introduction: The second year of life is characterized by a rapid development of children's lexicons. This development is reflected in vocabulary comprehension, vocabulary production, and by the emergence of new actions, gestures, and symbolic play. This study aims to examine the relationships between production, comprehension, and the use of actions and gestures and to characterize the inter-personal variability in these domains. Participants & Procedure: Hebrew-speaking parents of 881 healthy toddlers (12-24 months old) reported on their child's receptive and expressive lexicons, action and gesture use, and symbolic play activities. Parents completed a computerized version of the Hebrew adaptation of the MacArthur-Bates Communicative Development Inventories as well as a background questionnaire. Results: Positive and significant ($p<.01$) correlations were found between comprehension, production and actions and gestures use. The gap between vocabulary comprehension and vocabulary production was not constant across children, i.e. toddlers with large vocabularies in production compared to age-matched peers had a smaller gap between comprehension and production. Two hierarchical regression models revealed that vocabulary comprehension predicted a larger percentage of the differences in vocabulary production than did actions and gestures use. Based on cluster analysis of age-based percentile ranks in each domain, four groups of lexical



development styles were found (see figure 1). One group of participants had high scores in the three measures of comprehension, production, and actions and gestures use. The second group had average ranks in vocabulary comprehension and production but a low rank of actions and gestures use. The third group had average ranks in vocabulary comprehension and production but a high rank of actions and gestures use. The fourth group showed a low rank of the three lexical abilities. Discussion: The positive correlations between comprehension, production and actions and gestures use show that during the second year of life verbal and non-verbal behaviors are closely related as they reflect children's underlying symbolic development. The finding that the gap between comprehension and production is negatively correlated with size of the productive lexicon point to the importance of examining these two abilities separately as they show different aspects of the same ability. The identification of four groups of participants in which the relationship between verbal and non-verbal behaviors vary might explain the variability in language development and hence has research and clinical implications.

P1-D-56: Cues for within class language discrimination: Evidence from 4.5-month-old infants

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Previous research shows that infants can discriminate between languages that belong to different rhythmic classes at birth, and potentially even in the womb (Minai, Gustafson, Fiorentino, Jongman, & Sereno, 2017; Moon, Cooper, & Fifer, 1993; Thierry Nazzi, Bertocini, & Mehler, 1998). Partial within class language discrimination emerges around the fifth month of life (Bosch & Sebastian-Galles, 1997, 2001; T Nazzi, Jusczyk, & Johnson, 2000). The cues that infants use in order to succeed in such discrimination tasks are still elusive. Based on previous findings, infants show the first signs of word knowledge at 6 months (Bergelson & Swingley, 2012). Although, it is unlikely that 5-month-old infants have already established the phonetic repertoire of their native language(s), this does not preclude the possibility of having some proto-segmental information available, probably on vowels. Intonation has been also proposed as a potential cue for within class discrimination (Chong, Vicenik, & Sundara, 2018). To test these hypotheses, we decided to conduct four experiments. We tested participants using sentences in Central and Western Catalan (Exp. 1) and sentences in Western Catalan and Spanish (Exp.2). Both dialects of Catalan and Spanish are syllable-timed but they differ in terms of their vowel distribution, given that Central Catalan is the only one that has vowel reduction (table 1). Western Catalan and Spanish have comparable vowel distributions; therefore, it cannot be an informative cue for discrimination. We also tested participants using low-pass filtered sentences in the two Catalan dialects (Exp. 3) and low-pass filtered sentences in Western Catalan and Spanish (Exp. 4), as a way to dissociate between the contribution of segmental and suprasegmental information. In all four experiments we used the same paradigm as in Bosch and Sebastian-Galles (2001). In the first experiment, 40 4.5-month-old infants having Central Catalan as their dominant language were tested. In the second experiment, we tested another sample of 40 4.5-month-old infants having Spanish as their dominant language. In these first two experiments we tested both monolingual and bilingual infants (n=20 per group in each experiment) and no effect of language was found, which is why in the third and fourth experiment we tested 20 Central Catalan dominant and 20 Spanish



dominant infants respectively. We found that infants can discriminate between the two dialects in experiment 1 ($F(1, 38) = 13.89, p < .001, \eta^2 = .03$) and that they can also discriminate between Western Catalan and Spanish in experiment 2 ($F(1, 38) = 6.71, p = .014, \eta^2 = .02$). Infants failed to discriminate the two Catalan dialects when the sentences were low-pass filtered ($F(1, 19) = 0.01, p = .941, \eta^2 < .01$) but they could still discriminate between low-pass filtered Spanish and Western Catalan ($F(1, 19) = 5.06, p = .036, \eta^2 = .02$). Recapitulating, we have replicated previous findings of within class discrimination testing 4.5 month-old infants and have extended previous research by testing a pair of dialects and languages that has not been used before. Our control experiments showed that segmental information is necessary for the infants to discriminate between the two dialects and that using only suprasegmental information infants achieve to discriminate prosodically close languages.

P1-D-57: Child-directed speech: Assessing variations in speaking rate and effect on child word learning

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Background Studies have found that child-directed speech (CDS) is generally articulated slower compared to adult-directed speech, but little research has examined whether caregivers adjust speaking rate within CDS depending on their perception of children's knowledge (such as familiarity of words or the situational present/absent of objects), and how might the modification affect children's word learning. The current study contributed to this topic by asking (1) do English mothers slow down when introducing unknown words compared to known words, and when the referred objects are absent (less accessible) compared to present; (2) does speaking rate of known words, unknown words, and degree of modification between the two predict children's word learning. Method We collected 30 mother-child dyads (children Meanage= 3.5 yrs). The caregiver was asked to naturally talk about 4 sets of toys (in each set, half are known to the child and half are unknown) in two conditions (toys being present or absent). Afterwards children received a recognition test for the unknown toys. Caregiver's speech was transcribed and segmented to words in Praat. The target referents (stimuli toys) were labelled with familiarity (known vs. unknown), condition (absent vs. present), their position in the utterance, and number of mentions. Speaking rate was measured as average number of syllables per second, and the degree of modification for unknown words (speaking rate ratio) was calculated by the speaking rate of known words divided by that of unknown words for each caregiver. The recognition scores were the proportion of trials that children answered correctly. Analysis We used a linear mixed model to assess which factors influence caregivers' speaking rate. The model included the familiarity (known vs. unknown) and condition (present vs. absent) as fixed effects, with three control variables: the child's age, number of mentions, and word position. The dependent variable was caregivers' speaking rate of target referents in a given condition. To assess the effect of caregivers' speaking rate on children's learning of unknown word labels, we used a regression of caregivers' speaking rate of known words, unknown words, or the speaking rate ratio as separate independent variables and children's recognition results as the dependent variable. Result We found that speaking rate was significantly slower for unknown objects compared to known objects and when objects were absent compared to present, even when the number of mentions and word positions were controlled for. Despite that there was no correlation between the raw speaking



rate and the recognition results for both known and unknown words, there was a significant correlation between caregivers' speaking rate ratio and children's recognition learning result. Such an effect still held when the average number of mentions of the unknown referents and children's age were controlled for. This indicated that caregivers' greater adjustment between known and unknown words predicts better immediate learning for children. Conclusion Caregivers would decrease their speaking rate in more demanding situations to adapt to their children, and the differences in speaking rate between known and unknown words could assist children in word learning.

P1-D-58: Noun bias in English-Mandarin bilingual speech: Evidence from a novel assessment context

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A long-standing debate in language development is whether noun dominance in early lexical acquisition is universal or language-specific (see Waxman et al., 2013 for a recent review) and whether such lexical bias manifests in different contexts (e.g., Altinkamiş et al., 2014). Evidence from monolingual children is mixed. Some report universal noun dominance (Bornstein et al., 2004), whereas others report language-specific noun dominance (e.g., Tardif et al., 1999). Mixed results may emerge from methodological differences such as using checklists or observing productive speech (Piccin & Waxman, 2007), which can be further biased depending on the context in which the speech is observed in (Tardif et al., 1999). For example, book reading contexts tend to elicit more noun production than verb production, whereas toy play contexts tend to elicit more verb production than noun production (e.g., Altinkamiş et al., 2014; Tardif et al., 1999). To date, early noun dominance has been primarily examined in monolinguals. However, examining early noun dominance in monolinguals raises potential concerns involving between-subjects variability and limits our understanding of early lexical biases. Specifically, children who receive noun biased input (e.g., English) are also the children who typically demonstrate a noun bias, while children who receive verb biased input (e.g., Mandarin) are also the children who typically demonstrate a verb bias. By investigating lexical biases in bilingual children learning both a noun-bias and a verb-bias language simultaneously, we can reduce the intra-individual variability and ask whether bilinguals' early lexical bias will be the same as monolinguals learning either language. In Singapore, bilingualism is the central language policy for over half a century. Starting from preschool until at least 16 years of age, all Singaporeans must learn both English and their "mother tongue" language (Mandarin for Chinese Singaporeans, Malay for Malay Singaporeans, and Tamil for Indian Singaporeans). Thus, Singapore provides a unique setting and opportunity to study a bilingual population who is learning one of the languages that is central to the conflicting in the noun dominance debate: Mandarin. The primary aim of the present study is to investigate whether noun bias is a universal or a language-specific phenomenon by sampling Singaporean English- and Mandarin-speaking mothers' and their 20-month-old toddlers across two contrasting contexts, book reading and toy play. Nineteen dyads were provided with a standard set of toys and two books. Mothers were instructed to engage in a 20 minute, 10 minutes per language, interaction. Across contexts and languages, English- and Mandarin-learning toddlers produced more nouns than verbs (Figure 1). In contrast, their mothers produced more verbs than nouns in both languages and were lexically biased depending on the context (Figure 2).



More specifically, mothers produced more nouns than verbs during book reading but more verbs than nouns during toy play. Together, these findings support early noun dominance as a universal phenomenon in the lexical acquisition debate and cast doubt whether language specificity plays a major role in early lexical acquisition.

P1-D-60: Does phonological overlap across translation equivalents predict earlier age of acquisition?

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Previous literature on early vocabulary has been mostly committed to exploring how the receptive and productive vocabulary size changes with age, and its relationship with toddlers' performance on language tasks (e.g. Fernald, Swingley, & Pinto, 2001; Fernald, Perfors, & Marchman, 2006). The content of the developing lexicon has remained relatively unexplored. More recently, studies have focused on the characterisation of the developmental trajectory of individual words, reporting an earlier age of acquisition for words with high frequency, concreteness, and phonological neighbourhood density (e.g. Braginsky, Yurovsky, Marchman, & Frank, 2019; Jones & Brandt, 2019). Such item-level analysis allows not only to predict the age of acquisition of specific words, but also to shed light on the cognitive processes that underlie early word learning. This approach is particularly interesting for investigating the potential impact of acquiring two languages simultaneously. A recent study by Floccia et al. (2018) compared vocabulary sizes of 24-month-old children learning British English, together with an additional language from a pool of 13 diverse languages. They found larger productive vocabulary sizes of toddlers learning two languages that are phonologically similar (see for a similar approach Bosch & Ramon-Casas, 2014). The mechanisms underlying this effect remain unknown. One possibility is that the similarity between the two languages speeds the acquisition of form-similar translation equivalents. The aim of this study is to perform an item-wise analysis on infant's vocabulary contents. We developed an online tool to collect parental reports of receptive and productive vocabularies from children learning Catalan and/or Spanish. We expect that phonological overlap between translation equivalents will predict earlier age of acquisition. If this effect is driven by the phonological overlap between translation equivalents, cognate pairs should be acquired closer in time than non-cognates. For instance, the translation of cat /gato/ in Spanish and /gat/ in Catalan should be learnt at approximately the same age. This should not necessarily happen for the translations of dog, /pero/ and /gos/. We analyse the time elapsed between the acquisition of a word in one language, and its translation in the other. We present preliminary data (data collection is ongoing) on receptive vocabulary of 90 monolingual and bilingual toddlers aged 18 to 36 months. We obtained parental responses to 230 pairs of Catalan-Spanish translation equivalents, resulting in a total of 41490 responses. Words that yielded a phonologically similar translation equivalent were more likely to be present in toddlers' receptive vocabulary at all ages, and were acquired earlier, even when accounting for the effect of word frequency. Further analysis will explore the distance in time between the acquisition of pairs of translation equivalents using a more detailed measure of phonological overlap across translation equivalents and taking into account cross-individual and cross-item variability.



P1-D-61: Do infants use more social or non-social protophones? An opinion survey and observational study

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The study of vocal development has been dominated by the expectation that infants primarily vocalize when they are in social engagement, a belief suggesting social interaction drives prelinguistic vocal development. In spite of the possible importance of endogenous vocal activity in language development, to our knowledge there is no published evidence specifically targeting the directivity of individual infant protophones. We first sought to quantify the responses of the general public regarding how often they thought infants vocalized for various functions using an opinion survey. We hypothesized that survey participants would report higher proportions of social directivity. Our primary goal was to obtain overall proportions of socially and non-socially directed protophones produced by infants at in the first year of life across different levels of interactivity. We hypothesized that infants would produce more non-social protophones than social ones, but that infants would use more socially directed protophones in interactive circumstances compared to non-interactive circumstances. 239 participants responded to a survey where they estimated what percentage of infant vocalizations are directed towards another person and NOT directed towards another person. They were asked these questions three times with respect to the ages used in the observational study. For the observational study, six parent-infant dyads completed two naturalistic recordings each at 3, 6, and 10 months of age in our laboratory. Using these video recordings, coders labeled all infant protophones in terms of illocutionary force (Austin, 1962) to indicate potentially communicative functions, which were later collapsed into social and non-social categories for data analysis. The results from the opinion survey (Figure 1) show that overall, respondents thought approximately 43% of infant protophones were non-social in nature. In addition, they thought infants produce more social protophones at the later ages than the earliest age, suggesting participants think infants increase social directivity throughout the first year. Infants used significantly more non-social protophones at all three ages compared to socially-directed ones and a relatively stable use of social and non-social functions across the three ages studied (approximately 75% overall) compared to the survey data (Figure 2). In the Non-Interactive circumstance, non-social directivity predominated to a substantially greater extent, with four times as many non-social protophones as social ones (Figure 3). Even in the Interactive circumstance non-socially-directed protophones predominated, with twice as many non-social as social protophones used by the infant. Overall, infants used about three times as many non-socially-directed protophones as socially-directed ones, a pattern that remained stable across the three ages. These results contradict the standard viewpoint in the field of child development and the apparent expectation of the general public, that infant vocalizations are often treated as responses to adult utterances or as attempts to engage adults in social interaction. The results emphasize the infant as an agent in vocal learning, not as a passive recipient of vocal input. We propose that vocal exploration may have a deeply significant role in development, alongside the support of caregiver interaction and ambient language exposure.

P1-D-62: Investigating the features of child-directed versus overheard speech in all-day recordings of Spanish-speaking families



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Recent studies of day-long recordings have shown that children's language environments consist of many different opportunities for caregivers to support their children's learning. Importantly, verbal engagement during child-directed speech, but not overheard speech, has been linked to children's later outcomes (Weisleder & Fernald, 2013). A growing list of verbal features has been hypothesized to explain why child-directed speech supports learning, including total number of words, number of different words, and number of conversational turns (Hart & Risley, 1995; Romeo et al., 2017; Rowe, 2012). However, few studies have compared how these features vary within the same families in the different settings in which child-directed and overheard speech occur (Foushee et al., 2013). Using data from Weisleder & Fernald, we examined three automated metrics from LENA (adult word counts (AWC), conversational turns (CTC), and child vocalizations (CVC)), exploring the extent to which these metrics, individually or in combination, predicted classification of child-directed versus overheard speech. Investigating these differences can help us better understand why child-directed speech, in particular, supports children's language learning. Participants were 29 primarily lower-SES Spanish-speaking families with 24-month-old children who recorded one typical day using LENA. Native Spanish-speaking coders listened to each 5-min segment of the all-day recording and classified each segment as: (1) primarily child-directed, (2) primarily overheard, or (3) 50% child-directed and 50% overheard (split). We conducted hierarchical logistic mixed models to examine the degree to which LENA-provided metrics predicted the classifications. Segments of split speech were divided equally into child-directed and overheard speech categories. All metrics were converted to rates/minute and mean-centered within each family to reduce collinearity and to allow interpretation of values as relative to each family's mean rates. In our first model, we tested whether AWC, CTC, and CVC each independently contributed to the probability of child-directed versus overheard speech. We found that AWC ($B=-.44$, 95%CI=[-.54, -.33]), CTC ($B=.37$, 95%CI=[.23, .52]), and CVC ($B=.30$, 95%CI=[.18, .42]) each contributed unique variance. Interestingly, lower AWC rates were associated with a higher probability of child-directed speech, whereas higher rates of CTC and CVC were associated with a higher probability of child-directed speech (Figure 1). In our second model, we tested whether the interaction between AWC and CTC contributed unique variance (Figure 2). That is, does CTC help our prediction of child-directed speech at all levels of AWC, beyond the unique and independent contributions for each metric? We found that while AWC ($B=-.53$, 95%CI=[-.63, -.43]) and CTC ($B=.62$, 95%CI=[.50, .74]) each still contributed unique variance, the interaction of both metrics was not significant ($B=-.02$, 95%CI=[-.09, .05]). These findings demonstrate that child-directed speech may, in part, be defined by lower rates of adult words and by higher rates of conversational turns and child vocalizations than in overheard speech. Ongoing analyses employ ROC curves to test the sensitivity and specificity of these metrics. This work is a critical step towards understanding what defines child-directed speech in naturalistic settings and elucidating how child-directed speech supports children's language learning.

P1-D-63: Cerebral basis of non-adjacency grammar learning: Neonates and 6- to 7-month-old infants



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Introduction Sensitivity to nonadjacent dependencies (NADs) is critical to learn hierarchical structures underlying language. For example, English speakers can track relations between auxiliaries and inflectional morphemes, even if intervening middle elements vary (e.g., is happily singing, has hurriedly walked). Previous studies show that 15-month-old infants can track NADs behaviorally (Gomez et al., 2005), while ERPs indicate learning effects have already emerged at the age of 3 months (Mueller et al., 2012). However, little is known about the neurocognitive basis of NADs learning at its initial stages. Thus, we conducted two functional near-infrared spectroscopy (fNIRS) experiments using an artificial grammar learning paradigm with neonates and 6-7-month-olds. **Materials and Methods** Twenty-three 6-7-month-old awake infants (6 females) and 15 full-term sleeping neonates (3~5 days) were analyzed in Experiments 1 and 2, respectively. In both experiments, stimuli were tone triplets that either followed (standard and correct stimuli) or did not follow (deviant stimuli) an AXB rule where A predicted B with variable X. Each tone type was characterized by its specific pitch contour (e.g. A: rising tone, B: slow-wave alternation). In order to test for generalization, the pitch range was different across the learning and testing phases. In the learning phase, infants were familiarized with 2 types of standard NADs (AXB, CXD, 60 triplets in total). During the test phase, they were either presented with correct or incorrect pitch-shifted NADs (AXD, CXB) against the baseline of non-pitch shifted standard stimuli. The oxygenated-hemoglobin (HbO) concentration data were measured with two Hitachi systems (ETG-7000 with 44-channels for Exp. 1 and ETG 4000 with 46-channels for Exp. 2) covering frontal and temporal brain regions during the test phase until infants get fussy or listen to 7 blocks for each condition. Data were band-pass filtered (0.02-0.5 Hz) to eliminate physiological noises and averaged to the target (correct or incorrect) block onset. After removing blocks with motion artifacts, block data were normalized with a 5-s baseline period before each block. Averaged HbO values for each target block were calculated using early of 7.5-12.5 s and late time windows of 17.5-22.5 s from the onset and then were used to compare statistical differences between correct and incorrect conditions. **Results and Discussion** As shown in Fig. 1, we found significantly greater activation to the correct condition in both frontal and temporal channels for 6-7-month-olds. Conversely, neonates had greater activation to the incorrect condition, compared to the correct condition only in frontal cortices. These findings thus suggested that both 6-7-month-old infants and neonates can discriminate between correct and incorrect NADs, but in a different way. Specifically, 6-7-month-olds recruited higher cognitive processes including memory and syntactic computation to detect NADs, while neonates seemed to distinguish different NADs at the level of working memory.

P1-D-64: Infants learn vowel minimal pairs produced in adult-directed speech before 18 months

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Many studies have shown that learning words that differ in a single phoneme, also known as minimal pairs (e.g. bin-din or bon-bin), can be challenging for infants, with success depending



on the task, specific minimal pairs tested, and learners' age. These studies use novel words produced in infant-directed speech (IDS), based on the assumption that IDS facilitates the use of phonetic detail in early word learning. However, IDS has been shown to obscure some contrasts (e.g., vowel length in Japanese and vowels in certain contrasts overlap more when produced in IDS). Whether it is possible for infants to learn minimal pairs produced in adult-directed speech (ADS) is unknown. The current study examined 15- and 17-month-olds' ability to learn words that differ in a single vowel in ADS using the Switch paradigm. During familiarisation, 15-month-old and 17-month-old Australian-English monolingual infants were habituated to 10 tokens of the word "DEET" in ADS presented with a moving novel object, until looking time decreased to 65% of the initial looking time, or a maximum of 24 trials. During test, a Same trial ("DEET"), with the original word-object pairing, and two Switch trials, in which the pairing is violated by replacing the word with "DIT" (Switch 1), or "DOOT" (Switch 2), were presented. Results show a main effect of test trial for the 17-month-old group, $F(2, 30) = 11.53$, $p < .001$, $\eta^2 = .99$, with longer looks to the DOOT Switch ($M = 13.23$, $SD = 3.97$) than to the Same trial ($M = 7.51$, $SD = 3.10$; $F(2, 14) = 15.30$, $p < .001$, $\eta^2 = .99$) and marginal detection of a switch to DIT ($M = 10.50$, $SD = 4.92$, $p = 0.59$). There was also a main effect of test trial for the 15-month-old group, $F(2, 12) = 6.51$, $p = .012$, $\eta^2 = .82$, with longer looks to the DIT Switch ($M = 14.44$, $SD = 3.89$) than to the Same trial ($M = 7.91$, $SD = 4.20$; $F(2, 5) = 18.09$, $p = .002$, $\eta^2 = .97$) but no difference in looking time between DEET and DOOT trials ($M = 9.22$, $SD = 4.39$, $p = 0.91$). As with the IDS stimuli, 17-month-olds noticed a switch from DEET to DOOT when presented in ADS and can marginally detect a switch from DEET to DIT, constituting the first demonstration that infants under 21 months can learn a minimal word pair in ADS. The success in detecting a switch from DEET to DIT at 15 months in ADS runs counter to their inability to detect the same switch in IDS. We posit that 15-month-old infants' success in the current study may be a result of the specific acoustic properties of IDS vs ADS stimuli. Specifically, vowel duration is a cue in ADS (see Figure 2) but not in IDS where vowels are typically long. Implications of these findings for the results of previous word learning studies and theories of lexical development will be presented.

P1-D-65: The role of verbal and nonverbal behaviors in children's later language processing: Data from low-SES Latino families in the US

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Caregivers are children's first teachers, engaging children in rich interactions that help them learn about the world. Early disparities in the quantity and quality of caregiver interactions, particularly verbal engagement, have been shown to begin early and to contribute to children's academic outcomes (Hart & Risley, 1995; Walker et al., 1994). This work has inspired decades of research devoted to understanding why individual differences in early language environments link to later language outcomes (e.g., Gilkerson et al., 2018; Pan et al., 2005). Weisleder and Fernald (2013) proposed that language processing skills mediate the link between caregivers' verbal engagement at 19 months and children's vocabulary development at 24 months. How does caregiver engagement support children's language processing? One hypothesis is that language processing skills develop as a function of children's ability to identify referents in broader communicative interactions, which include verbal and nonverbal behaviors. Research has shown that the nonverbal dimensions of caregivers' referential input



(timing, gesture, gaze) positively relate to children's later vocabulary knowledge (Cartmill et al., 2013; Trueswell et al., 2016). However, it is unclear how verbal and nonverbal behaviors work together. Here, we compare 5 models (differing in the predictors they include) which represent ways in which the amount of verbal and nonverbal behaviors could contribute to children's later language processing skills and vocabulary size: 1) labels only 2) gestures only 3) labels and gestures (additive), 4) labels and gestures (interaction), or 5) labels overlapping with gestures. Participants were lower-SES Spanish-speaking families in the US. We video-recorded a 5-min free play session at 18 months and coded the number of labels and gestures (i.e., pointing, holding, giving, or touching objects) used by caregivers as well as the number of times caregivers paired a label with a gesture (overlap). At 25 months, children's speed of language processing was assessed in the Looking-while-Listening task (Fernald et al., 2008) and vocabulary size was approximated using the MacArthur-Bates Communicative Developmental Inventories (CDI) (Fenson et al., 2007). We preregistered the sample size, coding procedures and analysis plan. The five models were fit as Bayesian linear regression models (Table 1). For language processing, a model including the number of labels as a predictor (Model 1) provides a better fit to the data compared to a baseline model which includes only control predictors (processing at 18 months, SES). For vocabulary size, Model 1 also provides the best fit, yet labels paired with gestures (Model 5) also explains the data better than the baseline model. This research replicates and extends previous findings showing that verbal engagement predicts the development of children's later language skills, even when pitted directly against the frequency of gesture use, measured either alone or in combination with labels. Nevertheless, different combinations of labels and gestures also explain variance for both language processing and vocabulary size. Ongoing analyses are exploring possible explanations for these patterns. Investigating verbal and nonverbal communicative behaviors in relation to child language outcomes can offer new insights into how caregivers can support children's later language development.

P1-D-66: Prosody facilitates word segmentation in infants at risk for language impairment

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The ability to extract word-forms from continuous speech plays a crucial role in language acquisition, particularly for vocabulary development (Singh et al., 2012; Kidd et al., 2018; Hoareau et al., 2019). This ability is known to develop differently across languages (e.g., Mersad et al, 2010), and to be modulated by prosodic structure: namely, words at prosodic edges are segmented earlier than in utterance-medial position (Johnson et al., 2014, Butler & Frota, 2018). Studies on word segmentation in infants at-risk for language impairments are rare, and have reported mixed findings (Bosch, 2011; Berdasco-Muñoz et al, 2018, on preterm infants). Moreover, the role of prosody has not been explored. The current study investigates early segmentation abilities in a mixed group of European Portuguese-learning at-risk infants and toddlers (AR), including premature birth and familial risk for autism or language disorder. We examined whether prosody facilitated word segmentation, as shown for typically developing infants (TD), and whether segmentation abilities correlated with concurrent language skills. Using a modified version of the visual familiarization paradigm, AR infants were familiarized with passages with target word-forms located at prosodic edge and medial



positions, and then tested with four sequences of isolated word-forms, two of which consisted of familiar targets, and two were new, unfamiliar word-forms (as in Butler & Frota 2018 study with TD infants). Results from 19 participants (mean age 15 months; range 6-26 months; 10 female) revealed overall segmentation with longer looking times to familiar ($t(18)=2.48$, Cohen's $d=.51$). However, a RM ANOVA with the factor condition (edge, medial, unfamiliar) showed that the main effect of condition ($F(1.92, 34.39) = 6.46$, $p=.005$, $\eta^2=.27$) was driven by the prosodic edge (posthoc tests Bonferroni corrected yielded a nearly significant result for edge vs. unfamiliar, $p=.058$; all other comparisons non-significant; Fig.1). No effects of age were found, whether the data was grouped following the CDI-I and CDI-II age groups (up to 16 and from 18 months; $F(1,17)=1.4$, $p=.25$, $\eta^2=.08$), or age was included as a continuous variable in a regression model. These findings are similar to the ones reported for TD infants, with an important difference: TD infants start to develop medial segmentation by 10 months (Butler & Frota, 2018), while AR only show segmentation abilities at the prosodic edge (Fig.2). Moreover, AR segmentation abilities were correlated with two concurrent language assessment scores, measured by the CDI (Frota et al, 2016): edge, as well as edge-minus-medial, positively correlate with language comprehension (Spearman's $\rho=.52$, $p=.048$; Spearman's $\rho=.58$, $p=.03$); and edge-minus-medial positively correlates with language production (Spearman's $\rho=.44$, $p=.03$). Taken together, these findings demonstrate that prosody guides early segmentation abilities in AR infants and toddlers, and that segmentation abilities and receptive and expressive language skills are closely linked in this at-risk population.

P1-D-67: Eye-gaze patterns to communicative cues in early infancy and later language and communication outcomes

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Attention to talking faces plays an important role in early language and social communication development (Ayneto & Sebastián-Gallés, 2016; Fort et al., 2017; Pejovic, 2019). Specifically, the attentional shift from the eyes to the mouth by 8months of age has been linked to language development (Lewkowicz & Hansen-Tift, 2012). It has been suggested that infants' increased attention to the mouth is correlated with concurrent language skills (Tsang et al., 2018), and predicts later expressive language skills (Tenenbaum et al., 2015). However, few studies have addressed the development of eye-gaze patterns to talking faces and other social communicative gestures in early infancy relative to measures of language and communication development. The current study explores how eye-gaze patterns to talking faces (eyes/mouth) and other communicative cues (arm) develop in the first year of life, and whether eye-gaze patterns are related to concurrent and later language and communication development. The eye-gaze patterns of European Portuguese learning-infants were examined at 5-6months ($N=26$, 9girls) and 8-10months ($N=16$, 9girls) while watching a 4-second-long video of a cartoon character talking and waving at the infant. First, the percentage of looking time to the upper vs. lower face regions, and to the waving arm vs. the background were compared within and between age groups. Next, eye-gaze patterns were correlated with longitudinal measures (i) of receptive and expressive language, using The Portuguese CDI short forms (Frota et al., 2016), completed between 8-30months, and (ii) of social communication, language and symbolic functioning skills, using the CSBS-DP Checklist adapted for EP (Frota et al., 2014-



2016), completed between 6-24months. Over development infants increased their attention to the mouth ($F(1,40)=5.096, p<.05$), as expected. At 5-6months, infants attended longer to the eyes over the mouth ($t(25)=3.893, p<.001$), and linguistic (the face) over extralinguistic (arm) audiovisual cues ($t(25)=-8.277, p<.001$). Moreover, a negative correlation was found between attention to the mouth and receptive vocabulary by 12-18months of age, suggesting that increased attention to the mouth is recruited in infants with lower language abilities ($r=-.60, p<.05$). By contrast, at 8-10-months infants attended similarly to the upper and lower face regions ($t(15)=.397, p>.05$; Fig.1). Further, this increased attention to the mouth was positively correlated with expressive vocabulary at 18-24months ($r=.71, p<.05$), but not with concurrent language skills. Interestingly, although eye-gaze to the waving arm was still quite low at 8-10months (Fig.2), it was positively correlated with the concurrent social composite score of CSBS ($r=.50, p<.05$), revealing the ongoing acquisition of social skills, as well as with expressive vocabulary at 18-24months ($r=.65, p<.05$), indicating the relation between the development of language and social communicative skills. Overall, our results, similarly to other reports (Pejovic, 2019), demonstrate that the attentional shift to the mouth at 8-10-month-old EP-learning infants is a gradient rather than a categorical developmental process. Importantly, we observe that early attention to the mouth was differentially associated to later language outcomes, depending on the tested age. Finally, the study emphasizes the relation between eye-gaze to non-linguistic social cues and the development of language and communication.

P1-D-68: Cerebral correlates of statistical learning of phonemic categories in neonates

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Young infants have a remarkable ability to learn. Statistical learning of phonemic contrast is one of the significant learning mechanisms for language acquisition. However, the cerebral base underlying learning remains mostly unknown even though neuronal measures could detect learning ability in young infants, including neonates. Consequently, the present functional near-infrared spectroscopy (fNIRS) study aims to show whether neonates learn phonemic categories according to statistical distribution by comparing discriminative response to phonemic contrast pre- and post-learning. Furthermore, the cerebral mechanism of learning and plastic change of the brain network due to learning was also examined by assessing neuronal connectivity. Brain connectivity during the learning phase, as well as resting-state connectivity before and after the learning phase, were analyzed to examine changes in the brain network. For this purpose, we tested 41 full-term neonates (mean age: 4.7 days; range: 3 to 7 days). They were divided into two groups by learning conditions: bimodal and monomodal distribution. Targeted phonemic contrast was English /r/ and // and stimuli were generated from the /light/-/right/ continuum by manipulating F2. For the bimodal condition (BM), stimuli were stochastically sampled to form a bimodal distribution in frequency with two peaks at prototypical /light/ and /right/ sounds (Fig.1). Contrastingly, the stimuli for the monomodal condition (MM) had a monomodal distribution with a peak in the middle of prototypical /light/ and /right/. The experiment consisted of five phases in the following order: pre-resting, pre-discrimination, learning, post-resting, and post-discrimination. In the pre- and



post-resting phase, we measured the spontaneous fluctuation of activity in the brain. In the pre- and post-discrimination and learning phase, we measured hemodynamic responses to auditory stimuli. During the learning phase, a stimulus set of either bimodal distribution or monomodal distribution was presented randomly for approximately 7 minutes. In the pre- and post-discrimination phases, we measured discriminative responses using an oddball paradigm with /light/ and /right/ prototypical sounds. Results of the pre- and post-discrimination tests for the BM group showed a significantly larger hemodynamic response to the phonemic contrast in various areas. Notably, a comparison of the subtracted discrimination response (i.e., post- vs. pre-discrimination) between the 2 groups revealed a larger response in the left supramarginal gyrus (SMG) and the right precentral gyrus for the BM group than the MM group. This suggests that the BM group had enhanced sensitivity to the targeted phonemic difference than the MM group, following the learning condition. Furthermore, comparison of the pre-resting state and post-resting state networks showed that the connectivity between SMG and the right middle frontal gyrus was strengthened after the learning in the BM group (Fig. 2). The number of such enhanced connectivities was larger in the BM group. As SMG is a crucial brain region for phonemic processing, it is suggested that neonates can learn phonemic categories based on the distributional information of phonemes.

P1-D-69: Does auditory deprivation affect selective attention to a talking face? Data from 10-month-old deaf and hearing infants

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Infants' selective attention to a talking face follows a developmental pattern that begins in the talker's eyes and shifts towards the mouth at around 8 months of age, coinciding with the onset of canonical babbling (Lewkowicz and Hansen-Tift, 2012). This shift to the mouth seems to reflect infants' increasing interest in language and audiovisual speech. Attention to the mouth of a speaker is also found in adults, when the auditory information becomes unclear (e.g. speech-in-noise) and relying on the audiovisual redundant cues can improve speech processing (Lansing & McConkie, 2003). In infants born with sensorineural hearing loss, early communicative interactions, vocalizations and language experience differ in important ways from hearing infants. Cochlear implantation is infrequent below the age of 12 months and the use of hearing aids before implantation does not compensate for the overall poor quality of deaf infants' oral language experience. To date, no studies have specifically investigated whether deaf infants (of hearing parents, DoH) attend to a talking face in a similar fashion as their normally-hearing (NH) peers do. It could be hypothesized that DoH infants would pay greater attention to a talker's mouth than NH infants, to "compensate" for the low quality or degraded auditory speech input they perceive. On the other hand, since attention to the mouth has also been linked to the onset of canonical babbling, the absence or limited production of babbling vocalizations in deaf infants could also predict lower attention to the mouth in this population. These hypotheses were tested in a sample of N=39 10-month-old participants (N=22 DoH, N=17 NH) using Pons, Bosch and Lewkowicz (2015) material, that is, two consecutive 45 sec. videos of a woman talking in IDS in a familiar and non-familiar language, while we recorded their eye gaze with a stand-alone eye tracker (Tobii X120). Subsequently, infants were presented with the same two clips but this time without the sound. We analyzed

the proportion of total-looking-time (PTLT) to the eyes and mouth areas of the talking face. Prelinguistic vocalization measures (MacArthur CDI) and scores from the Communication and Social subscales of the Adaptive Behavior Questionnaire (Bayley-III) were also obtained. While groups significantly differed in the vocal production and social/communicative measures, PTLT results showed striking similarities, with both groups looking significantly more to the mouth [$F(1,35) = 22.86, p < .001, \eta^2 = .40$]. Analysis for the silent videos yielded a similar result [$F(1,31) = 8.16, p = .008, \eta^2 = .21$]. Last, a significant correlation was only reached with the Social subscale of the Bayley Questionnaire in both groups collapsed [$r = 0.36; p = .037$], connecting greater attention to the eyes with higher social scores. No other correlations (vocalization and communication measures) reached significance. These results challenge the current understanding of the link between infants' shift to a talker's mouth and the onset of babbling. Further analyses are planned to better understand the complex interplay between hearing loss, poor linguistic experience and early intervention strategies on selective attention to a talking face in pre-lingual deaf infants.

P1-D-70: Do all roads lead to bilingualism? Characterization of dual language exposure strategies and their relation to input balance

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Globally, many babies grow up learning two languages at the same time, with the opportunity to become bilingual. For example, 25% of children being raised in major Canadian cities live in bilingual homes (Schott, Kremin & Byers-Heinlein, in prep). Parents raising a bilingual child face decisions about how to interact with their babies. Should each parent stick to one language or should they mix languages? Different families use different approaches. Perhaps the most well-known approach for bilingual families is "one-parent-one-language", where each caregiver speaks a different language. In 2007, De Hower performed a large retrospective study that looked at dual language exposure approaches on close to 2000 families living in Flanders (Belgium) who spoke both Dutch and another (minority) language. The most frequently reported approach was one-bilingual-one-monolingual parent, followed by two bilingual parents. The one-parent-one-language approach was used by only 12% of families, and generally yielded insufficient input in the minority language for children to become active bilinguals. To better describe the prevalence of different strategies in bilingual families and their relation to language exposure patterns, we interviewed 175 (of which 151 met criteria for analyses) Montreal-based families that were intending to raise bilingual infants (age range: 8-19 months, $M: 13.37, SD: 3.9$). Infants were learning English and French, which are both widely spoken in Montreal, and had <10% exposure to other languages. Language exposure was measured with the MAPLE questionnaire (Byers-Heinlein et.al, 2018). Parents rated the frequency in which they spoke to their child in French and in English (always, sometimes, never). Based on their responses, families were categorized into one of the following profiles: a) strict one-parent-one-language (each parent always speaks a different language), b) flexible one-parent-one-language (each parent primarily speaks one language but one or both occasionally speaks the other), c) one-bilingual-one-monolingual parent, d) both parents bilingual, or e) another pattern that did not fit into any of these profiles. In most families, one (32%) or both (45%) parents reported speaking bilingually to their infant. Strict (9%) and



flexible (14%) one-parent-one-language strategies were the least frequently used. These proportions were largely similar across different ages (Figure 1a). This is similar to what de Hower (2007) reported in bilingual families in Flanders, suggesting that these results generalize beyond our Montreal-based sample. We observed a link between the degree to which children's input was balanced across the two languages and family language strategies. Balanced input was more frequently observed in one-parent-one-language families (both strict and flexible); however, our results indicate that it is possible to have balanced exposure using any of the strategies (Fig 1b). This experiment constitutes a step forward towards characterizing the language strategies used by families and their links with input balance. Studying mechanisms that affect input balance is important, as children need sufficient input in each language to become bilingual (See Scheele, Leseman & Mayo, 2010). The findings from this study are a crucial step for developing adequate recommendations for caregivers wishing to raise bilingual children.

P1-D-71: French-learning infants' acquisition of phonological alternations

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Phonological alternations alter sounds' surface forms in specific contexts. For instance, the word 'sweet' can be pronounced with a final [p] in 'sweet boy', due to the English rule of place assimilation (both [p] and [b] are labial, while [t] is alveolar). Previous research using artificial languages has shown that English-learning 12-month-olds can use distributional cues to learn alternations (K. White et al., 2008) and that they are biased to generalize an alternation between dissimilar sounds (e.g., [p] changes to [v]) to affect similar sounds (e.g., [b] changes to [v]), but not vice versa (J. White & Sundara, 2014). Our aim is to focus more closely on the role that similarity plays when infants learn alternations, specifically by comparing how well infants learn alternations involving a small change (one feature: voicing, place or manner) vs. a large change (three features: voicing, place and manner). Since we test French-learning infants, we started out by running a set of pilot studies (N=61) to reproduce previous findings on one-feature voicing alternations. Our stimuli were based on the two studies mentioned above. During our habituation phase, one group of 12-month-old infants was exposed to [p]-initial words only after the 'functor' 'lu' [ly] and [b]-initial words only after the 'functor' 'mi' [mi] (e.g., lu péni [ly.peni], mi béni [mi.beni]), while [s]- and [z]-initial words appeared after both 'functors' (e.g., lu saro [ly.saro], mi saro [mi.saro]). Another group was exposed to the opposite distribution (see Table 1). Our design differed from previous work in two ways. First, instead of using a familiarization paradigm with a predetermined exposure, we used a habituation paradigm. This has the advantage of facilitating the prediction of the results (i.e., a novelty effect), and to generate a larger effect size (e.g., Cristia, 2018). Second, instead of testing infants on novel words without 'functors,' or preceded only by correct 'functors,' we presented congruent and incongruent test trials in which the assignment of the 'functors' to novel words either followed (e.g., lu sané, mi sané) or contradicted (e.g., lu pimo, mi pimo) the pattern learned during habituation. Contrary to our expectations, we failed to reproduce previous findings. That is, infants did not discriminate between congruent and incongruent test trials, regardless of whether the test phase involved two test trials ($t(35) = .604, p = .55, d = .101$), or four test trials ($t(24) = -.926, p = .364, d = -.185$; see Figure 1). It is unclear whether our failed



results are linked to voicing alternations being hard for French-learning infants (but not for English-learning infants), methodological differences, or to a true inability for infants to learn the co-occurrence patterns between 'functors' and disyllabic 'words' following short exposure to an artificial language. To test the first possibility, we are currently investigating if French-learning 12-month-olds can learn manner alternations, which are perceptually more salient than voicing alternations. A closer replication of White et al. (2008) is also planned in order to shed some light on infants' true ability to acquire phonological alternations based on distributional cues.

P1-D-72: Paternal education as a predictor of linguistic input to children with normal hearing and hearing loss

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Prior research has demonstrated the important role of early auditory environments on children's linguistic and cognitive development. For example, the amount of adult speech was found to be significantly correlated with later vocabulary in both children with normal hearing and children with hearing loss (HL) (Ambrose et al., 2014; Gilkerson et al., 2018). Since mothers are generally thought to spend more time with their children during infancy than fathers do, due to Western and American sociocultural contexts and policies related to parental leave from work, a great deal of attention has been paid to maternal speech and how maternal factors (e.g. maternal education) correlate with the language input experienced by their children (Dollaghan, et al., 1999). Comparatively, very little is known about paternal speech directed to children, despite an increasing trend of employers offering paternity leave (Mercer, 2018). This paternal input may also be essential for children's language acquisition. Exploring the similarities and differences of parental linguistic input to children with normal hearing and children with hearing loss (HL) would help us to better understand between-group variations in language outcomes. This study examined quantities of linguistic input from both mothers and fathers to children with cochlear implants (CIs), hearing aids (HAs) and normal hearing (NH). Our team collected and analyzed 249 naturalistic recordings using the Language Environment Analysis (LENA) system from 38 NH children, 17 children with CIs and 17 children with HAs, aged 3 months to 33 months. Maternal and paternal linguistic input was measured by female adult word count (FWC) and male adult word count (MWC), which were automatically generated by the LENA system. To account for variation in the durations of recordings, we normalized each measure by hour (i.e., FWC/hr and MWC/hr). For each family that completed a recording, we collected demographic data including years of maternal and paternal education. We ran a repeated-measures ANOVA with Gender (Female, Male) as the within-subjects variable, and Hearing status (NH, CI, HA) as the between-subjects variable. We found that across groups, children were exposed to more female adult words ($M = 791/\text{hr}$) overall than male adult words ($M = 302/\text{hr}$), $F(1, 69) = 85.78, p < .001$ [Figure 1]. The female adult word count was not correlated with maternal education, $p = .130$. However, the amount of male adult words that children may hear was positively correlated with paternal education, $p = .047$. Our results indicate that although maternal input may constitute a greater proportion of children's linguistic environments overall, children are still exposed to a significant amount of speech from their fathers (MWC= 27.63% of total adult words). Moreover, men with higher levels of education tend to produce a larger amount of linguistic input to their children.



Understanding children's auditory environments and how certain factors influence the amount of language input children receive from both their mothers and their fathers could help us understand the variability of these children's language outcomes

P1-D-73: I can't believe it's not chiz! Lexical effects on toddler's phonetic perception

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In encountering speech that departs from their dialect, mature (adult) listeners use multiple sources of information to flexibly adjust perception. One source of information that can be used is lexical knowledge, wherein knowledge of the typical sounds for a given word can help the listener interpret ambiguous sounds (Ganong, 1980; Norris et al., 2003; Samuel, 1981). A possibility supported by adult studies is that exposure to acoustically ambiguous sounds within familiar lexical contexts allows listeners to perceive these sounds as belonging to phonetic categories consistent with that lexical context (Norris et al., 2003). In general, young learners initially have difficulty processing speech that deviates from community norms, but can accommodate speech deviations given sufficient exposure time and conditions (San Juan, Lin, Mackenzie, Curtin, & Graham, 2019; Schmale, Hollich, & Seidl, 2011; Schmale, Cristia, & Seidl, 2012; White & Aslin, 2011). We ask if infants rely on developing word knowledge to accommodate short-term deviations in speech acoustics. We exposed children of 15 and 24 months of age to a perceptually ambiguous vowel token [ʔ], that could be perceived as either [i] or [ɪ]. The ambiguous token was placed in lexical contexts that biased its possible interpretation: "fʔsh" in the Shift-to-[ɪ] condition (15-month n = 24; 24-month n = 20), or "chʔse" in the Shift-to-[i] condition (15-month n = 27; 24-month n = 18). At test, infants heard repeated exemplar trials for each of three vowels ([i], [ɪ], and the ambiguous vowel [ʔ]), as well as alternating exemplar trials containing the ambiguous vowel [ʔ] juxtaposed with either [i] or [ɪ]. We hypothesized that if exposure context biased infants toward interpreting [ʔ] as belonging to the category of the canonical vowel for a familiar word, looking times would differ between test trial types. Specifically, looking times for test trials that juxtaposed the ambiguous vowel with another vowel that was perceptually different (e.g. alternating [ʔ] and [ɪ] in the Shift-to-[i] condition) should be longer than looking times for repeated exemplar trials corresponding to the canonical vowel category for the familiar word (e.g. [i] in the Shift-to-[i] condition). We found that only the 15-month-olds exposed to the ambiguous vowel in the context of the word "cheese" (Shift-to-[i]) look longer to trials which alternate the ambiguous vowel with [ɪ] than to repeated exemplar trials of [i] (18/27 participants). This suggests the 15-month-olds in this condition perceive a difference between the ambiguous vowel, which has been biased toward [i], and the vowel from the other category, [ɪ]. This was not the case in the Shift-to-[ɪ] condition, nor was there evidence of lexical influence on the 24-month-olds in either condition. The looking behavior observed in 15-month-olds could provide evidence of the ability of the emerging lexicon to drive perceptual learning effects of lexical context on sub-lexical categories.

P1-D-74: The prosodic properties and amount of parental speech input across infants' development



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Young infants are commonly spoken to in a very special way. This infant-directed speech (hereafter, IDS) differs from the speech used in adult conversation, also known as adult-directed speech (hereafter, ADS). While previous studies have investigated IDS and ADS across different languages, the quality and quantity of IDS across infants' development remains to be explored. Against this background, we audio- and video-recorded 212 mothers and fathers interacting with their own children between the ages of 5-months and 4-years. In particular, we assessed the amount of IDS as well as the prosodic characteristics of parents' IDS used towards their children during a 6-minutes interaction for which the experimenter left the room. In addition, these parents were also recorded producing speech addressed at another adult to reveal the degree of modification from ADS to IDS. Currently, the coding of the parent-child interactions is still ongoing. Preliminary analyses of IDS and ADS utterances from 78 mothers and 14 fathers confirm the validity of our collected samples indicating significantly higher minimum, maximum, and mean pitch for IDS compared to ADS (e.g., mean pitch, IDS: Mmothers=236 Hz, Mfathers: 150 Hz; ADS: Mmothers=198 Hz, Mfathers =122 Hz; cf. Fernald et al., 1989) but found no significant difference in pitch range in IDS relative to ADS. Further, the degree of modification in mean pitch from ADS to IDS becomes significantly less with infants' age for both mothers and fathers. Assessing the amount time that parents direct IDS at their infants, there seems to be a towards a significant increase of infant-directed input the older the infant that is being spoken to (see Figure 1). In addition to the parental input, we had part of the parents report infants' vocabulary size at the same time the parent-child interactions were recorded. Neither parents' prosodic enhancement from ADS to IDS, nor the quantity of IDS during parent-child interactions seemed to be related to infants' reported vocabulary score. While this study has clear limitations as to the laboratory setting in which IDS was produced, it nevertheless opens some first insights on how parents modify their ADS in order to produce IDS as well as the quantity of IDS may change across infants' development.

P1-D-75: Neural and behavioural correlates of auditory discrimination and phonetic processing in 5- to 11-month-old infants

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Inconsistency of accounts on auditory and speech processing in early development tends to be attributed to maturational factors in children (Cheour et al., 1998; Kushnerenko et al., 2002). However, variability in stimulus and design features used across studies likely contributes to this lack of consensus (Garrido et al., 2009). The mismatch response (MMR), an electrophysiological measure elicited to auditory stimulation, can provide a neural index of speech processing and language development (Benasich, Thomas, Choudhury, & Leppänen, 2002; Volkmer & Schulte-Körne, 2018). The current study investigated the design and paradigm features which influenced MMR in forty-three 5- to 11-month-old infants. Stimulus type and the number of simultaneous streams (phonemes and tone pairs) were systematically manipulated. Taking such an approach provided a means to gain an understanding of those factors that influence auditory and speech development in infants and address questions of



interest to researchers working within the field of neurodevelopmental research. A secondary objective of this study was to delineate the relationship between neural and behavioural correlates of language development in the same participants at the time of testing and a subset of nineteen infants at 24 months, as assessed with Bayley-III receptive and expressive communication subtests (Bayley, 2005). Stimulus modulation confirmed that tone pairs consistently elicited larger MMR amplitude than phonemes. Furthermore, the number of concurrent stimulation streams did not influence MMR to tone pairs but revealed dissociation in processing phonemes. Infants discriminated phonetic deviance when alternating with the tone pair stream, but this was not observed in the single stream design. Results of analyses relating to the secondary question revealed a positive association that linked MMR to acoustic change to receptive language at the time of testing and at 2 years. None such a relationship was identified with the MMR to phonetic contrast. Overall, the first finding revealed that narrowband tone frequencies are more discernible than spectral sounds, such as phonemes (Hancock, 2004). This has provided a more in-depth insight into the effect of the linguistic and nonlinguistic stimulus on the MMR in infants. Furthermore, neural acoustic discrimination was reflected in behavioural responsiveness to speech (Kushnerenko et al., 2013; Molfese, 2000), which has highlighted the predictive value of the auditory MMR in language development.

P1-D-76: The LENA system applied to the Awadhi dialect: Measuring language exposure in rural India

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Children's early language exposure impacts their later linguistic skills, with higher quantity and quality of language input leading to better language outcomes. Most of our knowledge about language input during childhood comes from western societies, and we do not know if similar patterns are found in other cultures and populations. Automated methods for recording and analyzing large datasets of input to infants, are key to expand our research to more diverse groups. Our study measures language input in a non-western sample (India, Uttar Pradesh) of 6-month-old infants. We carried on daylong naturalistic recordings of caregiver and child interactions from Indian families using the LENA recorder (Language ENvironmental Analysis) that can be placed on a vest that the child is wearing during the day. The LENA is able to capture the linguistic environment to which the child is exposed at home for an extended period of time. It also includes an analysis software that performs automated segmentation of the recordings and provides estimates for various measures: adult word count, conversational turn count and child vocalizations. These measures are an approximation of the number of words, turns and vocalizations produced in close proximity to the child. The LENA system was developed and trained on American English, but it has also been evaluated on its performance when applied to Spanish, Mandarin, French and Swedish. The present study is the first evaluation of the LENA system applied to Awadhi. To assess the validity of this measure in the new linguistic setting, we compare language counts in Awadhi with a matched sample of naturalistic recordings from 6-months-old British English infants. Our results show that adult word count, conversational turns and child vocalizations are surprisingly high in Awadhi, being twice as much than for British English (Figure 1). A possibility is that the LENA system is overcounting words in that particular dialect. To investigate this hypothesis, three native speakers transcribed LENA recordings of 10-minute dyadic interactions in the lab, and 5-



minute home LENA recordings. Data processing and analysis is still ongoing. Results from these transcriptions will help understand how the LENA system segments Awadhi words. Moreover, we will be able to identify the most reliable index of language input in LENA, when applied to that dialect. We will discuss the implications of our results for the language input literature with a special focus how cultural norms influence the shape of linguistic input and, thereby, the strategies best adapted for language learning in each community.

E-Communication 2 (syntax, pragmatics, signed, nonverbal, disorders)

P1-E-77: The language of support: Parents' verb uses in descriptions of support events

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Children and adults show a 'Division of Labor' (DoL) when talking about spatial configurations of support (teddy on table, picture on wall). In English, BE on is used to primarily encode support from below (SFB) (toy is on table), while specific manner of attachment (MoA) verbs (stick, hang) are used to encode mechanical support (poster stuck to wall) (Landau, 2018). A recent study reports a similar DoL in the spontaneous speech of children 1.5-4.5 years; children use light verbs (put) to encode SFB in dynamic events (rather than static configurations), and older children especially use MoA verbs to encode mechanical support (Lakusta et al., 2019) What accounts for such highly differentiated semantic space in children? The current study tests whether parent input plays a role. Participants (N = 190) were parents of children in the following age groups: 6-, 12-, 20-, 24-30, and 31-36-months. Parents were shown two dynamic support events that were previously viewed by their children: a hand putting a block 1) on top of a box and 2) on the side of a box (Figure 1). Prior to viewing the events, parents were told "We are going to show you the video that CHILD NAME just saw. We would like you to watch it, and then after describe to CHILD NAME what happened". If parent language plays any role in the differentiated semantic space that has been observed in young children, then parents should show a DoL when describing support events to their children. That is, they should map light verbs to SFB and MoA verbs to mechanical support. In order to test this hypothesis, parents' descriptions of the two support events were first coded in terms of light verb use. A mixed model logistic regression was conducted; age group and stimulus type (block on top vs. side) were treated as fixed-effects and both were significant in predicting light verb use; parents used light verbs more to describe BOX ON TOP than BOX ON SIDE ($B=2.45, p<.001$) and parents of children 31 months used significantly fewer light verbs than parents of children 6-, 12-, and 20-months ($p < .05$). Similarly, when predicting use of MoA verbs, parents used MoA verbs to describe BOX ON SIDE more than for BOX ON TOP ($B=-3.62, p<.001$) and parents of children 31 months used MoA verbs significantly more than parents of children 6-, 12- and 20-months ($ps < .05$), see Figure 2. Thus, parents show a DoL when describing SFB and mechanical support to their children; light verbs map to SFB and MoA verbs to mechanical support. This differentiation in parent language is especially prominent by the time children are 31-36 months, with parents using more MoA verbs and fewer light verbs to encode mechanical support compared to the younger children. These



results suggest a role for parent input in the DoL observed in young children and set the stage for future studies to test the direct relationship between parent input and children's acquisition of MoA verbs for encoding mechanical support.

P1-E-78: Prediction of lexical growth during the second year of life: A short-term follow-up study of TD and LT Hebrew-speaking toddlers

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Introduction: Lexical development during the second year of life is characterized by great variability in toddlers' rates of vocabulary growth (Fenson et al., 1994). This variability necessitates gathering information from large samples, which is greatly facilitated by the method of parent report (Fenson et al., 2007). While many parent report studies use cross-sectional data to provide information about developmental patterns across different participants (Frank et al., 2017), these data cannot provide information about the lexical growth within the same participants. Longitudinal vocabulary data were collected via parent questionnaires in order to explore the extent to which early vocabulary production can predict later vocabulary growth during the second year of life. This question was explored for both typically developing children (TD) and for late talkers (LT). Participants and procedure: Hebrew-speaking caregivers of 95 toddlers aged 12-24 months completed an online version of the Hebrew adaptation of the MacArthur-Bates Communicative Development Inventories: Words & Gestures (Hebrew MB-CDI; Gendler-Shalev & Dromi, 2020). Caregivers completed the inventory 3 times every few months during the second year of life (Administration 1: M=14 mos; Administration 2: M= 18 mos; Administration 3: M= 22 mos). Percentile scores were computed based on age and sex. Children were classified at Administration 1 as either LT (n=24), toddlers with vocabulary size \leq 25th percentile, or as TD (n=71), toddlers with vocabulary size $>$ 25th percentile. Results: Mixed effects growth curve modeling was performed. Results showed that both age and initial lexicon size predicted the growth rates in vocabulary size. With age, vocabulary size increased and the rate at which words were added to the vocabulary accelerated over time. Regression analysis showed that vocabulary size at the first administration predicted vocabulary size at the second ($p<.001$, $R^2=0.50$) and third ($p<.001$, $R^2=0.23$) administrations, with stronger prediction for the second administration. When lexical level (TD vs. LT) was added to the model, model fit increased significantly ($p<.001$). The absolute differences between the lexicon size of TD and LT were compared and the average change per month for both groups was calculated. Results showed that the lexicon size of both groups grew significantly over time, however, rates of growth were faster in LTs vs. TDs (Figures 1 and 2), suggesting "catching-up" in the LT group as a whole. Discussion: The results of our study justify the use of the Hebrew MB-CDI for screening vocabulary development in the second year of life. The acceleration in growth rates observed here offers corroborating evidence for a "lexical spurt" (Dromi, 1987) across the sample as a whole. The faster lexicon growth rate of LT toddlers is likely to reflect that many LT children are "late bloomers" (Dale et al., 2003) who catch up to their peer's vocabulary size later in development. Ongoing analyses will explore features of LT toddlers who catch up vs. toddlers who exhibit continued delays. Charting the paths of lexical developmental in LT and TD toddlers learning Hebrew will provide important insights relevant for both research and clinical efforts.



P1-E-79: Infant location and language exposure in the early home environment

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We know from cases of psychosocial deprivation that the early caregiving environment profoundly impacts development across domains (Nelson et al., 2014). One important component of the early caregiving environment is the amount of cognitive stimulation (e.g., language exposure) a child receives. Researchers studying children in family contexts have documented substantial variability in the amount of language spoken to and around young children, and this variability may account for later child abilities (Weisleder & Fernald, 2013; Golinkoff, Hoff, Rowe, Tamis-LeMonda, Hirsh-Pasek, 2018). We also know that language input varies based on context; in one study, parents and infants engaged in more conversational turns when infants were being carried in a backpack vs. pushed in a stroller (Mirault, Rainville, & Laughlin, 2018). However, very little is known about how specific contextual aspects of a child's everyday home environment may contribute to between- and within-family variability in language exposure. The present study is a part of a larger project aiming to address this knowledge gap. We are the first to propose that young infants' language exposure may be linked to where they are spending time in their homes (i.e., where caregivers physically place their pre-mobile infants). Specifically, we propose that some locations (e.g., held, worn, in a high chair) may encourage more infant-caregiver verbal interaction compared to other locations (e.g., exersaucer, bouncy seat, infant swing). Our primary research question is as follows: in a given segment of time, is the quantity of an infant's language exposure related to characteristics of the infant's immediate location? To answer this question, we coded 5-minute subsets of videos of 6-month-old infants and their parents (N = 27) interacting at home. We took note of (1) where infants were spending time ("infant location") and (2) how many words were spoken near the infant in the 5-minute period surrounding each observation of baby location. Data for this study are from the SEEDLingS project (Bergelson, 2017) and obtained from Databrary (Lingman et al., 2014). Figure 1 shows the average word count associated with each location. These results challenged our assumptions about particular infant locations and led us to wonder why some locations might be associated with more or less language exposure. Specifically, we explored the extent to which each location might encourage physical parental involvement. We grouped all observed locations into two main categories: one category (gray bars in Figure 1) that tends to encourage parental involvement and one category (blue bars in Figure 1) that tends not to encourage parental involvement. Using multilevel modeling to account for the clustering of observations within families, we found that location category (encourage vs. didn't encourage involvement) significantly predicted the number of words spoken in a given 5-minute segment, $B=57.84$, $SE=28.53$, $t(53)=2.10$, $p=.041$. This finding provides preliminary support for a link between infant location and language input. If this finding extends beyond the present video analysis, we plan to use infant location as a target for interventions aimed at increasing language exposure in the home environment.

P1-E-80: How child vocabulary varies by parent-child engagement and parent responsiveness in Spanish- and English-speaking dyads

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The vocabulary of young children is supported by the quality and quantity of direct language input from more competent speakers (Farrar, 1990; Hart & Risley, 1995; Hirsh-Pasek et al., 2015). However, to our knowledge, previous studies have concentrated exclusively on English-speakers. To address this gap, we examined two qualitative patterns of language input, parent-child engagement (Farrar, 1990) and parent responsiveness (Hirsh-Pasek et al., 2015) occurring during a free play session with Spanish- and English-speaking parent-child dyads. We hypothesized that both of these patterns of input predict child vocabulary, and that language spoken by the dyad would be associated with pattern of input use. Participants were 47 Spanish- (Mage=31;07, range=28;12 to 37;06) and 50 English- (Mage=30;13, range=28;00 to 32;27) dominant dyads living in the United States. All children had at least 77.6% exposure to their dominant language. Dyads participated in 20-minute free play sessions and parents completed the MCDI:WS (Fenson et al., 2007), a measure of expressive vocabulary. Conversations during these free play sessions were transcribed to inter-rater agreement $\geq .83$ and coded to inter-rater agreement $\geq .850$. We conducted analyses in parallel but independently for engagement and responsiveness. We first conducted model comparisons and then submitted the most parsimonious model to a regression analysis. Parent-child engagement accounted for 57% and parent responsiveness accounted for 47% of the variance in child vocabulary across languages, over and above control variables. In this model, language ($\beta = -.250$, $p = .008$), symbol infused joint engagement ($\beta = .206$, $p = .034$), and fluency and connectedness ($\beta = .365$, $p < .001$) were significant predictors of child vocabulary. In the responsiveness model, language ($\beta = -.194$, $p = .074$) was no longer significant; however, both parent responsiveness styles (recasts/expansions $\beta = .189$, $p = .043$; redirects $\beta = -.278$, $p = .001$) were significant predictors of child vocabulary. Quality of parent-child engagement and parent responsiveness independently predicted vocabulary in both English-and Spanish-dominant dyads. The effect of language in the first model but not the second indicates that language accounts for significant variance in vocabulary above and beyond parent child engagement, but not beyond parent responsiveness. To assess whether engagement and responsiveness vary across language groups, we conducted model comparisons including control variables or control variables and language predicting each pattern of input. In both cases the full model did not provide better fit than the reduced model ($\Delta -2LL = 840.631 - 838.546$, $\chi^2(1) = 2.085$, $p > .05$; $\Delta -2LL = 1287.350 - 1284.888$, $\chi^2(1) = 2.462$, $p > .05$, respectively). Although Language influenced vocabulary size, it did not predict either pattern of input over the influence of the control variables. Consistent with the literature, we found parent-child engagement and parent responsiveness to be strong predictors of child vocabulary. We extend this finding to Spanish-speaking dyads, suggesting that parent-child engagement and parent responsiveness support vocabulary across cultures with different language practices. Contrary to our prediction however, language did not predict use of either pattern of engagement, suggesting that the impact of parent-child engagement and parent responsiveness on vocabulary growth may be universal.

P1-E-81: Mouth-looking and early vocabulary acquisition: A longitudinal eye-tracking study in infants at-risk for ASD and typically developing infants

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Recent studies have reported that typically developing infants (TDI) start to more focus on mouth than eyes in talking face around 9-month-old, which is thought to relate to early audiovisual speech learning and predict the following vocabulary size in the first few years of life. Although a slow acquisition of first words and the delay of the following vocabulary acquisition is a phenotype of language development in infants with autism spectrum disorders (ASD), it remains unclear to what extent atypical gaze patterns to talking face affect the early vocabulary development in the infants at-risk for ASD. The present study investigated how selective attention to mouth on talking faces in 9-month-old infants at-risk for ASD and TDI influence on the following early vocabulary acquisition. We have collected longitudinal eye-gaze data from two groups of infants across 6-, 9-, 12-, and 18-month-old; a group of at-risk for ASD and a group of TDI. Among them the present study chiefly focuses on data of 9- (at-risk group, $n = 30$; TDI group, $n = 31$) and 12-month-old (at-risk group, $n = 34$; TDI group, $n = 25$). We presented a video of a woman who was talking to the infant (20 seconds), and infant's fixation data was captured using Tobii X120 Eye Tracker system (Tobii, Stockholm, Sweden). We calculated the proportion-of-total-looking-time (PTLT: total looking time at eyes or mouth / total looking time at the face) and analyzed the 9-month PTLT difference score (eye - mouth) grouped by the presence or absence (1 - 0) of imitation of words in 12-month-old infants at-risk for ASD ($n = 23$) and TDI ($n = 19$). An ANOVA with group (at-risk and TDI) and word imitation (1 - 0) as factors showed a significant main effect of group [$F(1,38) = 4.19, p < .05$] and word imitation [$F(1,38) = 6.35, p < .05$]. The mean PTLT difference score in 9-month-old showed a higher proportion of mouth-looking in TDI group, and in infants who could imitate word-level sound, respectively. Further analysis in each group (at-risk and TDI) revealed that, only TDI who more focused on mouth in 9-month-old could imitate word-level sound in 12-month-old [$t(17) = 2.73, p < .05$]. Imitation is significant for language as well as other cognitive and social development. The present study showed that selective attention to mouth in 9-month-old scaffold to imitate word-level sound in 12-month-old, which is based on the following increase of vocabulary size as the previous studies have reported. Infants at risk-for ASD, on the other hands, showed less attention to mouth in 9-month-old. Our longitudinal study indicates that the infants at-risk for ASD have increased fixation to mouth in 12- and 18-month-old, suggesting that such atypical gaze pattern to mouth might be related to the delay of vocabulary acquisition including the appearance of the first word.

P1-E-82: Toddler-directed and adult-directed gesture frequency in monolingual and bilingual caregivers

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It has been suggested that caregivers, when interacting with their children, may adjust their gesture to maximize communication success under high communication demands. For instance, during an interactive problem-solving task, caregivers with children who have diagnosed developmental language disorder gesture at higher rates, compared to caregivers with typically developing children (Wray & Norbury, 2018). It has also been demonstrated that bilinguals exhibit higher gesture rates compared to monolinguals (e.g., Gullberg et al., 1998; Nicoladis et al., 2007; Nicoladis, Pika, & Marantette, 2009), possibly to facilitate language access across two languages (e.g., Gullberg, 2013; Nicoladis et al., 2009). The current project was designed to assess whether monolingual and bilingual caregivers modify their gesture



depending on the addressee (own toddler vs. adult) and the task at hand (re-telling a story in one language vs. re-telling a story using both of their languages). We recruited 10 Spanish simultaneous bilingual and 10 monolingual caregivers. Each caregiver retold stories to their toddler (age=30-36 months) and to an adult under two different conditions: "monolingual" and "bilingual/synonym". In the "monolingual condition" (MC), bilingual caregivers were instructed to use one of their native languages and the monolingual caregivers used their only native language. The caregivers were given 5 specific labels, to include in their story re-telling. In the "bilingual condition" (BC), the bilingual caregivers were instructed to use both of their languages in their story re-telling. They were again given 5 labels, but now told to include these labels in both of their languages during story re-telling. In the "synonym condition" (SC), the monolingual caregivers were given two synonyms for the same 5 labels and they were instructed to include both synonyms in their story retelling. A comparison of gesture frequency (number of gestures normalized by the number of words produced) across the two groups showed that bilinguals generally gestured more than monolinguals ($t=3.47$; $p<.001$), in line with previous findings. In the adult-directed story retelling, bilinguals gestured at the same frequency across the MC and the BC. However, monolinguals gestured more in the SC than in the MC ($t=-6.95$; $p<.001$), which may reflect that gesture rate generally increases under higher cognitive load (e.g., Hoetjes & Masson-Carro, 2017). In the toddler-directed condition, no differences were observed across MC and SC in the monolingual caregivers. In contrast, the bilingual caregivers re-telling gestured more in the BC than in the MC during the toddler-directed story ($t=-2.87$; $p<.05$). Overall, our results suggest that bilingual caregivers modify their toddler-directed gesture but not their adult-directed gesture depending on task demands.

F-Attention, Memory and Learning

P1-F-84: Individual differences in the modulation of visual search performance by auditory concurrent stimulation in very young children

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Purpose To investigate whether visual search performance is affected by rhythmic auditory stimulations and individual external as well as internal factors. **Methods** Eye movement data were obtained from 29 young children from 16 to 48 months of age (17 male; mean = 36.9; sd = 9.89) during visual search tasks. In the within-subjects design, the order of visual (V) and audiovisual (AV) conditions was counterbalanced. Each condition contained 10 practice and 64 experimental trials. Each trial included one target located on 1 of 8 different spots. All spots had an equal distance from the center. Distractors were randomly distributed. Each set size (4, 6, 8, and 10) was presented 16 times. A fixation dot was shown for 1000 ms followed by a search trial of 1000 ms. Auditory stimulation was an isochronous and metrical sequence with 8 tones that were played throughout experimental trials. The first tone that was accompanied by the appearance of visual stimuli had a frequency of 880 Hz. The other seven tones had a frequency of 440 Hz. Each tone lasted 100 ms with an inter-onset-interval of 250 ms. After the experiment, all caregivers received questionnaires that assessed external (home music environment, and music use of caregiver) and internal (temperament types, and sensory processing patterns) factors. **Results** The major findings were (1) the number of search items



per second was positively correlated with age and it was significantly higher ($p = 0.046$) in AV (2.07/sec) compared to V (1.84/sec); (2) in the lower set sizes (4 and 6), the number of responses on the target was higher in AV compared to V. (3) Analysis of a series of questionnaires using ordinary least squares regressions with clustered robust standard errors, we observed multiple casual associations between search performance and internal factors (sensory profile and temperament types) but not with external factors. More interestingly, the associations between internal factors search performance differed from AV and V. Conclusion In sum, our results showed concurrent rhythmic auditory stimulations might affect visual search speed. Moreover, internal individual differences in the early years play a significant role in visual search, while external factors had little effect. We suggest future studies to investigate the effect of varying AV regularity and/or synchrony, and the dynamic interaction between individual differences and search performance.

P1-F-85: Sex differences in hippocampal connectivity with respect to prenatal maternal depression

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The association between prenatal maternal depression and brain-behavior outcomes in neonates is likely sex-dependent. In other words, males and female offspring may have different susceptibility to prenatal maternal depression. Many factors, including adrenal hormones (e.g. cortisol), lead to sex differences in fetal development. Preclinical animal models of prenatal depression show hippocampal sex differences. Finally, recent reports also suggest that sex differences in functional connectivity are observable as early as the fetal period. Thus, while prenatal maternal depression may have consequences for both males and females, the specificity of these effects may differ. Yet, only a few MRI studies report a sex relate differential susceptibility to prenatal exposures in humans. Using resting-state fMRI in neonates, we investigate sex differences in hippocampal connectivity with respect to prenatal maternal depression. In pregnant adolescents ($n=42$), we collected maternal depression measure during the 3rd trimesters. the Reynolds Adolescent Depression Scale (RADS). Resting-state imaging data were acquired in their infants at 40-44 weeks post-menstrual age. Standard functional connectivity preprocessing was applied. Functional connectivity was measured from hippocampal seeds. Maternal depression was modeled as both continuous and dichotomized (using the clinical cutoff of >77) variables. Higher maternal depressive symptoms as measured by the 3rd trimester RADS associated with significantly ($p<0.05$ corrected) weaker connectivity between the left hippocampus and posterior cingulate cortex and with weaker connectivity between the right hippocampus and PCC. When comparing dichotomized groups based on the RADS clinical cutoff scores, neonates from mothers with prenatal depression exhibited significantly ($p<0.05$ corrected) greater connectivity between the left hippocampus and the right temporal lobe and greater connectivity between the right hippocampus and the right sensory-motor cortex. These effects remained significant when controlling for co-occurring prenatal stress. Finally, we observed a significant ($p<0.05$ corrected) sex by prenatal depression interaction for connectivity between the left hippocampus and the left caudate. Males exhibited an inverse correlation between maternal prenatal depression and hippocampal-caudal connectivity while females exhibited a positive



correlation. Together, our results suggest that prenatal maternal depression may have both common main effects and differential sex-based effects on hippocampal connectivity for both males and females. Given the associations between sex and psychiatric disorders and between prenatal exposures and psychiatric risk, further research elucidating differential susceptibilities for male and female offspring is needed.

P1-F-86: The role of variability in enhancing attention during infant-directed actions

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When demonstrating new actions to their infants, parents tend to exaggerate their movements (van Schaik et al., 2019). Such infant-directed actions enhance infants' attention to the action (Brand & Shallcross, 2008) and facilitate infants' action learning (Brand et al., 2002). The question arises how parents' infant-directed actions capture infants' attention. One possibility is that larger movements draw infants' attention more than smaller movements. Alternatively, statistical learning literature suggests that infants pay more attention to variable, less predictable input (Johnson & Munakata, 2005). In a previous study on infant-directed actions (Fukuyama et al., 2015), parents increased the variance in their movements after their infant had performed irrelevant rather than the demonstrated target actions. In this EEG study, we investigated the role variability might play in enhancing infants' attention to infant-directed action. We hypothesized that during infant-directed actions variability in movement attracts infants' attention more than larger movements per se. Additionally, we investigated the relation between infants' attention and their learning. The experimental set-up consisted of two phases, a demonstration and an action phase (Figure 1). We measured 14-month-old infants' brain activity (final sample: N=23) while they observed demonstrations of three new actions in the demonstration phase. In each of these three actions, objects (e.g. balls) were used on a corresponding goal base (e.g. bucket). Within subjects we manipulated whether actions were demonstrated with movements of normal, high or varied amplitude. After the observation phase, infants were presented with the items manipulated in the demonstrated actions. In this action phase, infants had the opportunity to perform the actions themselves. First, each goal base was presented with all objects (balls, rings, cups) and subsequently with only the corresponding objects (Figure 1). To investigate how the different conditions affected infants' attentional processing, we compared infants' theta power (4-5Hz) in fronto-central midline channels (Fz, FCz, Cz) between conditions, controlling for multiple comparison. Theta band activity in frontal brain regions has previously been linked to attention and memory and is thought to reflect infants' learning of new information (Begus et al., 2015). We found that frontal theta was significantly higher, indicating stronger attentional engagement, in the varied compared to both the normal and high amplitude conditions at electrode Fz ($F(2,44)=5.00$, $p=.01$, $\text{partial } \eta^2=.18$; Figure 2). This suggests that variability in movement amplitude rather than larger movements alone engages infants' attention during infant-directed actions. We further examined whether this theta effect related to whether infants subsequently performed the correct target action and/or whether they explored corresponding or non-corresponding objects first (i.e. familiar or novel goal-object associations). The overall linear regression model was significant ($F(3,21)=3.35$, $p=.04$, $R^2=.36$). The results show that infants with higher theta

power were more likely to successfully perform the target actions and to explore objects that were novel in the context of the given goal. This suggests a tight link between infants' heightened attention during infant-directed actions that varied in movement amplitude and their subsequent learning and exploration.

P1-F-87: Fewer turns, poorly learned: The effects of noise on word learning and parent-child interaction quality

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Real-world learning environments are full of sources of background noise. To better understand how young children learn words, it is important to consider how they do so in noisy environments. Recent work on word learning and vocabulary outcomes has highlighted the importance of turn-taking and a fluid, bidirectional conversation in parent-child interaction (e.g. Hirsh-Pasek et al., 2015). Turn-taking depends heavily on the attention and active engagement of both parent and child. With their still-developing attentional skills, young children might be especially susceptible to distraction posed by noise, diminishing turn-taking and the overall quality of the learning interaction. The present study seeks to explore the impact of noise on children's turn-taking in a word learning task, and whether children who can better maintain turn-taking in noise are better able to learn from the interaction. Participants were dyads of 23-month-old children and their mothers. Parents were given two stuffed toys, one at a time, and were told to teach their child the words for these animals as they played. One of the words was taught in quiet, and the other with low-level multi-talker babble in the background. Afterwards, children's learning of the two words was assessed in a preferential looking task. Child expressive vocabulary was assessed through the Language Development Survey (Rescorla, 1989). To date, twenty 23-month-olds ($M=22.95$ mos; $SD=0.47$; 14 females) completed the preferential looking task. Results indicate children learned the words taught in quiet ($t(19)=3.50$, $p<0.01$) and in noise ($t(19)=2.93$, $p<0.01$). However, ongoing transcription and analysis of the playsessions suggest that noise affects the quality of parent-child interaction: children contribute more conversational turns in quiet than in noise ($t(15)=2.45$, $p<0.03$). Furthermore, children who contribute more conversational turns in noise demonstrate better learning of the noise-trained word than their peers ($r(14)=0.66$, $p=0.01$). Children who can maintain high levels of turn-taking in noise also have higher expressive vocabularies ($r(14)=0.54$, $p<0.05$). Importantly, these patterns are not seen in the quiet condition: children who are more successful in noise are not simply more successful learners overall, but react to noise in a way that is more conducive to learning. Results suggest that noise is disruptive to the quality of parent-child interactions, potentially impacting children's ability to learn from language input over and beyond the challenges posed by the acoustic signal itself. Some children are more greatly impacted, showing less engagement in the interaction via turn-taking, and poorer learning. There are several possibilities regarding why high-vocabulary children better maintain turn-taking in noise. Differences in vocabulary could result from children's prior experiences in noise: since most learning environments are noisy, children who can better overcome the effects of noise would have had better learning opportunities in the past, and thus have acquired more words. Alternatively, children with high vocabularies could have better communicative skills, which they can utilize to elicit parental input that is more tailored, promoting their own engagement and lessening the distraction of



noise. Further analyses will compare the relative contributions of child vocabulary and turn-taking in noise to learning in this task.

P1-F-88: Effects of repeated retrieval on long-term retention in learning verbal task in younger children

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It is important for children's adaptation to daily life to promote the long-term retention of to-be-remembered events, locations, and general factual information. A number of studies with adults have demonstrated that the retrieval practice effect is one of the most effective long-term retention strategies. But is it effective for young children? With the lack of other studies apart from Fritz et al. (2007), the robustness of the effects of repeated retrieval on long-term retention for preschool children remains unclear. We examined the effect of massed retrieval repeated three times during learning on retention after one day by using a short-answer task. Sixty children from 5 to 6 years old (31 girls and 29 boys; $M = 70.03$ months, $SD = 3.12$ months, age range = 60 to 82 months) participated individually. Of the 60 children, 30 children were assigned to the immediate test group, whereas the remaining 30 were assigned to the delayed testing group. The variables were Age group (5-year-olds/6-year-olds), Learning condition (Retrieval/Studying) and Retention interval group (Immediate/Delayed). Age group and Retention interval group were between-participants factors and the Learning condition was a within-participants factor. The dependent variable was the percent of words correctly recalled. The procedure consisted of three phases. In the first phase, all children were given 8 questions and corresponding answers. In the second phase, all the children received the 4 repeated retrieval (4RRR) items and the 4 repeated study (4SSS) items alternately one by one. In the third phase, children in the immediate test group were asked to overtly report the answer to each question after five minutes. Similarly, children in the delayed test group were asked to overtly report the answer to each question after 1 day. Figure 1 shows the mean recall performance on studied items as a function of Group, Learning condition, and Retention Interval. A 2 (Age group) X 2 (Learning condition X 2 (Retention interval) mixed factorial ANOVA was conducted. More importantly, in the immediate test group, the recall performance of the repeated retrieval condition did not differ from that in the repeated study condition ($F(1, 56) < 1$, ns, $\eta^2 = .00$), whereas in the 1 day later group, the recall performance of the repeated retrieval condition was better than that in the repeated study condition ($F(1, 56) = 34.38$, $MSe = .50$, $p < .001$, $\eta^2 = .38$). This selective modulation reflected a significant interaction of Learning condition and Retention Interval ($F(1, 56) = 16.13$, $MSe = .50$, $p < .001$, $\eta^2 = .06$). These trends were reflected in both the 5-year-olds ($F(1, 56) = 10.88$, $MSe = .50$, $p < .01$, $\eta^2 = .16$) and 6-year-olds ($F(1, 56) = 5.67$, $MSe = .50$, $p < .05$, $\eta^2 = .09$). The results showed a powerful effect for the importance of retrieval on learning retention. The result showed the benefits of repeated retrieval on long-term retention for young children in verbal task.

P1-F-89: Infant touchscreen use is associated with neural and behavioural differences in visual attention during video viewing



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Intro/Objective: Touchscreen devices enable young children to interact with the digital world earlier than previously possible (Cristia, & Seidl, 2015; Bedford et al., 2016). With this comes concern about the potential influence touchscreen use may have on cognitive development (American Academy of Paediatrics, 2016; Royal College of Paediatrics and Child Health, 2019). The current literature offers a conflicting view, suggesting these interactions may afford both detriments and benefits for development (Christakis et al., 2004; Landhuis et al., 2007; Levine & Waite, 2000; Green & Bavelier, 2003, 2006; Dye, Green & Bavelier, 2009). In the first study to examine these associations with neural (theta band activity) and behavioural (looking time) correlates of attention and learning, we sought to probe differences in sustained attention and information processing between high and low touchscreen users at 12 and 18 months during a dynamic video. Method: 56 infants were recruited into a longitudinal study, the 'Toddler Attentional Behaviours and Learning through Touchscreens (TABLET)' project, with visits at 12 and 18 months. Based on reported daily use, infants were assigned to a Low or High usage group (e.g., less or more than 10 minutes per/day). EEG and looking data were gathered during two presentations of a dynamic video depicting mechanical toys. Group differences in sustained attention and learning were assessed with Generalised Estimating Equation (GEE) models. Results: At 18 months visual attention is marked by longer total looking ($p=.006$) and less frontal theta power ($p=.01$) for infants with higher daily touchscreen use. This group difference was not present at 12 months of age ($p=.80$, $p=.75$ respectively). There was also no group difference in the modulation of looking time and theta activity in response to repeated presentation of the video at either time points (12 months $p=.16$, $p=.43$; 18 months $p=.94$, $p.41$, respectively). Conclusions: High touchscreen users appear to show less focused attention during a dynamic video, as indicated by less frontal theta power. While longer total looking may suggest attention to the stimuli was being driven by features of the clip. Despite these attentional differences, learning of the video does not appear to have been impacted. A significant decrease in looking time and a significant increase in theta power was found with repetition of the video for both groups. Importantly, the absence of a group effect at 12 months suggests the reported differences in attention are related to exposure rather than individual difference. These results offer the first indication that greater experience with touchscreen devices may be associated with both neural and behavioural differences in visual attention during infancy. However, it is not clear if these differences are causally related or if they generalise to attending to non screen based stimuli.

P1-F-90: 18-month-old infants' imitation in a short-term design: The impact of meeting the same or a new model on both test days

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Several studies show an apparent shift from selective towards exact imitation when infants are 18 months old, selective imitation meaning that only certain kinds of actions are imitated, and exact imitation meaning that all kinds of actions are imitated. This shift has been found in studies using different, but theoretically related, imitation tests, such as the Novel Means Test



(NM-test), the Necessary vs. Unnecessary Test (N/UN-test) and the Functional vs. Arbitrary Test (F/A-test). Although selective and exact imitation are operationalized differently in these test types, all three have yielded findings on a developmental trend from selective towards exact imitation around 18 months of age (Gergely, 2003; Hilbrink, Sakkalou, Ellis-Davis, Fowler, & Gattis, 2013; Óturai, Kolling, Rubio Hall, & Knopf, 2012). So far, no studies have examined the consistency and short-term stability of infants' imitation performance across these test types. Furthermore, since the social context is important for infants' imitation and it is suggested that infants imitate more exactly when the context is social (e.g. Király, 2009); an interesting question is whether short-term stability of imitation is affected by meeting the same or different model(s) both test days. In two experiments, we used two versions of the NM-test, N/UN-test and F/A-test to measure overall imitation performance and the degree of exact imitation in 18-month-old infants. The infants were tested on two days ca. one week apart, with either the same model or a different model on each test day. We tested the hypotheses that the degree of exact imitation is consistent across test types and stable across a short-term design. Additionally, we tested an explorative hypothesis about the difference between stability correlations in the same model and in the different models condition. Our preliminary findings show imitation effects for all tests, but the degree of exact imitation performance was low. Furthermore, infants' degree of exact imitation performance was not stable across the two test days, nor consistent across test types. These findings point to the important role of test characteristics in infants' imitation performance. The overall imitation performance, however, was stable across the two test days, and even more stable in the same model condition than in the different models condition. Interestingly, imitation performance was not affected by condition. These findings add to previous research on the role of the social context in imitation by showing that the person of the experimenter does not only affect infants' performance within one testing situation (e.g. Learmonth, Lamberth & Rovee-Collier, 2005), but also across a short-term design consisting of two independent testings and including different test materials. Our results suggest that the social interaction and rapport that infants build with a particular experimenter has an important effect on the imitation performance they show.

P1-F-91: Task difficulty moderates the impact of learning on fragmentation (but not duration) during REM-dominant sleep

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Research has typically focused on sleep's impact on learning (for review see King et al., 2017 or Dringenberg, 2019), but various types of learning also influence subsequent sleep, such as increased sleep spindle density (Peters, Smith, & Smith, 2007), slow wave activation (Määttä et al., 2010), REM episodes (Smith & Lapp, 1991), and proportion of time spent in REM (De Koninck et al., 1989). These changes relate to the ultradian cycle, the distribution of sleep states (REM and nonREM) throughout the night, and can be linked to features of the task such as type (declarative versus nondeclarative) or difficulty level (Dang-Vu et al., 2006; Peters et al., 2007). Few studies have explored the impact of infant learning on subsequent sleep (Cecchini et al., 2017; Friedrich et al., 2019). One barrier to extending this research to infant



populations is the invasiveness of methods that yield sufficiently detailed data to code sleep states, such as polysomnography. To circumvent this, researchers divide night sleep because nonREM dominates the first half while the latter is mostly REM (Dang-Vu et al., 2006). The current study explores changes to infant sleep following training on a motor problem-solving task. We expected factors impacting task difficulty to predict changes to infant sleep. We hypothesized that the second half of the night may be more impacted because REM is associated with problem solving (Walker et al., 2002). Newly-walking Infants (N = 27) were trained to solve the locomotor problem of navigating a tunnel to reach a caregiver at the other end. They wore an actigraph (Ambulatory Monitoring, Ardsley, NY, USA) on 2 nights: pre-training and post-training. Using the midpoint, infants' nightly sleep was divided into halves. Primary outcome measures captured two characteristics of sleep: fragmentation (comprised of wake episodes and longest sleep episode) and minutes of sleep. Using a stepwise linear regression, factors expected to impact task difficulty (prior tunnel experience and age), and whether infants napped after training were entered as predictors for sleep measures. As expected, sleep on Night 1 was unrelated to either predictor. On Night 2, no factor predicted sleep during the first half of the night or total sleep minutes during the second half of the night. Prior tunnel experience predicted second half night wakings ($R^2 = .245$, $F(1, 26) = 8.41$, $p < .01$) and longest sleep episode ($R^2 = .176$, $F(1, 26) = 5.535$, $p < .05$). Figure 1 displays the relationship between tunnel experience, wake episodes, and longest sleep period. Thus, infants who had no prior tunnel experience had more fragmented sleep during the REM-heavy, second half of the night, likely because the task was more difficult for them. More REM episodes may trigger increased wakings in this group as it is more common to wake from REM than nonREM (Sheldon, 2014; Smith & Lapp, 1991). The lack of a relationship between learning, task difficulty, and minutes of sleep suggest a unique impact of learning on fragmentation. Future research will employ more precise estimates of sleep states and the ultradian cycle.

P1-F-92: How to best analyze and report log-transformed looking time results in infancy research?

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It is common in infancy research to use infants' looking time (LT) as a dependent variable to measure how infants pay attention to certain stimuli. In a typical infancy experiment, researchers measure whether infants look differently when they are presented with two different sets of stimuli. If there is a significant difference in LT between different sets of stimuli, researchers typically conclude that infants can differentiate between these stimuli. Despite the wide usage of LT in infancy research, few studies have examined the most appropriate way of analyzing infants' LT data. Using a large repository of data from their lab and the literature, Csibra and colleagues (2016) reported that the distribution of infants' LT is positively skewed. Since parametric analyses often assume normality of residuals in the statistical models, much infancy research violates this assumption by running analyses using raw LT. Csibra et al. (2016) thus proposed that researchers should log-transform LT before running any parametric analysis. In the current study, we argue that log-transforming LT may not always guarantee a normal distribution of LT data. Using the data from a large-scale replication study (ManyBabies Consortium, in press), we demonstrated that the log-transformed LT is not normally distributed



(Figure 1). Using qqplots (Figure 2), we examined the normality of the distribution of the untransformed LT and log-transformed LT, and found that both distributions were not normally distributed. The non-normal distribution of log-transformed LT was also confirmed by a Kolmogorov-Smirnov test [$D = 0.76$, p -value < 0.001]. However, we suggest that log-transformation will still be useful in infancy research because of the possible multiplicative nature of infants' LT data. When infants pay attention differently to two sets of stimuli, infants may increase their LT by a fixed proportion instead of a fixed amount of time. For example, an infant looked at an old stimuli A during familiarization and later was presented with a new stimuli B at test. If this infant can differentiate stimuli B from A, this infant is likely to look at stimuli B longer by increasing his looking time by 20% rather than by 2 sec in comparison to his LT to stimuli A. This multiplicative relationship between an independent variable (i.e., experimental condition) and a dependent variable (i.e., looking time) in infancy research violates a necessary assumption in parametric analysis - the linearity assumption in which the relationship between the independent and the dependent variables must be linear and additive (Gelman and Hill, 2007). As such, if we stick with the linear parametric analyses in infancy research, log-transformation is useful for solving the problem of the multiplicative relationship of infant LT data. Finally, special interpretation is needed when reporting descriptive statistics because of the geometric nature of the log-transformed LT data. Thus, we will provide practical guidelines (e.g., symmetric percentage difference) to researchers of how to interpret the log-transformed LT statistics.

P1-F-94: Multisensory attention skills and parent language input predict children's vocabulary across 12- to 18-months of age

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Diversity (quality) and amount (quantity) of parent language input to children is known to predict child vocabulary development (e.g., Hart & Risley, 1995). Multisensory attention skills (e.g., sustaining and shifting attention to speaking faces) are also considered a foundation for language development (Bahrack & Lickliter, 2012) but have received less research focus. A newly-established individual difference measure, the Multisensory Attention Assessment Protocol (MAAP; Bahrack et al., 2018), now opens the door to examining relations between early multisensory attention skills and later outcomes. Here, we examine the extent to which infant multisensory attention skills predict later language outcomes, along with more well-established predictors, including parent language input and maternal education. At 12- and 18-months, 99 children (49 females) from an ongoing longitudinal study participated. At 12-months, multisensory attention skills (intersensory matching, sustained attention, reaction time to shift: RT) were measured using the MAAP. Trials begin with a 3-s central dynamic visual event, followed by two 12-s lateral events depicting two women speaking (see Figure 1). One woman speaks in synchrony with a centrally-presented natural soundtrack, and the other woman speaks asynchronously. For half of the trials, the central event remains on (high competition: the focus of this poster) during the lateral events, providing overlapping stimulation similar to that of the natural environment. On each trial, intersensory matching (proportion of looking time to the synchronous lateral event), sustained attention (total looking time to both lateral events), and RT (latency to shift attention from the central to a lateral event) were calculated. At 12- and 18-months, quantity and quality of child and parent language were



derived from a lab-based parent-child interaction. The number of unique words spoken (quality) and the total number of words spoken (quantity) per minute were calculated. Expressive vocabulary was assessed at 18-months using the MB-CDI. Maternal education indexed SES. Twelve-month intersensory matching (but not sustained attention or RT) predicted 18-month child quantity and quality of language, and expressive vocabulary ($p < .001$). Parent language quantity at 12- and 18-months predicted 18-month child quantity and quality of language, and expressive vocabulary ($p < .01$), whereas parent language quality at 18-months (but not 12-months) predicted 18-month child quantity and quality of language, and expressive vocabulary ($p < .01$). Excitingly, intersensory matching at 12-months accounted for 28% ($p < .001$) unique variance in child language quality (total- $R^2 = 0.36$), 12% ($p < .05$) variance in child language quantity (total- $R^2 = 0.23$), as well as 22% ($p < .01$) variance in child expressive vocabulary (total- $R^2 = 0.30$) at 18-months, beyond other predictors (parent language quality and quantity, maternal education). Intersensory matching, as early as 12-months, is an important predictor of later child language (quality and vocabulary). Moreover, intersensory matching at 12-months predicted unique variance in child language (quality and vocabulary, and to a lesser extent, quantity) over and above other well-established predictors, including parent language quality and quantity, and maternal education. These new, exciting findings highlight the important role of infant multisensory attention skills in fostering language development into childhood.

P1-F-95: The influence of centering and saliency on infants' real-world visual attention

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How do infants choose where to allocate their gaze? One influence is the visual salience of objects (Kwon, et al., 2016, Frank, Vul, & Johnson, 2009)--infants' attention is drawn to locations that visually stand out from the rest of the scene. Infants also show a center bias: They are more likely to look at the center versus the edges of a display (van Renswoude et al., 2019), however, the bias is weaker when the center is less salient compared with the edge of a display. Despite these advances, studies of the influence of saliency and centering on infant visual attention have been constrained to screen-based tasks. In the real world, both eye and head movements direct attention in all directions, far beyond the limits of a computer monitor. In the current study, we assessed how infants allocate their attention to salient and non-salient images depending on their centering when they are free to move their heads and eyes. Using a head-mounted eye tracker, we recorded the eye movements of 20 infants (4-8 months) while they viewed an array of 6 images. The 6 images were arranged horizontally on a semicircular board approximately 91 cm at six different angular eccentricities: -45° , -30° , -15° , $+15^\circ$, $+30^\circ$, and $+45^\circ$. Infants were presented with six search array trials. Each trial consisted of 5 non-salient images (black and white) and one salient image (in color with a high contrast border). The location of the salient target was counterbalanced to occur at every eccentricity once. At the start of each trial, the array was made visible while an attention-getting noise oriented infants to the center of the array. Infants were allowed to freely view the visual array for 15 s. We coded the first and second looks to target images to determine whether they looked at salient versus non-salient images and whether they looked at centered or less-centered images. In our real-world task, both centering and saliency influenced infants' visual attention.



As in screen-based tasks, infants' first looks were biased towards the center of the display, $X^2 = 16.31$, $p < .001$ (Figure 1A). During the second look, infants' attention was more evenly distributed as they explored different target locations, with no statistical difference in looks between the three eccentricities, $X^2 = 1.80$, $p = .406$ (Figure 1B). Across all trials, looks to salient targets occurred at a rate greater than chance (1/6 or .1667) for first looks (proportion of looks to salient target: .23, $X^2 = 4.05$, $p = .044$) and second looks (proportion of looks to salient target: .28, $X^2 = 4.05$, $p = .001$). However, there were no differences in the proportion of looks to salient locations between eccentricities for first looks ($X^2 = .162$, $p = .922$) or second looks, ($X^2 = 1.65$, $p = .436$) (Figure 2). Similar to previous findings, we observed a modest bias towards saliency. This bias existed even at the furthest eccentricities, indicating that infants chose to make eye movements as well as effortful head movements to allocate their attention to salient locations.

P1-F-96: 9-month-old infants' working memory tested with multimodal stimuli with sound/shape correspondence

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It has long been known that redundant multimodal information guides perceptual learning more effectively compared to unimodal information (Bahrick & Lickliter, 2000). For example, 7-month-olds' long-term memory was enhanced by redundant multisensory stimuli (Gogate & Bahrick, 2001). The current study aimed to examine the impact of multimodal stimuli on infants' working memory performance. Specifically, we chose multimodal stimuli with a well-known sound-shape correspondence (the "bouba-kiki" effect), where individuals (including nonverbal infants; Ozturk et al., 2013) spontaneously associate a spiky shape with speech sounds like /kiki/ and a rounded shape with speech sounds like /bouba/ (Kohler, 1929). Previously, we used Delayed Match Retrieval (Kaldy, Guillory & Blaser, 2016) to test infants' working memory by measuring anticipatory gaze responses in an eye-tracking task. In that study, we found that 10-month-olds, but not 8-month-olds could remember two object-location bindings, where stimuli differed in the visual modality only. We reanalyzed this published data set, and found that within that sample, 9-month-olds (N=16, Mean = 8.9 months, range: 8.03-9.90 months, 6 females) showed at-chance performance (50% correct based on first looks, $p > 0.05$). In the present study, we tested 9-month-olds in a closely matched paradigm, but used objects that differed in shape/color and were accompanied by speech sounds that followed the "bouba-kiki" correspondence (Figure 1). Seventeen 9-month-olds (Mean = 8.64 months, range: 8.07-9.67 months, 9 females) participated. In test trials, participants saw three face-down cards enter the screen. Two cards were then flipped face-up sequentially, revealing the objects with different visual shapes, along with the corresponding audio sound (round - /baba/, spiky - /kiki/). The two cards then flipped back face-down. After that, the third card was flipped face-up revealing an object which matched one of the previously exposed cards, along with the sound that corresponded to the shape on the card. After a 4 s response period, during which anticipatory eye movements were measured, the 'match' card was flipped face-up, accompanied by an engaging reward animation. Infants watched 12 test trials with the side of the match card randomized and counterbalanced. Our main dependent variable was the percent of correct responses, i.e. where the first anticipatory look during the response period was to the (face-down) match card. Results showed that 9-month-olds performed significantly

above chance (58% correct, $t(16)=2.79$, $p=0.013$, $d=1.34$; see Figure 2), and a two-sample t -test showed that the difference between these results, and those from the 9-month-olds in our previous study (where no speech sounds were present) had a medium effect size, though it was not significant ($t(34)= 1.39$, $p= 0.18$, $d= 0.58$). (Infants also looked longer at the correct card in the current study.) These results show that 9-month-olds could remember two object-location bindings with multimodal stimuli that corresponded in sound and shape, in a paradigm where they had previously failed with unimodal stimuli. Future studies will examine whether success can be explained by sound-shape correspondence only, or by multimodal input in general.

G-Cognitive Development

P1-G-97: Early number word input and later mathematical skill in a diverse sample

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Children vary substantially in their early number language environments. Some children experience environments containing frequent math-relevant language (e.g., number words), whereas others rarely hear such language. Variability in number word input matters: Early differences in number word input relates to children's later mathematical skills, including understanding of cardinal values (e.g., Levine, Suriyakham, Rowe, Huttenlocher, & Gunderson, 2010) and general math skills (e.g., Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006). However, research on parent number word use is relatively recent, with most studies based on data from middle- to high-socioeconomic, primarily English-speaking, US-native born mothers. Here, we extend research on number words to a culturally, racially, and linguistically diverse sample. In a 4-year longitudinal study, we examined the: (1) changes in mothers' use of number words with their 14- (Mage=14.65 months; SD=1.46) and 24- (Mage=24.52 months; SD=2.81) month-old toddlers, and (2) associations between number word input and children's math skills at 4 years of age in N=187 (51.3% female) toddlers and their mothers from diverse backgrounds. Dyads were recruited from the greater New York City area; all mothers identified as Dominican (n=71), Mexican (n=66), or African American (n=64), and 48.0% had a high school degree or above. During home visits, we videorecorded mothers and children during two tasks. Mothers shared a book with their child that contained images that pulled for number talk (e.g., pictures of 1, 2, and 3 balloons; a pizza cut in 6 slices; Arabic numerals). Then, mothers played with a string and beads with their child. Videos were coded for the presence of number words (e.g., "one," "two") and the context in which each word was stated (i.e., whether in reference to a cardinal or count value and whether the referent was present or absent). Mothers used more number words when children were 24 months than when they were 14 months ($t(126)=-4.05$, $p<.001$), and growth in number language was seen in both booksharing and beading activities ($ps<.01$) and count and cardinal references ($ps<.02$). The magnitude of numbers also grew: Mothers more often referenced numbers above 3 with their 2- versus 1-year olds. Moreover, mothers who used more number words when their children were 14 months were also more likely to use more number words when children were 24 months, $r(127)=.31$, $p<.001$). Mothers' ethnicity, mothers' completion of high school, and child gender were unrelated to number word use, ($ps>.07$). Most centrally, mothers' number word use at both 14- and 24 months related to children's performance on a



standardized assessment of child math skills at 4 years, even when controlling for child language skills at age 4 (14 months: $\beta=0.18$, $p=.046$; 24 months: $\beta=0.38$, $p=.046$), providing the first evidence that even very early number language input relates to later math skills. Patterns of mothers' use of number words and implications for parenting and education will be discussed.

P1-G-98: Cardinal number gestures encourage children to focus on numerosity

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Cardinal number (CN) gestures have been hypothesized to play a role in children's early number development. The words used to label sets are arbitrary; there is no inherent 'two-ness' or even 'set-ness' about the word "two", whereas the gesture for two (index and middle finger held in a V shape) is not only a conventional symbol in our culture but also physically describes two with the number of outstretched fingers. Thus, CN gestures can be transparently mapped onto the number of items in a set and, as a result, might help bridge the gap between children's innate representations of numbers and number words (Gunderson et al., 2015). Children's knowledge of number words (Levine et al., 2010) and use of CN gestures (Oswald et al., 2019) are both influenced by parental input, but the mechanism underlying this effect is unclear. To explore how CN gestures improve number learning, we coded spontaneous parent-child interactions for (1) parent number words and CN gestures, and (2) child responses to parents' numerical input. Fifty-nine children and their parents were filmed in their homes engaging in typical daily activities for 90 minutes every 4 months from when the child was 14 months old to when the child was 30 months old. We focused on those parents ($n=32$) who produced CN gestures, which often occurred with number words (e.g., mother says four and holds up 4 fingers). We found that children responded with more numerically relevant responses when their parents used a CN gesture than when they used a number word alone (46% vs. 14%). Children not only gave more correct numbers (in this case, the number 4), but also gave more numerical responses that were incorrect (e.g., the number 3), following a CN gesture than a number word without a gesture. These findings suggest that CN gestures not only help children arrive at a correct numerical response, but also help them focus on numerosity per se. Interestingly, the numerically relevant response rate when a number word was used alone is not significantly different to that of children whose parents never gestured. This suggests that our results cannot be explained by other parent characteristics.

P1-G-99: Infants recognize the counting routine as numerically relevant

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Children typically start to count at around 2.5 years, with understanding of the counting principles slowly developing over the next few years (Gelman & Gallistel, 1978; Sarnecka & Carey, 2008; Wynn, 1992). However, little is known about very young children's understanding of counting prior to their comprehension and production of specific number words. Here we

asked whether, long before mastering counting, infants appreciate that counting refers to quantities. Specifically, we asked whether seeing objects counted would improve infants' ability to remember the number of objects in a hidden array. Previous work shows that 12- to 22-month old infants can remember up to 3 hidden objects, but fail to remember 4 or more (Barner et al., 2007; Feigenson & Carey, 2003). Using a manual search task, we showed 14- to 18-month-old infants different numbers of objects being hidden in a box. As in previous research, we found that infants failed to differentiate four hidden objects from two when the objects were not counted ("this, this, this, this, these cars") --suggesting an upper limit on the number of individual objects they were able to represent in working memory. However, we found that infants successfully differentiated four from two hidden objects when the objects were simply counted ("one, two, three, four, four cars") aloud before hiding (Experiment 1). We found that counting also helped infants differentiate four hidden objects from six (a 2:3 ratio) (Experiment 2), but not three hidden objects from four (a 3:4 ratio) (Experiment 3), suggesting that counting helped them represent the arrays' approximate cardinalities. Additionally, we asked what aspects of counting do infants link with quantity. Do infants recognize the familiar English count words, or did they recognize something more abstract, like counting rules? We found that monolingual English-speaking infants also successfully differentiated four from two hidden objects after watching the toys being counted in German (Experiment 4). Additionally, we manipulated the availability of each of the counting rules, including one-to-one correspondence between count words and objects, stable order of counting, as well as that the last word counted refers to the cardinality of the whole set. We found that infants failed when one or more of the counting rules were disrupted (Experiments 5-7). Our findings suggest that long before mastering the counting principles, infants recognize that counting highlights quantities. Hearing objects counted may change the way infants represent an array--impelling them to represent the objects as a set or collection, rather than as individuals.

P1-G-100: Features of experimental and parental instruction support object learning in toddlers

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Caregivers are children's first teachers, and their informal instruction influences how infants engage with objects in their everyday environments. Yet, the techniques caregivers use to support object learning are relatively unexamined. Infants may learn to use objects through at least two different methods: imitating adult demonstrations and active experience. Infants are keen imitators of adult actions (Bauer, 1996) and in some cases, viewing demonstrations enhances object engagement beyond infant independent actions (Fagard & Lockman, 2009). However, infants' active experience with objects benefits object exploration (Needham et al., 2002) and understanding of others' goals (Sommerville et al., 2005). Thus, both imitating demonstrations and acting independently are routes to object engagement. Yet, few studies examine how instruction strategies support object learning. A semi-naturalistic study tested which everyday caregiver teaching methods benefitted object learning and found that toddlers learned when caregivers guided children's active experience; adult demonstrations negatively predicted learning (Brezack, Radovanovic, & Woodward, in prep). The present preregistered



study experimentally tested the findings of Brezack et al. (in prep) by pitting active and observational experience against one another to examine which boosted object learning and generalization. 48 22-26-month-olds were taught to use one novel, multi-step toy through active experience and another through observing the experimenter construct a toy. An assistant blind to instruction tested children on their toy reconstruction abilities both on toys they had been taught and on novel generalization items (see Figure 1). Additionally, caregivers taught toddlers to use a toy to measure natural parental teaching style. Surprisingly, results did not show a difference in learning from active or observational instruction ($B = 0.03$, $p = 0.291$). Similarly, performance did not differ between taught and generalization items ($B = -0.01$, $p = 0.800$). However, children's cognitive problem-solving skills (measured by performance on the Bayley Scales, Cognitive subtest) were a significant predictor of learning across instruction types ($B = 0.01$, $p = 0.011$), suggesting that more skilled toddlers learned most from instruction. Further, children's problem-solving skills interacted marginally with performance on active versus observational instruction such that more capable children performed better on the items learned through observational instruction ($B = 0.01$, $p = 0.069$; see Figure 2). Contrary to active experience findings and the results of Brezack et al. (in prep), the present study suggests that observational instruction may be a powerful tool for object learning, particularly for more capable toddlers. In addition, coding is ongoing to quantify children's action success during active instruction and overt engagement during observational instruction. Forthcoming analyses will test whether toddlers' skill and engagement during instruction benefitted learning from either instruction style. Further, coding is underway to quantify elements of parental instruction that may affect children's learning from active and observational teaching. These naturalistic caregiver teaching results, in conjunction with the present experimental findings, could have implications for our understanding of the social instructional contexts that affect object learning early in childhood.

P1-G-101: Normative expectation in preverbal infants

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Social norms pervade human social interactions and are foundational to human cooperation and coexistence in social groups. Understanding social norms marks a crucial milestone in socio-cognitive development. It is presently assumed that young children develop a normative understanding in their preschool years, when they begin to actively and verbally enforce normative behavior in others by themselves. In the present study, we investigated if infants understand the norm enforcement by others already in their first year. We showed 11-month-old infants' ($N = 30$) animated picture stories, in which two characters performed an identical action with an object, before a third individual performed either the same or a different action with the same object. The group responded either positively (with approval and inclusion) or negatively (with disapproval and ostracism; see Figure 1). To assess whether infants' would be surprised if the group behaved inconsistently (i.e., disapproving the same actions or approving a different action action), we tracked their relative change in pupil size upon the response of the group. The results suggest that infants understand social norms already in their first year. They expected individuals who conformed to the behavior of a group to be met with approval and included by the group, but individuals who did not conform to be disapproved and ostracized. This was indexed by infants' pupillary surprise response for unexpected (i.e.,



inconsistent) social reactions of a group, namely the disapproval and exclusion of an individual who showed the same behavior like the group or the approval and inclusion of an individual who behaved differently (Figure 2). Critically, the study was preregistered and effect size of the Action (conform, non-conform) * Group Response (positive, negative) interaction was relatively high, $F(1,28) = 6.17$, $p = .019$, $\eta^2 = .18$. In non-social control trials, which tested the reaction of the group to consistent versus inconsistent movements of auto-propelled objects, we did not find a significant interaction $F(1,19) = 0.38$, $p = .547$, $\eta^2 = .02$. Thus, already preverbal infants seem to understand that the behavioral codes within social groups are subject to social evaluation - a critical building block of human normativity. These findings suggest, in our opinion, that a basic normative understanding is present much earlier than presently assumed. We will discuss our results in the light of current theoretical accounts on human early normative development.

P1-G-102: ToMcat: A videotaped, open-access violation-of-expectation task for measuring false-belief understanding in infants and toddlers

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Theory of mind (ToM) - the ability to infer others' mental states - is essential for human social interaction. Investigators have long been interested in determining when this ability first develops, and much of this research has focused on false-belief understanding (FBU). Initial studies using explicit tasks indicated that FBU is not acquired until about 4 years of age. Subsequent investigations using implicit tasks suggested that some capacity for FBU is already present in infancy. However, recent failed replication attempts have led some researchers to question the reliability and validity of implicit measures of FBU. For demonstrations of implicit FBU using violation-of-expectation tasks, in particular, one challenge has been that these tasks have typically used live scenarios, making it difficult for other labs to recreate them precisely. The goal of our ToMcat project is to create a videotaped violation-of-expectation task that yields reliable evidence of implicit FBU in infants and toddlers and can be easily used by other researchers interested in early ToM. To this end, we have designed a non-verbal unexpected-transfer task in which children watch videotaped events on an eye-tracker. In the first two familiarization trials, while a cat watches, a dog places a toy in one of two open containers (side is counterbalanced); the dog then leaves the scene, and the cat reaches for the toy and pauses until the child looks away and the trial ends. In the next two familiarization trials, the cat leaves briefly after seeing the dog place the toy in one of the containers, and then it returns to get the toy. Finally, the two test trials are identical to the last two familiarization trials, with two exceptions: The containers now have lids, and the dog transfers the toy to the other container while the cat is away. Of interest is whether infants will look longer when the cat returns and reaches for the container that currently holds the toy (current-location event) as opposed to the container that it falsely believes still holds the toy (original-location event). The ToMcat project has three steps. In the first, we tested our new measure with 24 18- to 28-month-olds, using a within-subject design. We found that children looked reliably longer at the current-location than at the original-location event ($p = .006$), with 19/24 showing this pattern ($p = .003$). These results suggest that children represented the cat's false belief about the toy's location. The second step of the project, now under way, is to confirm these results in a preregistered replication that also includes a true-belief condition (in this condition, the cat



sees the dog transfer the toy before leaving the scene). Finally, the third step of the project will be to invite other researchers to participate in a preregistered, multi-lab replication using the same stimuli (presented on an eye-tracker or a TV). We hope that this work will provide researchers with a reliable measure for assessing early implicit FBU and, more generally, will support current widespread efforts to make developmental science more open, accessible, and replicable.

P1-G-103: ManyNumbers: A multi-lab collaboration examining the development of numerical cognition

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The ability to quantify sets of objects without language or symbols is found in a range of animal species, yet it is the ability to use and manipulate numerical symbols that is a uniquely human quality. How do infants leverage their early, evolutionarily ancient non-symbolic numerical abilities to acquire formal symbolic numerical abilities? While much research has examined early quantification abilities in infants and children, previous studies have been constrained by the small samples that can be obtained from a single lab. The ManyNumbers project is an effort to use a multiple-lab approach to address fundamental questions about the relationship between early, non-symbolic quantification and later, symbolic quantification. The goal of ManyNumbers is not exclusively to replicate previous findings, but also to exploit the efforts of multiple labs to answer novel theoretical questions. Led by a team of 10 scientists with expertise in the development of numerical cognition, ManyNumbers has two primary aims. The first aim is to examine number word acquisition in preschool children via a large-scale effort spanning dozens of labs in multiple countries. The second aim (which will be the main focus of this talk) is to examine infants' quantification of small sets. We will use two methods to assess infants' ability to track small numbers of objects: manual search and ordinal choice (e.g. Feigenson, Carey, & Hauser, 2002; Feigenson & Carey, 2005; Barner et al., 2007; vanMarle, 2013). Since this will be the first time both methods will be used to test the same infants, we can for the first time examine the reliability of these measures both within subjects and across labs. We will also utilize the strength of our multi-lab sample size to examine sources of individual differences and developmental change in small sets quantification (e.g., vocabulary, spontaneous focus on number, working memory) and potential correlations with early number knowledge (e.g. count-list knowledge, knower-levels). Due to the challenges of conducting research with infants, we have enlisted a small group of labs who have expertise in the methodologies we will use and the age groups we plan to test. This allows us to tightly control the methods while still obtaining a much larger and more diverse sample than would be possible to obtain by any single lab. The ManyNumbers timeline involves three stages. We are currently in Stage 1, in which we are attempting to secure funding through a collaborative grant written by the ManyNumbers leadership team. In Stage 2, we plan to submit a set of registered reports to journals for peer review. Upon acceptance of a registered report, the team will begin Stage 3, collecting and analyzing the data, and finally submitting the completed project to the journal. In this talk, I will outline the ManyNumbers approach. I will then discuss a range of logistical decisions that the ManyNumbers team has made, including determination of the theoretical questions of interest, methodological decisions, preregistration, estimation



of effect sizes and calculation of sample sizes, administration of the research, and leadership team oversight.

P1-G-104: A step towards higher replicability in developmental research: Beyond video studies

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Issues with replicability have plagued several areas of psychological research, with many failed replication attempts shedding light on its severity (e.g., Li & Bates, 2019; Ooestenbroek et al., 2016; Salvadori et al., 2015). The numerous additional challenges that infant research faces - most notably the generally small sample sizes and complex behavioural methodologies - further exacerbates this problem. In recent years, researchers have attempted to ameliorate this issue through large-scale, multi-lab collaborations (Byers-Heinlein et al., in press; Frank et al, 2019). Although results from these ambitious cross-country projects are undoubtedly beneficial, given their scale they are also typically restricted to easily implementable methodologies, for example video stimuli and attentional measures. As such, more complex paradigms cannot be subject to these collaborative efforts, and developmental questions that necessitates these paradigms remain unanswered or unreplicated. The current project seeks to bridge this gap in replication through a different approach known as 'Study Swaps' (see Chartier & McCarthy at osf.io/9aj5g/). Study Swaps take a 'SisterLab' approach, whereby researchers are trained directly by the original authors, study materials are constructed collaboratively, and participants' recorded sessions are continually reviewed to ensure close adherence to the original procedure. The project served as a 'proof of concept' that sought to establish best practices for replicating complex paradigms in a Study Swap format, and attempted a direct replication of Lucca et al. (2018)'s study of infants' willingness to approach fair versus unfair distributors. In the study, 17-month-olds watched videos in which two female agents distributed items to two recipients in either a fair (3:3) or an unfair (5:1) fashion. The two virtual agents then appeared to each 'offer' a toy by dropping it into a box, and infants selected the box from which they would like to retrieve the toy (in reality, the toys were placed inside the boxes without infants' knowledge). Infants' social preference was determined by whose box they approached first. We predicted that, like the original study, infants would selectively approach the fair agent. Two pilot studies were conducted to assess the viability of the paradigm. While infants in Pilot 1 did not prefer the fair agent (4 out of 13, $p=.27$, two-tailed binomial test), this pilot did reveal inconsistencies between the new and original stimuli. This prompted us to create new stimuli that more closely resembled the original. Pilot 2 also did not detect a fairness preference, but found a significant right-side bias (14 out of 19, $p=.03$). Upon reviewing participants' recorded sessions, several asymmetries in the testing environment were identified and addressed prior to launching an official replication attempt. The current attempt was pre-registered (planned $N=32$), and data collection is in progress (current $n=11$). The talk will present the process of engaging in Study Swaps and the results of the completed dataset, highlighting several challenges that cross-lab replications of complex methodologies face as well as suggestions for alleviating them. These efforts could inform and improve future Study Swaps and contribute to the ongoing effort of making developmental research more replicable.



P1-G-105: Individual differences in infant attention: Socio-demographic risk, stress, and home stability

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Infants' ability to control their visual attention allows them to be active agents in their learning and development by choosing where to allocate their cognitive resources. We will present two studies, the first of which examined whether certain socio-demographic factors, such as SES and minority status, predict young infants' ability to control their attention, while the second asked whether home stability and physiological response to stress may explain this effect. The overarching theoretical model being tested is that instability in the home and maladaptive child rearing practices cause dysregulation of infants' stress responses (indexed by basal cortisol levels) which in turn disrupts their attentional control abilities. First, to determine whether associations between attentional control and sociodemographic variables are present early in life, we examined average 3.5-month-olds' (N=102) fixation durations to determine whether the combination of risk factors (i.e., below median family income, below median maternal education, and/or being a racial/ethnic minority) predicts infants' attentional control as indexed by their ability to terminate individual fixations to efficiently scan visual stimuli (White, Heck, Jubran, Chroust, & Bhatt, under review). The results indicate that attentional control, as measured by fixation durations, varies with socio-demographic risk as early as 3.5 months of age and the combination of multiple risk factors appears to be especially predictive of deficits in attentional control, see Figure 1. This is, to our knowledge, the first demonstration of socio-demographic differences in attentional control below 6 months of age, and suggest that interventions aimed at reducing achievement gaps based on socio-demographic variables may need to begin very early in infancy. Second, in an ongoing longitudinal study, we have replicated the association between socio-demographic risk and attentional control at 3.5 months of age, $r(79) = .25$, $p = .03$, and are now investigating if infant stress responses, specifically HPA-axis activation indexed via basal cortisol, may explain this effect. Preliminary results indicate that by 5 months of age a greater number of socio-demographic risk factors is associated with significantly higher levels of cortisol, $r(28) = .38$, $p = .04$. This suggests that infants are sensitive to stressors in their environment related to lower-socioeconomic status and/or being a racial/ethnic minority. We also found that lower parent-reported adherence to routines is associated with marginally higher levels of infant cortisol, $r(28) = -.36$, $p = .06$, indicating that one potential source of stress may be lower stability in the home environment. These findings suggest that increasing the predictability and stability of the home environment may help alleviate infant stress and may be a promising avenue for intervention efforts seeking to facilitate cognitive development in at-risk populations. Taken together, the results of the current investigation are consistent with theories positing that socio-demographic risk factors influence child development through the disruption of executive functions (Lengua, 2012). Furthermore, the present results suggest that attentional control and home stability may be key target areas for intervention efforts aiming to reduce the gap in developmental outcomes between minority and low-SES infants and children and their peers.

P1-G-106: Factors influencing persistence through the integration of active and social learning

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The decision to persist in the face of difficulty has been linked from an early age to positive cognitive and life outcomes (e.g., Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014), motivating research into the factors which influence early persistence such as adult modeling (Leonard, Lee & Schulz, 2017). When making decisions, children have multiple sources of information available to learn from, both observing others and interacting with the environment themselves. Recent work by Lucca, Horton, and Sommerville (under review) has begun to investigate these two sources of information, suggesting that infants are able to integrate information from both sources to infer the difficulty of a task and leverage their persistence accordingly. The present work seeks to understand the limits of this learning by investigating the effects of age (Study 1) and prior experience (Study 2). In Study 1, 96 12-month olds (11.6 - 12.8 months; MAGE = 12.1; 51 female) took turns across three trials with an experimenter solving a difficult task to retrieve a toy (Figure 1). Using a between-subjects design, the difficulty experienced by the experimenter while demonstrating was manipulated (e.g., Easy, Hard, and Impossible). Following each demonstration, infants participated in a test trial during which it was impossible to retrieve the toy. Prior work with 18-month olds demonstrated that infants integrated their first-hand experiences with observation of the demonstrator to decide how much to persist (e.g., time spent trying, level of negative affect) and in what way to persist (e.g., help-seeking, pulling force). However, in Study 1, time trying and maximum force did not differ as a function of the difficulty the experimenter incurred (Figure 2). Yet, 12-month olds did try for less time over trials ($t(189) = -3.51, p < 0.001$), suggesting they were able to learn from their own experiences, expending less effort as they gained evidence that the task was unsolvable. Likewise, negative affect increased across trials ($Z = 3.87, p < 0.001$) and as the experimenter experienced less success across conditions ($Z = 2.15, p = 0.03$), suggesting that infants were also able to understand the difficulty incurred by the experimenter. Therefore, 12-month olds were able to make sense of both their own actions and those of the experimenter, but the ability to integrate these sources of information appears to still be emerging. Data collection for Study 2 is ongoing. 18-month olds will participate in a similar paradigm, using only the Hard condition and manipulating prior experience with the task by giving infants training before the turn-taking task. In this way, we will be able to ascertain whether the information infants gain from observation is gated by their own, prior experience. Therefore, future coding will evaluate how infants integrate their experiences from training, during which solving the task was easy, with the difficulty they incur during test trials and the demonstrator incurs. In addition, infants' evaluations of the demonstrator will be measured. The results of these studies will shed light on how early persistence is shaped.

P1-G-107: Deprivation and threat as mediators in the relation between early life SES and executive functioning in early childhood

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Research on childhood adversity and development has traditionally focused on cumulative risk approaches or cases of extreme adversity. Recently, the field has shifted to more dimensional approaches to studying adversity, namely the Dimensional Model of Adversity and Psychopathology (DMAP). This framework proposes deprivation and threat as core, yet distinct, dimensions of childhood adversity experiences. Deprivation is the absence of expected social or cognitive stimulation, and threat is the presence of dangerous or harmful stimulation. Previous work using the DMAP has found that deprivation, but not threat, predicts the development of executive functions (EF). Prior studies using the DMAP have laid a foundation for understanding how dimensions of adverse environmental experience uniquely contribute to developmental outcomes. However, these studies have been limited by small sample sizes and have conflated deprivation with poverty, which is itself a context in which children may be exposed to higher levels of both deprivation and threat. To expand upon this previous work, this study used data from the Family Life Project, a prospective longitudinal study of 1,292 children living in predominantly low-income, rural communities, to examine deprivation and threat at 24 months of age as longitudinal mediators between early life (15 months) socioeconomic status (SES) and EF at 48 months. We hypothesized that lower levels of SES would be related to higher levels of both deprivation and threat and lower EF. Further, we hypothesized that deprivation, but not threat, would mediate the associations between early life SES and EF outcomes. Our SES measure was a composite consisting of family income-to-needs ratio and primary caregiver education and job prestige. We used confirmatory factor analyses to create latent variables of deprivation and threat based on the definitions above. Deprivation was fit using direct observations of learning materials in the home and sensitive parenting, and a parent-report measure of single parent status. Threat was fit using primary caregiver report of physical and verbal aggression between caregivers and a direct observation of neighborhood noise and safety. Our EF measure was a composite score calculated from performance on a battery of EF tasks administered in the child's home. All analyses controlled for effects of child race and sex. We used structural equation modelling to test our multiple mediation model. The model with SES as the main predictor, deprivation and threat as mediators, and EF as the outcome fit adequately (RMSEA=0.054, $p=0.279$; CFI=0.954; TLI = 0.916; $X^2=92.027$, $p<0.001$; BIC = -72.744). Regression results indicated that lower SES was related to higher levels of both deprivation ($\beta=-0.587$, $p<0.001$) and threat ($\beta=-0.622$, $p<0.001$). Additionally, deprivation, but not threat, significantly and fully mediated the association between SES and EF (indirect effect: $\beta=0.466$, $p=0.012$). These findings provide evidence that children of low SES families face heightened risk of exposure to both threat and deprivation, with deprivation uniquely influencing EF outcomes. As researchers increasingly probe mechanisms by which SES influences brain development, the orthogonalization of threat and deprivation should be considered.

P1-G-108: Structure and development of inhibitory control from infancy to late childhood

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Executive function broadly is difficult to measure and there is controversy about its profile in early childhood. There is empirical evidence that a two factor model of EF with working memory and IC components can best fit the data, if more tasks are included and age ranges are restricted (Howard, Okely, & Ellis, 2015; Miller, Giesbrecht, Muller, McInerney, & Kerns, 2012). Theoretically, IC tasks contain characteristics that are conceptually different from working memory or set-shifting. It is difficult to quantify inhibitory control (IC) during early childhood because of its heterotypic profile and the rapid development that occurs from infancy through late childhood (Petersen et. al., 2016). To examine IC development, we created age-specific latent factors of IC using structural equation modeling and created an autoregressive model from infancy through late childhood. As part of an ongoing longitudinal study, 304 infants (151 boys) completed a lab-based behavioral IC battery at 5 months, 24 months, 4 years, and 9 years. An iterative confirmatory factor analyses showed the best fit for the data included the A-not-B task at 5-months; pre-switch DCCS, A-not-B, crayon delay, and tongue task and 24-months; hand game, post-switch DCCS, yes/no, gift delay, and Simon says at 4 years; and Stroop task response time at 9 year (figure 1). The autoregressive model using the above latent factors showed the IC was self-predictive starting at 24-months, and showed an indirect effect from 24-months to 9 years. Infant IC did not predict toddler IC in this sample (figure 2). Based on the model, IC stabilized at 24 months, suggesting that by toddlerhood, IC performance was measurable using the tasks included in the CFA. This demonstrates that although IC remains difficult to measure due to task constraints, toddler IC as measured by these behavioral tasks is a relatively stable predictor of later IC. The use of multiple age appropriate indicators of toddler IC is a strength of the current study and suggests that using multiple measures of IC at 24 months may be the key to showing continuity across early childhood IC. Understanding this constructs and its developmental trajectory is necessary for creating appropriate experimental designs and interventions to address IC in early childhood.

P1-G-109: Self-generated visual cues enhance crawling but not non-crawling 9-month-old infants' mental rotation ability

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From early in life, infants need to recognize previously moved objects by mentally rotating them. Previous research has shown that locomotion skills, such as infants' crawling ability, is positively related to their mental rotation (e.g., Frick & Möhring, 2013; Schwarzer, Freitag, Buckel, & Lofruth, 2013). However, these results still leave open the question regarding the specific processes by which locomotion influences infants' mental rotation ability. Antrilli and Wang (2016) demonstrated that rotation specific visual cues that infants generate through their own actions facilitate mental rotation processes. Therefore, it was the primary goal of the present study to examine whether 9-month-old experienced crawlers use such self-generated visual cues differently than same-aged non-crawlers and whether this difference in encoding leads to a better mental rotation performance in crawlers than non-crawlers. We tested 47 9-month-old infants (17 crawlers; 30 non-crawlers) with a cylinder task (Antrilli & Wang, 2016), and a mental rotation task (Moore & Johnson, 2011). In the cylinder task, infants manually rotated a vertically- or horizontally-striped cylinder around its vertical axis. Alternation of stripes in the vertical-stripe condition induced richer visual cues regarding the following mental object rotation than in the horizontal-stripe condition. In the mental rotation task, infants were



visually habituated to a vertical rotation of a Shepard-Metzler object and then preference-tested with the same object and its mirror version. Preliminary analyses revealed that 9-month-old infants in the vertical-stripe condition looked longer at mirror objects in the mental rotation task ($M = 53.4\%$, $SD = 13.7$) than infants in the horizontal-stripe condition ($M = 46.5\%$, $SD = 16.4$), $F(1,43) = 4.99$, $p < .05$, $\text{partial } \eta^2 = .104$. Notably, however, this preference for mirror objects was dependent on infants' crawling experience, $F(1,43) = 5.36$, $p < .05$, $\text{partial } \eta^2 = .111$. Experienced crawlers in the vertical-stripe condition showed a preference for mirror objects ($M = 56.9\%$, $SD = 12.6$), $t(7) = 1.54$, $p > .05$, $d = 0.54$, whereas non-crawlers in the horizontal-stripe condition preferred to look at the familiar habituation object ($M = 36.9\%$, $SD = 13.8$), $t(8) = -2.84$, $p < .05$, $d = -0.95$. In 9-month-old non-crawlers, there was no effect of the two cylinder conditions, $F(1,28) = 0.00$, $p > .05$, $\text{partial } \eta^2 = .000$ (Fig. 1). In accordance with previous studies our results strengthen the finding of a positive relationship between infants locomotion skills and their mental rotation ability (see Frick & Möhring, 2013; Schwarzer et al., 2013). Moreover, they are able to advance current research such that they provide first indications that the potential processes by which locomotion enhances 9-month-old infants' mental rotation ability lie in an advanced encoding of rotation specific, self-generated visual cues.

P1-G-110: Do infants and adults submentalize? A study on the processes involved in implicit theory of mind tasks

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More than 30 experimental studies have been by now published that address the issue of whether infants can reason about false beliefs by examining their spontaneous responses, most of them reporting positive evidence on a wide variety of ages, tasks and procedures (for reviews see Baillargeon, Buttelmann, & Southgate, 2018; Baillargeon, Scott, & He, 2010). Many authors proposed that infants' and adults' looking behaviour suggest a spontaneous and implicit ability to reason about others' beliefs. It has been argued, however, that these successes are false positives due to domain-general processes, such as retroactive interference. Heyes (2014) rejected rich accounts and proposed a more parsimonious explanation based on domain-general memory processes (see also Heyes & Frith, 2014): infants' looks are false positives since they are not due to mental state reasoning, but to difficulties in encoding the target object last hiding place. Heyes emphasizes that implicit theory of mind studies have to provide compelling evidence about the domain specificity of the mechanisms underlying infants' and adults' spontaneous responses, and to this aim it would be crucial to compare animate conditions with closely matched inanimate control conditions. In the present study, we investigated the domain-specificity of mechanisms underpinning participants' looking behaviour by manipulating the dynamic cues in the event stimuli. Infants aged 15 and 20 months ($N = 90$) and adults ($N = 134$) saw animation events in which either a self-moving triangle, or a hand holding an identical inert triangle, chased an animated disk. Animations were adapted from a previous study by Surian & Geraci (2012). The retroactive interference account predicts the same anticipations in both conditions, whereas the domain-specific accounts predict a belief congruent bias in the agent condition only. Infants looking behaviour was recorded using the Tobii T120 Eye-tracker. The main results were that twenty-month-olds and adults reliably showed belief congruent anticipatory



looks in the agent-triangle condition, whereas they showed no bias in the inert triangle control condition. The same trend was found in the 15-month-olds, but it was not significant. These results are not consistent with the submentalizing accounts based on domain-general low-level processes and they provide further support for domain specific explanations positing an early emerging mentalistic reasoning. However, the present findings do not rule out alternative parsimonious accounts based on ad-hoc heuristics and behavioural rules that by-pass the need to use metarepresentations.

P1-G-111: Can infants apply their judgements of prosocial behaviour across social domains to anticipate future behaviour?

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The ability to use prior information about an individual's actions in one context, to gauge how they will behave in a new situation, can help us to anticipate others' behaviour and guide our interactions with them. It is particularly important to be able to predict whether an actor who behaves in a prosocial or antisocial fashion in one context, will do so in another context, given the obvious advantages of associating with prosocial people and avoiding anti-social people. We investigated whether infants expect agents who are prosocial to also be helpful and trustworthy. In Study 1 (n=32), 22-month-old infants were familiarized with an unfair actor (distributes resources unequally) and a fair actor (distributes resources equally). Next, infants saw a protagonist who showed the unfair and fair actors her toy and asked the actors not to touch the toy before leaving the room. In her absence, the toy goes missing. When she returns to the room, she asks who took her toy. The goal of Study 1 was to (1) investigate whether infants expect that the unfair actor was the one who stole the toy, and (2) whether having siblings in the family would influence infants' expectations that the unfair actor is untrustworthy. Infants with siblings more strongly discriminate between unfair outcomes and unequal outcomes than those without (Ziv & Sommerville, 2017) suggesting that they are more sensitive to antisocial behaviours. Infants' anticipatory eye gaze was captured to measure which actor infants expected to have the toy, following the protagonist's question: infants' anticipatory looking influenced by presence of siblings ($\chi^2(1, N=28)=9.403, p=.002$). Infants without siblings anticipated the fair actor ($p=.02$), while infants with siblings showed a pattern of anticipating the unfair actor ($p=.12$). These findings may reflect that infants have a baseline preference for the fair actor, which infants with siblings begin to overcome when asked who possesses the stolen toy. Subsequent to this phase, infants also saw events in which either the fair actor or the unfair actor was revealed to have the toy: all infants, regardless of their sibling status, looked longer to the unfair actor, than the fair actor, holding the toy ($p=.04$). In a follow-up study, we are using a violation-of-expectation paradigm to determine whether infants link fairness with helping behaviour, and to determine whether they treat fair individuals as more trustworthy than unfair individuals. If infants understand that fair individuals are helpful and trustworthy, they should expect fair individuals, but not unfair individuals to help another person, and they should be more likely to trust fair individuals. Together the results of these studies will shed light on not only the scope of infants' moral inferences, but also the experiential factors that influence them.

P1-G-112: Psychological reasoning in infancy predicts counting skills at the age of four years

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Theory of Mind has been shown to be related to social, as well as non-social perspective taking; this is predicted by theoretical analyses of perspective taking and belief-understanding (Perner, Brandl, & Garnham, 2003; Perner, Mauer, & Hillenbrandt, 2011). One further prediction of an analysis of the shared representational demands of mental and non-mental perspective understanding is that there should be relations between Theory of Mind and counting skills. One important argument is that an understanding of the cardinality principle involves a representation of one and the same number word as referring to an ordinal and a cardinal number. Consistent with this prediction, there is some empirical evidence for correlations between Theory of Mind and counting skills in 4-year-olds (Osterhaus et al., submitted). Perspective representation does, however, start earlier than at the age of 4 years. The ability to track another agent's visual perspective independently of one's own has been demonstrated even in the first year (Luo & Johnson, 2009) and is involved in implicit false belief understanding. Further, goal representation is also involved in counting skills. In the present paper, we test for predictive relations from infant psychological reasoning to counting skills at the age of 48 months. In a longitudinal study of N=96 infants, goal-encoding (Woodward, 1998) was assessed at 7 months, implicit false belief understanding (Thoermer et al., 2012; Kloo et al., 2019) at the age of 18 months, and knowledge access, a precursor concept to false belief understanding at the age of 36 months (Wellman & Liu, 2004). A counting game (Bornstein & Putnick, 2019) that assessed the one-to-one principle, the cardinality principle, and the coordination of direction and counting, was administered at 48 months. All 3 infant psychological reasoning tasks were significantly correlated with performance on the counting game. These correlations were stable, when Verbal IQ was partialled out: Goal-encoding (decrement of attention), $r = .39$, $p = .047$, $df = 24$; Implicit false belief understanding, $r = .39$, $p = .035$, $df = 28$; Knowledge Access, $r = .27$, $p = .06$, $df = 46$. Moreover there were significant partial correlations of all 3 tasks with the numerate spatial factor of the intelligence battery by Bornstein & Putnick (2019) which included another measure of counting skills. These findings support the hypothesis that goal-encoding and perspective tracking in infancy are predictive of later verbal numerical skills. To our knowledge, this is the first set of findings indicating conceptual relations between infant psychological reasoning and number. The implications for models of domain-specificity will be discussed.

P1-G-113: Do pragmatics play a role in children's failure on verbal false belief tasks? The false memento study

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We hypothesize that one fundamental reason why most children below the age of 4 reliably fail on verbal false belief tasks is that they are provided with irrelevant information that is



ostensively communicated to them by the experimenter. For example, in the traditional verbal Sally-Anne false-belief task (Wimmer & Perner, 1983), the fact that Anne re-locates the marble is irrelevant to solving the task of predicting where Sally is going to look for the marble. Sally will look for it where she last put it, whatever may have happened to the marble in her absence that is unbeknownst to her. Yet to the extent that this irrelevant information is ostensively transmitted to the children, they are likely to take it as relevant to them (as predicted by Relevance Theory (Sperber & Wilson, 1985)). In this case, relevant information relates to information relevant to performing the task, that is, answering the test question. We believe that this can lead to potential confusion since children are likely to try to interpret the situation in such a way as to make this irrelevant information relevant, and as a result they fail to correctly answer the test question. The aim of our study was to test this pragmatic hypothesis by comparing two false-belief conditions, in one of which children are provided with ostensively communicated irrelevant information and in the other of which they are provided with ostensively communicated relevant information. In the study, we introduced a new element in the narrative, i.e. an epistemic tool, more specifically a memento that Sally used in order to remember where she put her marble. This was necessary, because as a general setup we used a small puppet-show where in the middle of the stage there was a rotating platform with two identical boxes (Fig. 1). In this way, once Sally put her marble in one of the boxes and left the scene, it became impossible for her to remember the location of the marble, unless she used a memento to mark the correct box. In both false-belief conditions, Sally placed the memento on top of the box where she placed her marble. In the "Memento change condition" (i.e. relevance condition) in Sally's absence, Anne moved the visible memento from the top of one box to the other. In the "Marble change condition" (i.e. irrelevance condition) Anne moved the marble from one opaque box to the other. In both conditions, Anne's action had the effect of causing Sally to falsely believe that her marble is in the box with the memento on top. We predicted that since the memento's actual location, unlike the marble's actual location, is relevant to predicting Sally's likely action, children's answers to the prediction question will be significantly more accurate in the relevance than in the irrelevance condition. Data collection is still ongoing, but in accordance with our hypothesis, preliminary data suggests that children in the "Memento change condition" tend to perform better than in the traditional "Marble change task" (Fig. 2).

P1-G-114: Exploring newborn behaviour using the Neonatal Behavioural Assessment Scale in Gambia and the UK

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Introduction: The Brain Imaging for Global Health (BRIGHT) project is delivering longitudinal measures of brain and cognitive development from birth to 24 months in Gambian and UK infants. In The Gambia, our research is taking place in a rural area, where undernutrition and poverty-related risk factors are highly prevalent. The aim of BRIGHT is to establish brain function-for-age curves of infants in both these settings and gain an insight into how poverty



related risk factors impact infant neurocognitive development. One of the measures is the Brazelton Neonatal Behavioural Assessment Scale (NBAS), the most comprehensive neurobehavioral assessment available for newborn babies (Brazelton & Nugent, 2011). Several studies have used the scale to study cross-cultural differences in early development and have suggested that infants in different cultural groups differ in behaviour within the first days of life (Brazelton, Koslowski, & Tronick, 1976; Eishima, 1992; Loo, Ohgi, Zhu, Howard & Chen, 2005). Method: Fifty-eight UK and 155 Gambian newborn infants were assessed using the NBAS during the second week after birth. We used the cluster scoring method suggested by Lester et al (1982, cited in Brazelton & Nugent, 2011) and grouped individual behavioural items into broader cluster scores, which look at infants' habituation, social orientation, motor systems, state organisation, regulation of state and autonomic stability. Group differences in these clusters were examined. Results: Preliminary results show that Gambian infants scored higher than the UK infants on the Motor System ($p = 0.03$) and the Autonomic Stability ($p < 0.001$) clusters. Conversely, there were also some trends, which we are currently exploring further, suggesting that infants in the UK showed a more organized state profile and exhibited a higher degree of alertness and attention to social interaction relative to the infants in The Gambia. Discussion: Our data supports the use of NBAS across contrasting settings and highlights distinct between-context differences including more mature motor skills and higher autonomic stability among Gambian infants (similar to the context differences found in a study of infants born in Kenya and the U.S.; Keefer, Tronick, Dixon & Brazelton, 1982) but more self-regulation behaviours and higher levels of alertness overall among UK infants. As early attentional and self-regulation factors have been related to cognitive development and intelligence (Canals, Hernández-Martínez, Esparó, Fernández-Ballart, 2010), we aim to further understand how poverty associated risk factors (such as under nutrition) may impact on newborn behaviour from the first days of life. Future work will aim to examine whether these early group differences contribute to later cognitive development within our sample.

P1-G-115: Word-object pairs facilitate disengagement of attention in infants

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Adults' object naming has a key role in language acquisition, possibly together with other factors. The way attention is deployed toward an object with or without a concomitant linguistic label abruptly changes across development. This pre-registered study (<https://orcid.org/0000-0002-2913-8770>) investigated the effect of word on attention deployment to visual objects, in 12-month-olds. Infants were familiarized with a visual object systematically presented with a word or silently, in two separate trainings. Then, infants performed an Overlap Task in which the familiar stimulus was presented at the centre of the screen while a peripheral stimulus overlapped it in time, in two conditions. In the Consistent condition, the central stimulus was identical to the familiar one. In the Inconsistent condition, the familiar object lacked the word or the colour, depending on the training. Three measures of attention deployment were obtained by an eye tracker: looking time, pupil dilation to the central object; and first saccadic latency towards the peripheral stimulus. Vocabulary size of infants was also measured using the Lexical comprehension quotient of the MacArthur Communicative Development Inventory.



The main hypothesis was that, if the word had had a facilitatory effect in guiding the infant visual attention deployment then, the familiar visual object systematically presented with a word should facilitate disengagement of visual attention compared to the silent training. Nevertheless, we expected the Consistent condition (familiar stimulus) to trigger disengagement of attention from the central stimulus with respect to the Inconsistent condition, independently from the training. Looking times revealed that infants spent more time to familiarize with the visual object presented silently. Accordingly, pupil dilation showed larger pupil diameter size in the silent training. Pupil dilation predicted faster saccadic latency in the Overlap task after the word training compared to the silent training and showed a consistency effect depending only on the word training. Infants with smaller vocabulary size spent more time looking at the word-object pair and had delayed saccades in the Overlap task. Altogether, results showed that the word trigger sustained attention and promoted the attention shift suggesting a facilitating effect of the word on attention deployment in 12-month-olds.

P1-G-116: Brain and behavioural markers of attention predict language development in infants

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Brain functional connectivity improve in the first months of life towards a more efficient small-world topology, which combines local specialization and long-range integration (Zhao, Xu & He, 2019). Likewise, early signs of attention control emerge from about the fourth month (Holmboe, Bonneville-Roussy, Csibra & Johnson, 2018). Parallel to attention and networks maturation, language acquisition also takes place, as infants of 6 months have been found to know the meaning of several common words (Bergelson & Swingley, 2011). Due to the shared trajectories, in this research we aim to identify the relationship between infant's networks' efficiency in theta band, previously related to attention (Orekhova, Stroganova & Posikera, 1999), and attention control measured at 6 months, and their association with vocabulary comprehension and production at 9 months. We expected higher small-world connectivity pattern (SWI index) to be related to higher attention control at 6 months. Moreover, we hypothesize that a higher SWI and attention control would predict vocabulary comprehension and production 3 months later. A simple version of the visual sequence learning task, in combination with eye-tracking, was employed to evaluate attention control at 6 months. We considered anticipatory looks previously to the appearance of the stimulus in each trial as an early marker of voluntary control of attention. A resting state protocol was used to register babies' brain activity using a high-density net (128 channels). Infants returned at 9 months to a second session and parents reported infant's vocabulary comprehension and production through the MacArthur Scale. Parent-reported socioeconomic status and household disorganization were used as control variables. We employed correlation and multiple linear regression to examine the association between the variables. To date, 123 infants were evaluated at 6 months, with pre-processed eye-tracking data from 100 infants and EEG from 54. Valid data in both eye-tracking and EEG was obtained from 32 infants at 6 months (mean age = 192.59, SD = 9.60, 14 females). We also collected vocabulary comprehension and production from 23 of those infants at 9 months (mean age = 280.26, SD = 6.99, 10 females). No associations between SWI or anticipations and control variables, nor between anticipations



and SWI, were found at 6 months. Furthermore, the regression model was not significant for vocabulary production. However, the SWI computed in theta frequency band ($\beta = .45$, $p = .012$) and anticipations ($\beta = .47$, $p = .009$) at 6 months were significant predictors of vocabulary comprehension at 9 months ($\Delta R^2 = .46$, $F(2, 22) = 8.69$, $p = .002$). Our results indicate that early small-world properties in theta band, and attention control measured by anticipatory looks, could predict vocabulary comprehension 3 months later. These results are in line with the literature, and extend the early relationship between attention and language acquisition to earlier stages in development as the first year of life both with behavioural and neuroimaging data.

P1-G-117: Implicit learning from noisy stimuli in 3-year-olds with high and low likelihood of autism

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Recent accounts of autism claim that due to altered predictive processing, autistic individuals cannot always identify signal from noise in sensory input, because they over-weight their prediction errors relative to their expectations. This means that when an observation differs from their expectations, autistic individuals may revise their expectations more than non-autistic individuals, which leads to models of the world that are overfitted to specific experiences (Manning et al., 2015; van der Cruys et al., 2017). According to these accounts, information processing differences should be present at a very young age, even before autism can be reliably diagnosed. Due to the hereditary nature of autism, we can currently study the development of the condition by following younger siblings of autistic children. These younger siblings have around 20% chance of receiving a later autism diagnosis themselves, and around 30% chance of showing sub-clinical autistic symptoms. We therefore call younger siblings of autistic children "high-likelihood siblings" and younger siblings of non-autistic children "low-likelihood siblings". In the current study, we examined whether the high-likelihood siblings have difficulty in distinguishing signal from noise, by manipulating sensory noise in a touchscreen Serial Reaction Time Task. In our novel self-paced paradigm, a picture of a frog appeared on lily pads in a sequence (see Figure 1), and the children were asked to press the frog. In block 1, the sequence was identical on every repetition, while in block 3, the frog's exact location included random jitter; it was possible to learn which lily pad the frog would appear on next, but not precisely where on the lily pad it would appear. Block 2 served as a baseline condition in which the frog appeared in random locations without a sequence. According to Predictive Processing accounts of autism, high-likelihood siblings should show difficulty separating signal from noise, and should thus learn the pattern slower in the block with added jitter when compared to low-likelihood siblings. This disruption of learning should be especially pronounced in the children who receive an autism diagnosis themselves. Data collection is ongoing, but preliminary results (see Figure 2) suggest that participants do all learn the pattern, and that high-likelihood siblings (N=18) both learn faster where there is no noise and are more disrupted when there is added noise than the low-likelihood siblings (N=21), as shown by a more pronounced reduction in their learning rate. This is in line with Predictive Processing theories of autism and suggests that younger siblings of autistic children do show some early signs of overfitting their model to specific experiences. Once data collection is complete, we will use multi-level modelling to look for an interaction between group (high- vs. low-likelihood),



condition (Noise vs. No Noise), and number of times the pattern was repeated. We expect to include random effects of block and participant. The final sample will be 24 siblings of autistic children and 26 siblings of non-autistic children, and testing will be concluded in December 2019.

P1-G-118: Training infants to focus on the function of objects facilitates word learning

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By the end of the second year of life, typically developing infants have a preference for extending labels based on objects' shapes, instead of other properties, in what is known as the shape bias (Ellis Weismer, Venker, Evans, & Jones Moyle, 2013; Jones, 2003). In contrast, adults tend to generalize object names based on objects' functions. Previous research has suggested that a preference of shape over function in infancy occurs because most words infants learn during the first years of life are of object categories clearly defined by shape (Colunga & Smith, 2008) and because functions tend to be more cognitively demanding (Gathercole & Whitfield, 2001). Besides being part of typical development, teaching the shape bias at the end of the second year of life can facilitate noun learning (Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002). We asked whether infants can be taught to generalize labels based on function and if this would also boost vocabulary development. If infants can learn to generalise by function, it would mean that the shape bias is not caused by functions being too cognitively demanding. If the training facilitated vocabulary development, then focus on shape would not be the only means to acquire words quickly at this early developmental stage. Thus, the aims of this study were a) to teach infants to use function as the relevant property for extending known and novel labels, and b) to assess if this training has similar positive effects on vocabulary development as the shape bias training conducted by Smith and colleagues (2002). Twenty-four typically developing infants were randomly divided into two groups: function-training group and control group. During seven weekly sessions, infants in the function-training group played with four sets of novel objects, presented alongside novel labels and demonstrations of the objects' functions. Infants in the control group played with the same sets of objects, but did not hear any labels or saw the functions being presented. In two further sessions, infants were assessed on first and second-order generalization. Parents reported infants' productive vocabulary at the beginning and end of the study. Results showed that infants can learn to extend object labels by function, both labels that had been taught alongside functions and entirely novel labels for entirely novel objects. In contrast to the shape training (Smith et al., 2002), training infants to extend novel objects by function did not facilitate vocabulary development. These results suggest that the preference of shape over function is not about function being cognitively too difficult, as infants in our study were able to learn to utilize function for word generalization. But shape seems to have a special status in early vocabulary development. Function seems not to be that relevant at this stage, maybe because many of the first words infants learn are of objects or categories organized by shape and shape is a more salient property of objects than function, even for adults (Landau, Smith & Jones, 1998).



P1-G-119: The role of SES in predicting language outcomes: New insights from multisensory attention skills

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Previous research has demonstrated that children from lower socioeconomic status (SES) households have poorer language outcomes compared to children from higher SES households (e.g., Hart & Risley, 1995). Recent findings from our lab have highlighted three multisensory attention skills (MASks; attention duration, speed of shifting, and intersensory processing accuracy), established in infancy, that are foundations for subsequent language development. This poster will explore the extent to which MASks differ as a function of SES, highlighting their potential roles in the early prediction of language outcomes. The Multisensory Attention Assessment Protocol (MAAP) is designed to assess individual differences in MASks (Bahrack et al., 2018; Figure 1). The task consists of 24 15-s trials, 12 social (women speaking with positive affect) and 12 nonsocial (objects dropping into a clear container). Each trial consists of a 3-s central visual stimulus and is followed by two 12-s lateral, dynamic video events, one in synchrony with an accompanying natural soundtrack and the other out of synchrony. On half of the trials, the central event remains on while the lateral events are presented (high-competition trials) and on the other half it is turned off during the lateral events (low-competition trials). MASks are quantified as follows: 1) attention duration: proportion of available looking time to the lateral events, 2) speed: reaction time to shift attention from the central event to fixate a lateral event, and 3) intersensory accuracy: proportion of total looking time to the sound-synchronous lateral event. A total of 106 infants (part of an ongoing longitudinal study), participated in the MAAP at 12 months of age. Their gaze was live-coded by two trained observers. Children also participated in two standardized language outcome measures at 36 months of age: the Peabody Picture Vocabulary (PPVT) and the Expressive Vocabulary Test (EVT). Maternal education was used as a proxy for SES. Approximately half of our sample reported having a bachelors degree or higher (higher SES), and the other half reported not having attained a bachelor's degree (lower SES). Replicating prior findings, children from lower SES households scored lower on both the PPVT and EVT compared to children from higher SES households ($p < .001$). Results also suggest that MASks differed significantly as a function of SES. Specifically, higher SES 12-month-old infants showed longer attention duration ($p = .037$) and greater intersensory accuracy on the social high-competition trials ($p = .032$) than lower SES infants. In addition to replicating the well-established finding of SES differences in language, the present study also found new evidence of SES differences in MASks, an earlier developing set of skills that provide a foundation for language. Compared to children from higher SES households, children from lower SES households showed both poorer language and poorer multisensory attention skills. These novel findings can elucidate the roles of SES and early attention skills in the later development of language. Further by assessing both MASks and SES, we may be able to identify children at-risk for later language delays during the first year of life, when targeted interventions are more likely to be successful.



P1-G-120: Semantic relationships emerge from visual temporal co-occurrences: A statistical analysis of a learning mechanism in early infancy

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While many questions remain about the types of information learned during early infancy, evidence suggests that infants are sensitive to temporal patterns of visual objects. 3-4 month olds look preferentially at an image from a deviating category to one which has already been shown. For example, when shown images of cats followed by a dog, the infant will look for longer at the dog (Quinn et al., 1993) . Additionally, 6 month old infants are able to associate objects to a given action; a cup is expected to be held up to the mouth rather than to the ear, contrasting with the expected action for a phone (Hunnis & Bekkering, 2010). While the importance of statistical cues for learning semantic categories has been explored in the lexical domain (Lany & Saffran, 2010), it is unclear whether infants can form clusters which map onto semantically meaningful categories by simply observing visual co-occurrences over time. Here, we conducted a large-scale statistical assessment to investigate the richness of these temporal co-occurrence patterns for learning semantic categories. We hypothesised that the temporal structure of co-occurrences for visual objects would reveal semantically meaningful clusters. For example, the presence of an apple might predict a mouth or hand a few seconds later. The rationale for this is that models in other modalities have demonstrated that rich and distinct semantic information can be obtained through such co-occurrences. In particular, models like Word2Vec learn subtle semantic relations from large corpora of written text which are distinct from those learned by a deep neural network (DNN) trained on pictorial datasets. Word2Vec will learn that an apple is a sweet fruit, whereas the DNN will emphasise visual information such as colour and shape. Here, we bring these methods together by testing a dataset which is comparable to a narrative visual corpus. We explore whether this dataset contains an observable structure which can be learned through visual experience. 159 hours of naturalistic movies were chosen to be representative of environments containing objects that an infant may typically encounter. The movies were tagged using Amazon Rekognition, generating a dataset of 40,000,000 labelled objects with preserved temporal structure. An exploratory analysis based on association rule mining showed that over increasing windows of time, an increase in the associative structure for frequent objects began to emerge. In a 200 ms window, there was a weak association between 'table lamp' and 'chair'. When the window was extended to 2 s, the presence of a clear 'furniture' cluster was detected. This emergent structure was assessed for meaningful semantics by comparison to the LCH similarity measure. Next, a vector autoregression was performed to quantify the relationship between an object's time series and its lagged values. Preliminary results highlight that temporal co-occurrences, requiring a large amount of experience and exposure to learn, can be clustered into semantically meaningful categories. The mechanisms underlying the development of this structure may be measurable in infant experiments, furthering our understanding of the means by which human learning progresses in the first months.

P1-G-121: Inhibitory control and working memory in 16-month-old bilingual and monolingual infants

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Research demonstrates that bilinguals often outperform monolinguals on tasks that tap into executive functions such as those requiring inhibition, shifting, and updating (e.g., Adesope, Lavin, Thompson, & Ungerleider, 2010). However, this advantage has been debated (e.g., de Bruin, Treccani, & Della Sala, 2015). Thus, the existing literature on whether there are differences between monolingual and bilingual individuals, particularly during childhood, is inconclusive. Observed cognitive advantages in bilinguals are attributed to the established finding that both languages in the bilingual mind are jointly activated (Kroll, Dussias, Bogulski, & Valdes Kroff, 2012). Therefore, a mechanism is needed to inhibit interference from the unwanted language. One would expect such cognitive benefits to gradually emerge with proficiency in speaking two languages. The first studies to have addressed this issue reported a small effect at 24 months (using tasks adapted for toddlers and young children, i.e. Stroop task) that became more widespread by 4 years of age (Bialystok et al., 2010; Poulin-Dubois et al., 2011). More recently, better attentional control has been detected in infancy on a non-verbal conflict task, thereby providing a possible basis for cognitive differences in executive function reported at a later age (Comishen et al., 2019; Kovack & Mehler, 2009). The goal of the present study was to examine if inhibitory control and working memory are more advanced in bilingual infants. A detour reaching task and a multiple location task were administered to infants, whereby accuracy and latency to respond on correct trials were measured. The multiple location task was completed by a group of 32 infants aged 16.83 months (SD = 0.88), where 16 were bilinguals (exposure to L2 > 20%) and 16 were monolinguals to assess working memory. In this task, a toy was hidden in one of three drawers, the drawers then hidden from the infant's view for 5s and the infant asked to retrieve the toy. Contrary to what was expected, preliminary results demonstrate that monolinguals achieve more correct responses than bilinguals but they do not differ in terms of their latency to respond. In addition, the detour reaching task was completed by a total of 42 infants aged 17.01 months (SD = 0.91), where 21 were bilingual and 21 were monolingual. This task assesses inhibitory control by showing the child a toy inside a box that needs to be retrieved by turning a knob on the side of the box instead of directly pushing a window located on the front of the box. To succeed, the child must inhibit the spontaneous tendency to retrieve the toy by pushing the window. Preliminary results for this task are in the expected direction, that is, bilinguals seem to be reaching for the knob more quickly (i.e. shorter latency to respond) than monolinguals. However, there is no difference on accuracy. Overall, these findings seem to suggest a small effect of bilingualism on inhibitory control, as previously reported in 24 month-olds.

P1-G-122: Developing an eye-tracking toolbox for measuring early-infancy individual differences in attention and emotion control

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During the first year of life, infants acquire a number of attention and emotion control mechanisms allowing them to better shape their own internal states, marking the emergence of self-regulation. Sustained attention improves rapidly during this period and individual differences in one-year-olds' have been shown to predict executive functioning a year later (Johansson, Marciszko, Gredebäck, Nyström & Bohlin, 2015). Already at 4 months, however,



infants become reliable in other endogenous forms of attention (Hunnius, 2007), around the same time they start using behavioral strategies to regulate their own arousal states (Mesman, van IJzendoorn & Bakermans-Kranenburg, 2009). Although the development of attention and emotion control are theorized to constitute a foundation for later self-regulation (Garon, Smith & Bryson, 2014), how their interplay contributes to cognitive development remains elusive. To study these developmental pathways, we first need stable individual differences measures, which has proven a major challenge in such young populations due to the scarce, noisy data they tend to provide. The current research aims to develop a toolbox of sensitive and reliable measures of infant attention and emotion control. Eye-tracking is especially suitable for studying the micro-structure of fast-paced processes such as attention (Hessels, Andersson, Hooge, Nyström & Kemner, 2015) and at the same time can yield stable measures within individuals (Wass & Smith, 2014). We thus repurposed classic paradigms originally aimed at probing group-level infant attention to measure individual differences in the attention-driven control of eye-movements. In three eye-tracking tasks, we relate how infants differ in the speed of recovering attentional focus in a gaze-contingent sustained attention task (Wass, Porayska-Pomsta & Johnson, 2011) to the speed of endogenous attention shifts in a Gap-Overlap task (Hood & Atkinson, 1993), and to the speed at which infants gather information about novel stimuli in a Habituation task (Fantz, 1958). Given the temporal covariation between changes in arousal and attention states characterizing early infancy, individuals should vary in the degree to which changes in arousal precede and co-occur with the onset of attention-driven eye-movements. Measuring pupil dilation and head-movement velocity concurrently further allows us to account for on-task changes in the infant's anticipatory readiness. To minimize spurious changes in attentional behavior and pupil diameter, non-social stimuli sets were designed using high-contrast equiluminant colors generated in a perceptually uniform color space (CIELUV, 1976). We expect that infants faster at restoring attentional focus are also faster and more reliable at shifting attention and information gathering, while exhibiting attentional episodes more strongly correlated to corresponding arousal changes. Individual differences in endogenous attention may further translate to global measures of temperament, sleep, and feeding regulation, as well as to micro-coded video measures from the Still-Face paradigm, where we assess infants' ability to regulate their emotional responses following a disruption in the natural flow of the social interaction. Quantifying how early-infancy attention and emotion control mechanisms interact is of primary importance to understanding, predicting, and eventually enhancing the individual developmental course of later-life sociocognitive outcomes.

P1-G-123: Associations between sedentary behaviour and self-regulation in early childhood

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There is growing evidence that sedentary behaviour is related to poorer cognitive outcomes in early childhood (Carson et al., 2015). However, children's typical patterns of sedentary behaviour have changed substantially as mobile devices become increasingly common. Mobile apps and games require more active engagement, in contrast with television viewing which is a more passive activity, so one might expect relations with cognitive outcomes to



differ. Further, many studies have relied exclusively on parent-report rather than objective measures of children's exposures. The objective of this study was to examine the relationships between sedentary behaviour (measured objectively and through parent report) and self-regulation in preschool children. The sample included 59 children (29 boys, 30 girls) between 3;0 and 6;0 years of age. Children and their parents visited the lab on two occasions separated by at least a week. Between visits, children wore Actigraph accelerometers for 7 consecutive days (with the exception of overnight sleep, swimming, and bathing). Sedentary time was defined as 0-25 counts per 15 seconds, and was adjusted for total wear time. Parents also reported on their children's sedentary behaviour, including time spent watching video and playing games/apps. Children completed two self-regulation measures: the Head Toes Knees Shoulders (HTKS) task (Ponitz et al., 2008), a measure of response inhibition, and the Preschool Gambling Task (Garon & Moore, 2004), a measure of risky decision-making. These tasks represent two separate but related facets of self-regulation (Hongwanishkul et al., 2005), where HTKS requires children to regulate prepotent responses, and Preschool Gambling Task requires children to regulate the temptation to choose larger rewards because they are accompanied by disproportionately greater losses. Associations between variables were examined using partial correlations, controlling for child age (see Table 1). More objectively-measured sedentary time was related to poorer decision-making performance. More time spent playing games or apps was related to poorer response inhibition performance, but time spent watching video was not significantly related to either cognitive outcome. In addition, different measures of sedentary behaviour were positively correlated, although the relation between objectively-measured sedentary behaviour and game or app use was not statistically significant. Response inhibition and decision-making performance were positively correlated. Results were largely unchanged when child sex and maternal education were statistically controlled. These findings are consistent with long-standing evidence that increased time spent in sedentary activities (particularly screen time) is associated with poorer cognitive outcomes. Associations were present across approaches to measuring sedentary behaviour and across distinct facets of self-regulation. These findings support existing guidelines to limit young children's engagement in screen-based activities.

P1-G-124: Acoustic features of infant directed speech correlate with language development

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Infant directed speech (IDS) universally exhibits features such as exaggerated prosodic contours and lengthening at utterance boundaries (e.g., Kitamura et al., 2001). Recent studies have shown that the amount of IDS an infant hears is related to vocabulary size (Ramírez-Esparza, García-Sierra, & Kuhl, 2014), though it remains unclear which acoustic properties of IDS drive these effects. In the present study, we recorded families across two days using LENA technology to investigate whether, in everyday interactions, acoustic features such as prosodic contour variations, as measured by frequency, and lengthening effects, as observed through vowel length and pause duration, are related to infants' vocabulary size. Method. Fifty 12-month-old (48% female) infants and their families participated in our study; all the adult speakers in the recordings were monolingual native-English speakers. For each infant, audio recordings were transcribed in CLAN and acoustically coded in PRAAT. To capture the



characteristics of IDS for each sentence, we measured Overall F0, F0 change, Vowel Lengths, as well as Phrase- and Utterance-Final Pause Durations. These measures were then standardized by speaker into z-score values. 1575 full sentences were coded across infants. We also collected demographic data regarding Income and Maternal Education. Using the MCDIs, we obtained the infants' language outcomes at 12 months. Results. Consistent with previous findings, Income and Maternal Education together predicted infants' receptive $[F(2,45)=4.57, p=.016, R^2=.169]$ and productive vocabulary $[F(2,45)=5.88, p=.005, R^2=.207]$ at 12 months. Stepwise multiple linear regressions were conducted to evaluate whether additional acoustic features accounted for unique variance, above and beyond that explained by Income and Maternal Education. Models showed that only F0 change significantly contributed to the equation for both receptive and productive vocabulary ($ps < .05$), while Overall F0, Pause Duration, and Vowel Length did not impact the model. When separated by infant sex, Income and Maternal Education together were marginally correlated with receptive $[F(2,22)=3.25, p=.058, R^2=.228]$ and productive $[F(2,22)=3.33, p=.055, R^2=.232]$ vocabulary for males, but not for females. Stepwise regressions revealed that for males, only F0 change accounted for additional unique variances for both productive and receptive vocabulary ($ps < .05$), whereas Overall F0, Pause Duration, and Vowel Length did not. None of the acoustic factors was significant for females. Using acoustic coding from naturalistic speech input, the present study shows that only pitch change at the sentence level is correlated with infants' vocabulary size, whereas pause duration and vowel lengthening are not. These effects differed as a function of infant sex, such that acoustic features in IDS correlate with vocabulary size at 12 months of age for males but not females. In sum, these results indicate that prosodic contour change in IDS matters to infant language development, above and beyond infants' socioeconomic background. Furthermore, sex-based differences may exist for IDS benefits given that males' vocabulary size was correlated with the degrees of prosodic contour variation in IDS.

P1-G-125: Who talks to babies? Multimodal ambulatory assessments predict hour-by-hour fluctuations in caregiver speech over a week

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Socioeconomic status and maternal depression have well-established implications for children's language development (Hart & Risley, 1995; Treat et al., 2019), likely mediated in part through differences in caregiver speech volume (Gilkerson et al., 2018). Recent advances in mobile sensing now allow for more dynamic assessments of what predicts caregiver speech. For example, word count is increased during storytime and play (Soderstrom and Wittebolle, 2013). However, much is still unknown about "who talks to babies?" and "when?". For example, while mood states dynamically change throughout the day (Krueger & Schkade, 2008), the implications for speech interactions is unknown. The current study aims to predict within- and between-person variation in caregiver speech using multimodal assessments of caregiver and infant daily activity. N=51 caregiver-infant dyads (ages 6-41 weeks, M=19, SD=9) were drawn from N=81 dyads participating in a mobile-sensing study. Mothers completed 6 surveys per day, and continuous motion (Movisens) and audio (LENA) recorders were worn by dyads for up to 72 hrs (M=47, SD=23) over the course of 1 week. Automatically



detected hourly speech data were linked with objective markers of sleep, movement, and self-reported maternal positive and negative affect, sleep quality, confidence, social support, proximity to infant, and daily clinical symptomatology (PHQ-4, PSS-4). Periods with over 80% infant waking activity were included. All variables were normed to 60 mins. Hourly sums of adult word count over the course of 72 hours indicated that 91.9% of speech variability was within-person (Figure 1). Independent-variable hierarchical linear models considering both between person (i.e. person mean) and within person (within-person centered) level data were used to predict hour-by-hour adult word count. Between participants, mothers who were more depressed spoke less ($b=-206.77$) and those who spent more time awake spoke more ($b=4450.56$, both $p<0.05$). Within-person, mothers spoke more in hours where on average, infants moved more ($b=205.52$, $p>1.34e-15$), and when they spent time with their infants ($b=186.4$, $p<0.04$). Adult word count was reduced during hours that contained more electronic noise than average ($b=-0.3979$, $p<0.04$), and when infants slept more than average ($b=-2150.37$, $p>1.34e-15$). Neither positive nor negative mood predicted speech, however, days that mothers felt more depressed than average were associated with increased word count per hour, and negative mood trended in the same direction ($b=208.52$, $p=.076$), a finding we will explore further. Also, while overall social support did not show relations with speech, caregivers spoke more ($b=62.30$, $p<0.02$) on occasions when they reported receiving more help from their partners, and less when reporting more satisfaction in their relationships ($b=-119.51$, $p<0.003$). This is the first paper to predict context-dependent objective markers of variation in adult word count using time-locked reports of caregiver's mood and clinical symptoms. Future work will explore models with multiple predictors to identify potential mediators of these effects, such as SES or time spent with infants, which we show increases depression symptoms and speech. Such examination of dynamic changes in caregiver's activity and mental state as they predict speech can thus provide new insight into language acquisition in the context of maternal mood disorders.

H-Social Development

P1-H-127: Gaze-contingent eye tracking as a measure of early social deviancies in infant siblings

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Recent studies with infant siblings of children with Autism Spectrum Disorder (ASD) suggest that symptoms of ASD emerge between 12 and 24 months (Bussu et al., 2018). Early detection of ASD symptoms is essential for early treatment and improves prognosis (Fernell et al., 2013). Current research suggests a gradual onset of impairments across multiple domains (Rogers, 2009); however, a reliable first-year marker remains elusive. The lack of predictability in the first year of life could be due to the inability of current methods to capture ASD-related social deviancies at an early age. Fundamentally, ASD is a social-communication disorder; therefore, in order to identify early manifestations, we must develop methods that are sufficiently socially demanding and realistically interactive. Yet, past studies (e.g., Chawarska et al., 2013) have attempted to detect deviancies in socially interactive behavior, whilst using methods that employ non-interactive stimuli. Consequently, we developed a novel and interactive gaze-



contingent (GC) eye-tracking paradigm in which the participant's viewing experience is contingent upon their eye movements and enables the participant to 'interact' with stimuli to provide a more naturalistic experience (Figure 1). This paradigm strives to retain the ecological validity of a real-life interaction without jeopardizing scientific rigour. In this symposium, we present two studies using GC stimuli with infant siblings, referred to as the High Likelihood (HL) group. Infants with an older sibling without ASD will form the Low Likelihood (LL) group. In study 1 (Keemink et al., 2019), infants could trigger socially engaging or non-engaging responses from on-screen actors by fixating the eye or mouth area. We collected eye-tracking data from 151 LL infants and 11 HL infants (6-, 9-, and 12-month-olds). Additionally, infants were video-recorded during the GC task to obtain measures of reciprocity. Our findings demonstrate the efficacy of the GC paradigm; all infants elicit the responses from on-screen actors and a substantial proportion displayed behavioural responses (Figure 1), indicating engagement in the simulated interaction. To examine HL infant behaviour we took a distribution-based approach in which we compared deviant z-scores of HL infants and LL infants, rather than treating them as an established separate group. On a number of measures HL infants present with significantly more deviant z-scores (e.g., on overall dwell time on the eyes, $p = .003$). In study 2 (Keemink et al., in prep), infants elicited 'basic' emotional expressions (happiness, sadness, surprise, fear, disgust, anger) by engaging in eye contact with an on-screen actor. Eye-tracking and video data were collected from 120 LL infants and 29 HL infants. Overall, we found a significant Expression by AOI interaction ($F(10, 1470) = 10.003$, $p < .001$, $\eta^2 = .064$). Infants' eye movements were 'expression-specific' with, for example, greater looking at the mouth for 'surprise' and at the eyes for 'fear' (Figure 2). Comparisons of behavioural-response data found that relative to LL infants, HL infants were significantly less responsive ($p = .014$), showed fewer instances of imitative response rates ($p = .006$) and were less likely to respond with a smile ($p = .030$). We argue that the GC paradigm provides a realistically interactive experience capable of detecting deviancies early, and we discuss our results in relation to subsequent HL infant development.

P1-H-128: Follow my lead: Parent-child interaction in infants at elevated likelihood for Autism Spectrum Disorder

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Introduction & hypotheses. Parent-child interaction (PCI) plays a major role in the development of children, especially in the first years of life. These interactions may be even more vital in infants who have an elevated likelihood (EL) for ASD, because they have an older brother or sister diagnosed with ASD (Wan et al., 2019). The aims of the current study were therefore a) to investigate if PCIs in the first year of life were similar in parent-infant dyads with infants at EL for ASD compared to infants who had a typical likelihood (TL) for developing ASD; and b) to explore the predictive value of PCI in the first year or life for cognitive development and ASD-characteristics at 14 months of age. Study population & methods. 49 TL- and 56 EL infants were enrolled in a longitudinal study, following them up from 5 to 36 months of age. For the current study, 5-minute video fragments of parent-infant free toy play at 5 and 10 months were coded with the PInTCI (Parent-Infant/Toddler Coding of Interaction), including 5



infant scales (initiatives, attentiveness, shared affect, positivity, negativity), 5 parent scales (sensitive responsiveness, negative control, scaffolding, positivity, negativity) and 1 dyadic scale (dyadic reciprocity), all scored on a 7-point Likert scale. At 14 months, the Mullen Scales of Early Learning (MSEL) and ADOS-2 Toddler module were administered. As the coding process is still ongoing, preliminary results are presented from 18 TL- and 25 EL infants. More elaborate results will be presented at the meeting. Results. At 5 months of age, parental positivity tended to be higher in TL- compared to EL infants ($p = .067$). This was confirmed at 10 months, where both parent- and infant positivity were higher in TL- compared to EL infants ($p = .041$ and $p = .027$, respectively). In addition, at 10 months, the number and clarity of child initiatives and the dyadic reciprocity tended to be lower in EL- compared to TL infants ($p = .060$ and $p = .059$, respectively). MSEL scores at 14 months were not predicted by child, parent, or dyadic scales. The Repetitive and Restricted Behavior (RRB) score of the ADOS-2 at 14 months was significantly predicted by infant initiatives and infant negativity at 5 months ($p = .031$ and $p = .047$, respectively); the Social Affect (SA) score of the ADOS-2 at 14 months was predicted by infant initiatives, infant attentiveness, parent positivity, and dyadic reciprocity at 10 months ($p = .003$, $p = .047$, $p = .039$, and $p = .040$, respectively). Conclusion. PCIs with an infant at EL for ASD may already show subtle differences at 5 months, and more clear differences at 10 months of age. While the cognitive development of the infants at 14 months could not be predicted by PCI in the first year of life, both RRB- and SA scores of the ADOS-2 were predicted by characteristics of PCI, mainly derived from the infant scales. Graphic: group differences in PCI at 5 and 10 months (red cells = EL < TL) and predictive value for 14 month ADOS-2 scores (red arrow = negative correlation, green arrow = positive correlation)

P1-H-129: Infant understanding of different forms of social exclusion

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In a series of eye-tracking studies, we investigated preverbal infants' understanding of social exclusion by analyzing their gaze behaviors as they were familiarized with animations depicting social acceptance and explicit or implicit social exclusion. In addition, we implemented preferential reaching and anticipatory looking paradigms to further assess understanding of outcomes. Across all experiments ($n = 81$), it was found that 7-9 month-old infants exhibited non-random visual scanning and gaze behaviors and responded systematically and above random chance in their choice of character and, to some extent, in their anticipation of the movement of a neutral character during a test trial. Together, the results suggest that not only do preverbal infants follow and understand third party social events, such as acceptance and exclusion, but that they also update their representations of particular characters as events unfold and evaluate characters on the basis of their actions, as well as the consequences of those actions.

P1-H-130: Measurement of heart rate variability during hugs in parents and infants

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For an infant, not only satisfaction with food and thirst but also intimate physical contact with caregivers is necessary for development (Bowlby, 1969; Harlow, 1958). Although parents often hug their infants in their arms to express affection and joy, the effects of the hug on parents and prelinguistic infants are largely unknown. Here we investigated how a hug affected parents and infants during the first year of life (Figure 1). We found several parameters of infant heart rate variability changed around four months of age, indicating pronounced parasympathetic activity. We examined changes in the R-R interval (RRI) in infants younger than four months, and older than four months, while being held, hugged, and hugged tightly by their parents. RRI is the reciprocal of heart beats, meaning that RRI increase ratios rise when heart beats reduce. Among three tasks such as holding, hugging and tight hugs, only during hugging, older infants showed higher RRI increase ratio than younger infants. This difference was not exhibited during holding or tight hugs. We also measured the moving time of each body part and then classified into "few" and "many" movements groups depending on whether the infant moved the body part for more than half of the task time or less. Older infants who moved their heads few before hugging exhibited further heightened RRI increase ratio than those who moved them a lot (Figure 2). Such context-dependent change was apparent both in maternal and paternal hugs, but absent in younger infants and older infants hugged by unfamiliar women. Decision tree classification suggested that the RRI increase ratio can be predicted if both the infant's age and the head movement type are known (Figure 2). We also measured the contact pressure between the infant's back and mother's hand during the hold/hug session using a flexible pressure sensor attached to the mother's hand (Figure 1). Younger infants showed the heart beat increase by pressurization derived from a hug. In contrast, the heart beats of older infants during a hug were not simply determined by pressurization but changed depending on the head movement types immediately before the hug. The parent-infant hug reduced heart beats in parents irrespective of their infants' ages. Our study suggests that a hug begins to function as a communication tool between parents and infants around the same time that infant parasympathetic activity increases. These findings will contribute to an understanding of typical and atypical psycho-physiological development.

P1-H-131: Maternal reports of father involvement in infancy: Links to perceived social support and maternal and child outcomes at 48 months

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Father involvement robustly predicts positive child outcomes (Cabrera & Tamis-LeMonda, 2013), but less is known about maternal outcomes. Although often criticized, maternal reports of father involvement deserve further evaluation in this literature because they may be a marker of mothers' perceived social support, which itself is a robust predictor of maternal and child outcomes. Here, we evaluate whether (a) mothers' perceptions of greater father-child involvement during the first 48 months postpartum predict higher maternal perceived social support at 18 months, and positive maternal and child outcomes at 48 months, controlling for income-needs ratio; and (b) 18-month social support mediates these associations. Analyses utilized data collected for 182 African American mother-child dyads, followed from the child's



birth to 48 months. Table 1 provides descriptive statistics for sample demographics and current study variables. Mothers reported on father involvement with the child at 3-, 6-, 12-, 18-, and 48 months using the Parental Care Inventory. Mothers listed all persons who cared for the child during the past 7 days, then assigned each caregiver a score of 0-7 for each of 16 possible caregiving or play activities. 18-month social support was evaluated using the Inventory of Parent Experiences. 48-month outcomes included: maternal parenting stress (Parenting Stress Inventory), children's cognitive competence (mean standard score, Differential Ability Scale, Bracken School Readiness subtest, and K-SEALS Vocabulary, $\alpha = .82$), children's behavior problems (CBCL), and mother-child interaction quality scored from a videotaped dyadic problem-solving sequence (mean 7-point Likert rating, reliability ICC = .89). Trajectories of father involvement across visits, and their associations with 18-month social support and 48-month outcomes, were evaluated using latent growth modeling (Mplus, Muthen & Muthen, 2008). An unconditional growth model centered at 12 months had good model fit ($X^2=11.22$, $df=10$, $p=.33$; RMSEA=.026) and indicated significant variability in the intercept ($b=.444$, $p < .00$) and slope ($b=.03$, $p=.02$). A conditional growth model examined the association of father involvement trajectories with the 48-month outcomes, as mediated through 18-month maternal social support, controlling for income-needs ratio (Figure 1). Level of father involvement (intercept) was associated with higher social support at 18 months ($b=.58$, $p = .001$), and less maternal parenting stress ($b=.23$, $p=.005$), marginally higher child cognitive competence ($b=4.27$, $p=.059$), fewer child behavior problems ($b=-3.42$, $p=.045$); and higher dyadic interaction quality ($b=.35$, $p=.032$) at 48 months. Mothers reported higher social support when fathers' level of involvement increased over time ($b=.286$, $p=.04$). An indirect path showed that greater father involvement predicted 18-month maternal social support ($b=.58$, $p=.001$), which in turn predicted higher 48-month dyadic interaction quality ($b=.35$, $p=.022$). Maternal perceptions of father involvement with their children during the first 48 months postpartum are linked to maternal social support at 18 months and to maternal and child outcomes at 48 months. Higher social support at 18 months mediated the association between father involvement and mother-child interaction quality. Maternal reports of father involvement may be a marker of maternal social support and useful to include in assessments of father involvement.

P1-H-132: Infants' neural sensitivity to real-world faces varying in the level of expressed trustworthiness

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Sensitivity to facial cues to trustworthiness - i.e., those facial configurations we use to infer whether a stranger could be safely approached or better avoided - is a crucial and adaptive social skill. Studies with adults show that trustworthiness judgments based on facial cues are fast and automatic (e.g., Todorov et al., 2009), and that these cues modulate electrophysiological markers of visual attention, with untrustworthy faces eliciting larger attentional responses compared to trustworthy ones (e.g., Lischke et al., 2018; Yang et al., 2011). In spite of the wealth of literature on the cognitive and neural mechanisms underlying adults' ability to make social trait inferences based on facial appearance, still little is known about whether and how sensitivity to the facial cues that drive these inferences develops in preverbal infants. Evidence from three electrophysiological studies with 7-month-old infants



suggest that the infant brain discriminate between neutral faces and faces displaying both positively- and negatively-valenced cues to trustworthiness (Jessen & Grossmann, 2016, 2017, 2019), while behavioral evidence suggests that infants prefer to look at highly trustworthy faces compared to low trustworthy faces when tested in visual preference tasks (Jessen & Grossmann, 2016, 2017; Sakuta et al., 2018). Like the majority of the adult studies, these infant studies used artificial, computer-generated male faces as stimulus material (Oosterhof & Todorov, 2008), which allows to rigorously manipulate the features of interest but have limited ecological validity. In the current study, we used a more ecological set of truthful female faces that were previously validated in adult participants. Event-related potentials (ERPs) were recorded in young adults (N = 20) and 6-months-old infants (N = 21) while they observed a Low Trustworthy (LT), a Neutral (N), and a High Trustworthy (HT) face taken from the set. Infants were also presented with different pairwise combinations of the three faces to test their behavioral visual preference, and had their temperamental traits measured through the IBQ-R VSF (Putnam et al., 2014). In line with the literature (Dzhelyova et al., 2012), adult data revealed a significant linear trend in the amplitude of the N170 and the Late Positive Potential (LPP) in the direction of larger responses to the LT faces ($p < .02$). In infants, the P400 and the attentional Nc peaked faster in the left hemisphere in response to HT compared to N ($p < .05$), and this HT latency advantage at the Nc was larger in infants who scored higher on the Negative Affect scale of the IBQ-R ($r = -.54$). No significant effects emerged from the analysis of infants' looking times ($p > .55$). These findings provide further evidence of early neural attunement to the facial information that drives adults' perception of trustworthiness, and show that individual differences in temperamental traits have a role in modulating the neural processing of this information. However, our results conflict with those emerged from previous studies using computer-generated faces as stimuli, suggesting that artificial and realistic faces might be processed differently by the infant brain.

P1-H-133: Ten-month-old infants share arousal more readily with language in-group than out-group members

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Sharing arousal with others is an important early aspect of empathy. Infants have shown arousal sharing from early in life as evidenced by dilation of their pupils when viewing others with dilated pupils (Fawcett, et al. 2017). In adults, this pupillary contagion effect is modulated by racial group membership (Kret, Fischer & De Dreu, 2015) and one study with infants demonstrated different brain responses to others' pupil dilation based on racial group (Kelsey, et al. 2019), however no study has yet shown differences in infants' pupillary contagion across different social groups. Here we manipulated language in- and out-groups to examine this question. Method 48 10-month-olds' gaze was tracked while they viewed a series of videos. In each video, they saw a woman's eye region while audio of a woman saying a child-friendly sentence in either their native language (Swedish) or an unfamiliar language (Italian). After she spoke, the woman's pupils either dilated or constricted and remained the new size for 3s (see Figure 1). The videos were presented in four language blocks (2 Swedish and 2 Italian), each with 8 alternating dilation and constriction trials. Across infants, voices and images were counterbalanced for which were presented as Italian- vs. Swedish-speakers. We calculated infant's own pupil dilation (minus a baseline of 500ms before the size change began) and their



gaze duration while the woman spoke and while her pupils were dilated or constricted (contagion phase). Pre-registered analyses were carried out using mixed-effects regression with infant pupil dilation or looking time as outcome and pupil size (dilated vs. constricted), language (Swedish vs. Italian), study half (blocks 1-2 vs. blocks 3-4) and their interactions as predictors. P-values for post hoc tests are Holm-corrected. Results For pupil dilation in the contagion phase, there was a three-way interaction between size, language, and half ($t = -3.587, p < .001$). In the first half, only when viewing Swedish speakers was pupil dilation greater for individuals with dilated vs. constricted pupils (Swedish: $t = -2.997, p = .017$; Italian: $t = -0.196, p = 1.00$). In the second half, the effect reversed with greater dilation for individuals with dilated vs. constricted pupils only for Italian speakers (Swedish: $t = 1.314, p = .594$; Italian: $t = -2.785, p = 0.037$). Looking time in the contagion phase showed a similar pattern of results with a three-way interaction in the initial analysis ($t = -2.367, p = .018$). In the first half, only when viewing Swedish speakers was looking time greater for individuals with dilated vs. constricted pupils (Swedish: $t = -2.786, p = .033$; Italian: $t = 1.271, p = 0.585$). In the second half, there were no significant effects. In the speaking phase, the only significant effect was a decrease in looking time from the first to second half of the study ($t = -4.951, p < .001$).

Discussion This study demonstrates that by 10 months, sharing of arousal, as indicated by pupillary contagion, is modulated by language in- and out-groups. In the first two blocks of the study, infants preferentially showed pupillary contagion for individuals who spoke their language, however in the second half, they began to do so for language out-group members, indicating a possible increasing familiarity effect over the study.

P1-H-134: Effects of maternal depression on sensitivity to distress and non-distress

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Maternal sensitive responsiveness towards infants is important because an infant's early experiences with their caregivers are essential for healthy development (Bowlby, 1988; Brazelton & Greenspan, 2000). Specifically, infants who experience empathic, well-timed, and sensitive caregiving, particularly in response to their distress, are more likely to develop secure attachments, better skills in emotion regulation, as well as social and behavioral competence (Leerkes, Blankson, & O'Brien, 2009). Prior research has demonstrated that elevated maternal depressive symptoms undermine the quality of parenting during infancy primarily during non-stressful activities, particularly among mothers with low socio-economic status (SES; Lovejoy, Gracyzk, O'Hare, & Newman, 2000). Less is known about predictors of sensitive maternal behaviors in contexts that elicit infant distress. Furthermore, many studies focus exclusively on White participants or confound race and SES (Earnshaw et al., 2013). We extend the prior literature by (a) examining the extent to which prior and concurrent depressive symptoms predict maternal sensitivity in distress and non-distress contexts, (b) testing SES as a moderator of those associations, and (c) determining if pathways are similar or different for Black versus White mothers. The sample included 259 primiparous mothers (128 White, 131 Black) and their infants (52% female; 48% male). Mothers completed a demographic questionnaire prenatally, which assessed mother's age, race, education level, family income, and family composition. When infants were 6, 12, and 24 months, maternal sensitivity was rated during non-distress tasks (free play; caregiving) and distress eliciting tasks (fear;



frustration). Scores were averaged across the three waves and appropriate tasks to reflect two scores: average sensitivity to distress and average sensitivity to non-distress. Maternal depressive symptoms were assessed prenatally, and at 6, 12, and 24 months using the CES-D (Radloff, 1977). The prenatal measure was used to index prior depressive symptoms and the average of 6, 12, and 24 months was used to index concurrent depressive symptoms. Initially, multi-group analyses were run for all regressions and revealed no differences between pathways for White and Black mothers, thus race was included as a covariate in the final four regression models (see Table 1). Results were similar across the 4 models, except that depression was associated with lower sensitivity as a main effect in all cases but the model including prenatal depression and sensitivity to distress. Black mothers and mothers with higher SES risk were rated as less sensitive. All two-way depression by SES risk interactions were significant and were probed. Patterns were similar across all four models, thus only one plot is presented in Figure 1. For mothers higher in SES risk, depression was associated with lower sensitivity; this was not the case for mothers with low SES risk. In sum, mothers with elevated depressive symptoms are at greater risk of less sensitive caregiving of their infants in the context of elevated SES risk. This did not vary based on context or maternal race. Thus, interventions need to focus on alleviating the stressors of low SES when addressing depression and caregiving to promote sensitive interactions between infants and their caregivers.

P1-H-135: Parenting practices and attitudes in early life in British and Ugandan mother-infant dyads

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Early social experience is largely controlled by parents, and this can affect the development of social skills (e.g. joint attention, Gaffan et al. 2009). Two typical models of socialisation parenting have been suggested; the relational model stresses body contact and physical stimulation and is common in rural agricultural communities; the autonomous model stresses object stimulation, mutual gaze, and independence, and is common in Western Educated Industrialised Rich and Democratic (WEIRD) societies (Keller 2007). However, parenting style can vary in many ways and these categorisations of parenting style are not appropriate for all cultural groups (Kagitcibasi 2003; Keller et al. 2003). It is thus important to test assumptions to understand or confirm how cultures may differ in parenting style when working with new study groups. This study will describe parents' attitudes, and parenting practices in two cultural groups: 37 mother-infant dyads living in rural Uganda, where subsistence farming is common; and 52 mother-infant dyads living in, or close to a (WEIRD) British city. We predicted that Ugandans would show more relational parenting, and the British group would show more autonomous parenting. We also predicted that mothers' attitudes would be reflected in their actual parenting behaviour. We measured mothers parenting attitudes with a parenting and socialisation goals questionnaire when their infants were between 3 and 6months old. We measured parenting behaviour through developmental and background questionnaires at 3, 6, 9, and 12months. At 6, 9, and 12months we also followed mother-infant dyads for 8hours, taking point samples of mother and infant behaviour, and mother-infant distance at 30minute

intervals. Preliminary results found that as predicted, significantly more Ugandan mothers agree with six (of ten) relational parenting and socialisation statements than British mothers (with no significant difference on the remaining items). A less clear pattern emerged from the eight autonomous parenting statements: significantly more British mothers than Ugandan mothers agreed with three statements; significantly more Ugandan mothers agreed with two statements; and there was no difference in the proportion of mothers across cultures who agreed with the remaining three autonomous parenting style items. We found that British mothers' attitudes regarding sleep location and sleep training were not significantly related to their infants' sleep location or whether their infant slept through the night in the first 12 months of life respectively. British mothers who agree that infants should spend more time in close proximity to mothers did not show significantly more time near to their infants at 6 months compared to mothers who disagreed with this statement. We found that the Ugandan mothering attitudes were more relational than British mothering attitudes, but that the British mothers were not clearly more autonomous. This data confirms that investigation into specific parenting must be done before the assumption that parenting in rural agricultural groups will be more relational and less autonomous than WEIRD cultural groups. Our results also indicate that opinions of parenting practices do not necessarily predict parenting behaviour, and stresses the importance of inquiring about or observing actual behaviours to make an accurate assessment of early infant environment.

P1-H-136: The microstructure of gaze following in 10-month-old deaf infants of hearing parents

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Although gaze following behavior (GF) has often been explored in typically developing and infants at-risk of autism spectrum disorder, less is known about GF development in infants born deaf. Crucially, even when implanted at an early age, some infants are still delayed in reaching speech and language milestones and hence understanding a language precursor such as GF pre-implantation can be highly informative regarding later language and communicative outcomes. The present research explored deaf pre-implanted infants from hearing parents (DoH) and a normal hearing (NH) age- and gender-matched control group, with the aim of identifying differences in the microstructure of their behavior. A sample of thirty-nine 10-month-old participants (18 deaf and 19 NH) were tested using Senju and Csibra's (2008) task, consisting of six video-clips of a woman that, after a first direct gaze, shifted towards one of two toys placed in her left and right side on a table. Infants' eye gaze was recorded using a stand-alone eye tracker (Tobii X120). The following measures concerning infants' first look (FL) and the whole trial (WT) were obtained: 1) GF Score (n° of congruent and incongruent FL trials), 2) Frequency of congruent and incongruent looks during WT (n° of shifts), 3) Latency of congruent FL, 4) Fixations duration for FL and WT. Firstly, it is highly relevant that only 60% of deaf infants - compared to 80% controls - performed the minimum of 2 face-to-object saccades (out of 6 trials) and hence were included in the analysis. Then, the results from the included infants (15 NH and 11 DoH) revealed that only NH infants but not deaf infants were more likely to first look to the congruent object (see Figure 1) [$t(18) = 2.62$, $p = .018$, $d = 0.60$; $t(17) = 1.25$, $p = .227$; respectively] and to shift more between Face-congruent than Face-incongruent [$t(14) = 2.44$, $p = .029$, $d = 0.63$; $t(10) = 1.09$, $p = .302$].



Moreover, when infants did look to the congruent object, a trend to a slower orientation was identified (see Figure 2) [NH=1.7s, DoH=2.5s: $t(15.45) = 1.82, p = 0.08$]. Overall, these results suggest a slower, less consistent GF behavior in deaf infants of hearing parents, as compared to their control peers. Additionally, their behavior heavily contrasts with Brooks, Singleton & Meltzoff (2019), reporting increased GF in deaf infants of deaf parents. The current results suggest that deaf infants' (DoH) communicative experience affects the dynamics of GF.

P1-H-137: Social and motor milestones and their relation to collaboration and helping

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Introduction/Current Literature Researchers have recently started to examine prosocial behavior (PSB; voluntary behavior that assists others) in the first year of life (e.g., Dahl, 2015; Davidov et al., 2013; Hammond et al., 2017; Xu et al., 2016). The shift to examining PSB earlier in infancy signals the importance of carefully examining the relation of social and motor development (what in the past might have been called sensorimotor intelligence) to PSB (see Köstner & Kärtner, 2019). To some extent, research on PSB in the second year of life (e.g., 14-24 months of age) has been able to overlook these issues as toddlers are generally able to locomote in a way that roughly and functionally resembles the movement of adults (e.g., walk over to a dropped item and return it to someone) and as such their PSB looks superficially similar (Carpendale et al., 2013; Hay & Cook, 2007). If we assume that two-year-old infants already know how to pick up and hand over objects is unproblematic, we can focus more cleanly on issues such as motivation for prosocial acts (e.g., Dahl et al., 2017; Warneken & Tomasello, 2006). In contrast, earlier PSB-like behavior (e.g., handing over a dropped or requested object from a sitting position or comforting someone who is holding the infant) seem to emerge at 6-10 months of age, alongside the very body movements and social interaction involved in these behaviors.

Purpose The purpose of this current study is to examine the emergence of behaviours such as empathy (e.g., offering comfort) and instrumental helping (e.g., picking up and returning a dropped object) in relation to social and motor milestones in infants from 5 to 10 months of age.

Methodology Analyses will be conducted with longitudinal data from 35 Canadian caregiver-infant dyads (data collection ongoing, final N may be higher). Participants engage virtually (e.g., via Skype, Facetime) in monthly, 10-15 minute sessions that include three interactive dyadic tasks (both structured and semi-structured) including tasks that assess instrumental helping and empathy (adapted from Davidov et al., 2013 and Xu et al., 2016) and complete either the Ages and Stages Questionnaire (ASQ; Briggs et al., 2012) or the Early Motor Questionnaire (EMQ, Libertus & Violi, 2016). Caregivers are also asked to report on their infants' PSB in the home by completing the Everyday Helping Questionnaire (adapted from [blinded for review]),

Expected Results In addition to data on the emergence of PSB over the 5- to 10- month period, correlational analyses will examine longitudinal relations between individual differences in social and motor milestones (from questionnaire data) will be related to the PSB in the behavioral tasks and to parent-reported helping in the home.

Conclusion The anticipated findings are one way to answer Köstner and Kärtner's (2019) recent call to explore the role of social and motor development in relation to PSB.



Results will be discussed in terms of contemporary research issues (as above) and framed in terms of historical work on infants? sensorimotor development.

P1-H-138: Two-year-olds demonstrate false-belief understanding in a novel intent-based social-preference task

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Our research built on prior social-preference findings to create a novel measure of early false-belief understanding. According to these prior findings, infants and toddlers (a) distinguish between positive and negative actions, (b) prefer agents who act positively over agents who act negatively, and (c) show this social preference even when agents' positive actions fail to achieve their intended outcomes. In our task, 2-year-old toddlers first saw events involving a protagonist and two characters: a helper and a hinderer. The helper had a false belief about which of two containers held an object and inadvertently gave the protagonist the empty container. In contrast, the hinderer had a true belief about which container held the object and knowingly gave the protagonist the empty container. Next, toddlers' preference for either character was assessed using a preferential-looking measure. We reasoned that finding a preference for the helper over the hinderer -- even though each character had given the protagonist the same empty container -- would provide new evidence of false-belief understanding in toddlers. Children were assigned to an experimental or a control condition and watched videotaped events on an eye-tracker. In the experimental condition (Fig. 1), children first received two familiarization trials designed to establish the protagonist's goal of coloring: In each trial, while the helper and the hinderer watched, the protagonist arrived, picked up a crayon, and colored on paper. Next, children received a help and a hinder test trial (counterbalanced). In the help trial, the helper was initially the only puppet present and saw an experimenter's gloved hands hide the protagonist's crayon in one of two containers. Next, a bell rang, and the helper went away. In its absence, the hands transferred the crayon to the other container. At that point, the helper returned, and then the protagonist arrived and asked for the crayon. The helper then slid the empty container to the protagonist and paused until the trial ended. The hinder trial was identical except that the helper was replaced by the hinderer, who watched the second (as opposed to the first) hiding of the crayon and therefore knew where it was. Finally, in the choice trial, static images of the helper and hinderer were displayed side-by-side. The control condition (Fig. 2) was identical except that the two test events were truncated and ended just before the protagonist asked for the crayon. The helper and the hinderer thus held the same beliefs as in the experimental condition, but neither gave the protagonist a container. Toddlers in the experimental condition looked significantly longer at the helper than at the hinderer in the choice trial, whereas toddlers in the control condition looked equally at the two characters. These results indicate that toddlers (a) represented the helper's false belief and the hinderer's true belief about the crayon's location, (b) used these beliefs to ascertain each character's goal, and (c) evaluated the helper more favorably, based on its intent to help the protagonist. Our results thus provide evidence of early false-belief understanding using a novel social-preference task.



P1-H-139: Socioemotional/behavioral and caregiving outcomes of infants born with Neonatal Abstinence Syndrome

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The opioid epidemic has garnered significant attention as a global health crisis, with opioid dependence accounting for 9.2 million disability-adjusted life years across the world (Degenhardt et al., 2014). Relative to opioid dependence, less attention has been paid to the estimated 1 in 5 pregnancies occurring in the context of opioid exposure (Patrick et al., 2015). Neonatal Abstinence Syndrome (NAS), or the occurrence of withdrawal symptoms severe enough to require pharmacologic intervention, occurs for 75-90% of infants exposed to opioids in utero. Research on these infants' outcomes has focused on intellectual disabilities, neurological problems, and physical/sensory deficits (Yeoh et al., 2019). Few studies address socioemotional development and behavioral outcomes. Fewer, still, are studies addressing the correlates of NAS in infants' caregivers. The current study examined socioemotional/behavioral and caregiving outcomes of infants and their caregivers in a follow-up to NAS treatment at a major children's hospital in the United States. Infants diagnosed with NAS (N = 143) and their caregivers attended the NAS clinic (standard involvement in the clinic is 2 years) between 2012 and 2017, where they received ongoing evaluation, continued pharmacologic treatment, and referrals. All procedures for the current study received IRB approval. Caregivers were invited to participate in a follow-up survey (age range of children: 2 to 7 years) in 2019. Caregivers (37.1% biological parents, 39.9% adoptive/foster parents, 21.7% grandparents/relatives) completed an online survey assessing demographics, temperament (negative affect, surgency, and effortful control domains from the Early Childhood Behavior Questionnaire - Very Short Form [Putman et al., 2006] or the Child Behavior Questionnaire - Very Short Form [Putnam & Rothbart, 2006], depending on age), socioemotional and behavioral functioning via the age-appropriate Strengths and Difficulties Questionnaire (SDQ; Goodman, 1987), and parenting sense of competence (Parenting Sense of Competence Scale [Johnston & Mash, 1989]). Analyses were completed separately for children falling into younger (age 2 to 3; n = 51) and older (age 4 to 7; n = 92) groups. Mean scores on the SDQ Total Difficulties scale suggested children, in general, were functioning in the "Close to Average" or "Slightly Raised" risk categories. However, children were unevenly distributed across bands of functioning for both the younger ($\chi^2[3] = 45.04, p < .001$) and older ($\chi^2[3] = 26.18, p < .001$) groups. Heavier representation occurred at the two extremes (Close to Average Difficulties, Very High Difficulties) than the two moderate (Slightly Raised, High Difficulties) bands (Table 1). In both age groups, caregivers of children in the Very High Difficulties group perceived greater negative affect and lower effortful control than caregivers of children in the Close to Average Difficulties group, with large effect sizes (Table 1). Caregivers of children in the Very High Difficulties group reported lower sense of parenting competence than caregivers of children in the Close to Average Difficulties group, with medium effect sizes (Table 1). Results suggest heterogeneity in outcomes of infants born with NAS and that screening should identify high-risk infants and their caregivers for extra support.

P1-H-140: Mobile digital media exposure among infants and toddlers: Parental and infants' factors



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Objective: The emerging technologies are now embedded in the daily lives of young children who are born into digital ecosystem that is enhanced by mobile media. Despite clear recommendations from the American Academy of Pediatrics (AAP) discouraging use of media in children younger than 2 years of age, media use by infants and toddlers remain very common. Most studies focus on the effects of smartphone or tablets on development mainly among elementary school children and adolescents. However, research on the possible factors increasing the degree of exposure among infants and toddlers is still very sparse. Therefore, in the present study we are interested in investigating infant factors, parental factors and their combined effect on the degree of media exposure in early childhood (0 to 3 years), when parents play the major role in determining children's media use habits. Based on the Ecological theory empathizing the importance of the parent-child relationship context, we investigated how perceived infant factors interact with parental attitudes regarding infant digital media exposure influence the amount of infant media exposure. **Method:** 650 parents (325 Mothers, 325 fathers) of children under the age of 36 months were recruited to take part in an online study on "Infant digital media exposure". Parental demographic variables (years of education, income level and number of children in the household), parental attitudes regarding infant digital media exposure, infant characteristics (age, gender and sleep problems) and the degree of media exposure were measured using validated questionnaires. **Results:** Results revealed that the parental demographics factors predicting infants screen exposure were parental level of education and gender. However, number of children in the household and income level were not significant. Infants' age and sleeping problems were also significant predictors of the degree of media exposure. Moreover, a significant interaction effect was found between parental attitudes regarding infant digital media exposure, infant sleep problems and infant's age on infant digital media exposure. **Conclusion:** These results may shed further light on possible risk factors within the context of parent-child relationship increasing infant digital media exposure. Moreover, this understanding may have clinical and interventional consequences.

P1-H-141: Maternal sleep-related cognition and young children's sleep: A comparison between two different Arab societies in Israel

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objective: Cultural and parental factors (e.g., parental sleep-related behaviors and cognitions) have an important role in the development of children's sleep. However, to the best of our knowledge, no study has yet investigated parental factors in relation to children's sleep among Arab families in Israel. Overall, there are two Arab ethnocultural groups living in Israel, namely Christian and Muslim. Although sharing the same general Arab background and language, the two groups differ from each other culturally, residentially, and in their social and economic characteristics. While Muslims families live in a very traditional and conservative society, Christians are more urban and have a lower fertility rate, higher educational attainment, and higher occupational status than that of the Muslims. Thus, this study provides an opportunity to examine similarities and differences between these two groups regarding parenting, and



specifically, maternal sleep-related cognitions and children's sleep in an Arab sample of young children and their mothers, and to assess the relationship between maternal sleep-related cognitions and sleep in these young children. Method: Mothers of 120 young children aged 3 to 36 months from two different Arab Societies in Israel participated in this study (54 Christian, 66 Muslim). Mothers completed the Brief Infant Sleep Questionnaire (BISQ), and the Infant Sleep Vignettes Interpretation Scale (ISVIS) aimed at assessing parental sleep-related cognitions. Results: Analysis revealed significant group differences with regard to the infant sleep-quality measures and maternal sleep-related cognitions. Overall, infants of Muslim mothers slept longer hours during the night and woke up less frequently compared to infants of Christian mothers. In comparison to Muslim mothers, Christian mothers were more likely to attribute infant's sleep difficulties to infant's distress while Muslim mothers tended to attribute infant's sleep difficulties to limits and boundary setting. The expected association between maternal cognitions regarding infant sleep and infant's sleep quality measures was found only among Christian mothers. In the Christian mothers group, cognitions that attribute sleep difficulties to infant's distress were associated with poorer infant's sleep-quality measures compared to cognitions attributing sleep difficulties to setting limits. Conclusion: The findings of this study support the literature on the importance of cross-cultural factors in the development of sleep in early childhood and demonstrate for the first time cross-cultural differences in sleep and maternal sleep-related cognitions in Israeli Arabs. Our results confirmed that, like in other societies, maternal sleep-related cognitions are related to poorer sleep in young children.

P1-H-142: Willing and able: Toddlers utilize others' benevolence and competence to inform their help-seeking behaviour

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Human toddlers often require assistance from adults in their everyday life. In order to receive adequate help, children must be able to correctly identify those who are 1) willing to help, and 2) capable of helping. Research has shown that children are sensitive to the helpfulness of agents (Hamlin et al., 2007; Hamlin & Wynn, 2011) as well as their perceived competence (Zmyj, Buttelmann, Carpenter, & Daum, 2010); it is less clear whether they use this information to guide their help-seeking behaviour. The current studies seek to answer these questions. In Study 1, we examined whether toddlers would selectively seek help from a puppet who previously demonstrated willingness to help by acting prosocially toward a third party. First, 34 twenty-two-month-olds were familiarized with three novel electronic toys which made different animal sounds when activated. Next, toddlers watched puppet shows featuring a cow puppet who played with and accidentally dropped a ball. Two frog puppets alternatively helped and hindered the cow by giving back and taking away its ball, respectively (as in Hamlin & Wynn, 2011). After the puppet shows, toddlers were presented with a new toy similar to those previously introduced, except this one was broken. The experimenter then presented the toddlers with the two frogs puppets and asked, "which frog could help fix the broken toy?" while gesturing towards the puppets. Toddlers were asked similar questions across 3 phases, during which the puppets were moved progressively closer. Toddlers' responses during each phase were assigned a score from 0 to 2 to reflect different types of behaviour (e.g. hold out



toys to puppets received a higher score than looking/pointing at puppets). The scores were then transformed such that a positive score reflects behaviour directed towards the helpful puppet (benevolent), and vice versa. Overall, significantly more toddlers preferred seeking help from the benevolent puppet (25 of 34, binomial test, two tailed $p=.01$), and toddlers on average directed more behaviours towards the helpful puppet (Mscore = 1.29, one sample $t(33)=3.57$, $p=.001$). To rule out the possibility that toddlers simply preferred the puppet associated with the positive outcome rather than evaluating the puppet's 'helpfulness', we conducted Study 2 ($n=32$), which was otherwise identical to Study 1 except the frogs in the puppet shows were now recipients of nice/mean actions rather than the conductors. Toddlers no longer preferred to seek help from one of the puppets over the other in this scenario (16 of 32 preferred the beneficiary puppet). In Study 3 (preregistered $n=32$, data collection in progress), we explored whether toddlers' help-seeking behaviours incorporate information about puppets' ability to help. The study is identical to Study 1, except the puppet shows now feature the frog puppets either successfully (competent) or unsuccessfully (incompetent) opening a box. Currently, preliminary results suggest that toddlers are more likely to seek help from the competent frog (17 of 22, binomial test, $p=.02$). Altogether, our studies suggest that toddlers take into consideration perceived benevolence as well as competence when seeking help from other agents.

P1-H-143: Early biobehavioral social features of infants with Down syndrome and fragile X syndrome

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Characterizing physiological and behavioral features during infancy in children with genetic syndromes is important to understanding the development of negative outcomes such as anxiety and depression. Two genetic syndromes with known behavioral and physiological differences in later development are fragile X syndrome (FXS) and Down Syndrome (DS). Both DS and FXS present with intellectual disability and an increased presence of maladaptive behaviors later in life (Cornish et al., 2013; Will et al., 2018). However, there are many phenotypic differences between the groups, and little research has examined such differences in infancy. Infants with FXS show increased behavioral inhibition (i.e. withdraw, shyness; Roberts, Tonnsen, Robinson, 2014), atypical autonomic function (Tonnsen et al., 2013), and an increase in social fear (Scherr, et al., 2017). Infants with DS display a more difficult temperament across toddlerhood and an increased propensity for social interaction (Fidler et al., 2006; Fidler, 2005); however, no studies have characterized physiology. The current study uses a biobehavioral approach to characterize early physiological and social behavioral inhibition profiles of infants with DS and FXS in comparison to TD infants. Participants included 16 infants with FXS (M CA:13.12 months), 14 infants with DS, (Months:12.20), and 30 TD infants (Months:12.46). Parent-reported social behavioral inhibition was measured using a composite from the Infant Behavior Questionnaire-Revised (IBQ-R; Garstein & Rothbart, 2003). Respiratory sinus arrhythmia (RSA), which is the beat to beat variation in heart rate associated with respiration (Porges, 2007) was measured during a resting state and during response to a novel social situation. A repeated measures linear mixed effects model was estimated to test differences within and across physiological response to the stranger paradigm. Results indicated no main effect of group ($F(2,49) = .08$, $p=.921$) or condition ($F(2,49)=0.02$, $p=.886$).



The condition-by-group interaction was significant ($F(2,49)=6.49, p=.003$). Phase comparison across conditions demonstrated a significant change in RSA across condition for infants with DS and TD infants (see figure 1), whereas infants with FXS remained stable. No group differences in social behavioral inhibition emerged via parent-report, ($F(2,38)=.24, p=.578$). This study demonstrated distinct physiological patterns across the groups, but no differences in parent reported social behavioral inhibition. Infants with FXS showed a blunted modulation in response to the novel social situation, which indicates elevated risk for social anxiety according to extant evidence on typically developing children (Booker et al., 2013). Infants with DS demonstrated a significantly greater RSA in response to the stranger. Increased RSA in response to anxiety provoking novel situation may suggest physiological evidence for the increased social propensity often associated with DS. TD infants displayed a somewhat expected response of a decrease in RSA in response to the stranger paradigm, indicating physiological preparation for response to a perceived threat. Inconsistent patterns between physiology and behavior may be due to parent-report, and future studies should examine behavioral responses during the stranger task. This is the first study to identify unique physiological profiles across multiple genetic syndromes which could be an early indicator of later phenotypic differences.

P1-H-144: Experiences of surrogates, intended parents, and new parents by surrogacy

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The advancements in the biological and medical fields mean that Assisted Reproduction has become an opportunity for a larger population of intended parents. Surrogacy is one method of ART that allows parents to have children that are genetically theirs partly (traditional surrogacy) or fully (Gestational surrogacy) via a surrogate. The law and surrogacy varies dependent on county and even state and is changing dramatically (Patterson, Riskind & Tornello; 2014). There are many aspects to these legislations that have caused debate. For example as it currently stands the surrogate mother is put on the child's birth certificate in the first instance, despite having no biological connection (Oultram, 2015). This makes for an area of development where policies have massive impact on parents, surrogates, the surrogates partner and ultimately the children. The current study focused on the experiences of surrogates, intended parents by surrogacy, and parents by surrogacy. The participants consisted of $n=28$ Intended parents (IP), $n= 69$ Surrogates and their partners and $n=86$ parents by surrogacy (PBS) recruited from Surrogacy UK. Results: Demographics For the IP and PBS groups, all were in a relationship or married apart from one who classed themselves as separated in the IP group. For the surrogates, fewer participants stated they were in a relationship and showed more varied results (married $n=27$, in a relationship not cohabiting $n=3$, in a relationship cohabiting $n=5$, single $n=17$, separated $n=4$ and divorced $n=2$). The results showed that IP's PBS and Surrogates had similar rates of employment (IP's $n=22$, PBS $n=57$, SASP's $n=30$) and also similar levels of education. Surrogates and their partners had slightly lower income but not drastically different from the other groups. $n=6$ Surrogates earned below £12,000, $n=32$ earned £12,000 to £40,000 and $n=17$ earned over £40,000. No PBS earned below £12,000, $n=9$ earned between £12,000 and £40,000, whilst $n=58$ earned over 40,000. $N=1$ IP earned below £12,000, $n=3$ earned between £12,000 to £40,000 and $n=21$



earned over 40,000. Concerns with Current Surrogacy Policy/Legislation/Information/Resources When asked "Do policies and/ or legalisations around surrogacy need changing all participant group affirmed that the current surrogacy policy causes stress, concern and is not fitting with present surrogacy arrangements. Free text responses also suggested that they would like changes to make the process shorter, easier to understand, less stressful, more universal and essentially changes made to give the Intended parents more rights earlier on. Behind issues with current surrogacy policy is the lack of information that is available for IP, PBS, and Surrogates on how to talk to their children about surrogacy. All PBS and IP stated they were going to disclose the child's surrogacy origins if they had not already. In conclusion from this study the demographics between Surrogates and their partners, Parents by surrogates and intended parents do not differ significantly on measures of education, employment or finance. For policies and legalities there is much evidence to support that all three groups feel that there needs to be change especially when it comes to parental orders.

P1-H-145: Parent-infant interaction during the still face and later attachment security

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The Face-to-Face/Still-Face (FFSF; Tronick et al., 1978) is a widely-used assessment of infant responses to an age-appropriate stressor that shows associations with later attachment security. In the still-face (SF) episode of the FFSF, the parent is asked to become unresponsive. It is expected that parent-infant interaction ceases during the SF based on the examiner's instructions to the parent. However, Tronick et al. (2005) reported frank parental violations of the SF instructions (e.g., smiling at the infant) during 5.8% of the SF. There has been little empirical investigation of this premise, and no research examining associations between possible dyadic interaction during the SF and later outcomes. The present study asked whether parent-infant interaction is detectable during the SF and whether levels of SF interaction are associated with later infant attachment security. Parent-infant dyads (n=73) completed the FFSF at 6 months. Parents sat facing their infant and were instructed to play with their infant for 3 minutes (FF), stop playing and maintain a neutral expression for 2 minutes (SF), and then resume play for another 3 minutes (RE). Infant and parent were video-recorded with synchronized cameras. Continuous second-by-second ratings of infant and parent affective valence, ranging from -100 (most negative) to +100 (most positive), were separately coded from video by 4 independent, trained coders using CARMA software (Girard, 2014). Interrater reliabilities using intraclass correlation estimates of the average measure were 0.94 for infant and 0.84 for parent. Mean affect ratings were used in analyses. Dyads returned at 15 months to complete the Strange Situation Procedure (Ainsworth et al., 1978). Analyses included 69 infants who were reliably classified by expert raters as secure (n=45), resistant (n=9), avoidant (n=4) and disorganized (n=11). During the SF, zero-order Pearson correlations (r) between infant and parent second-by-second mean affect ratings (M=.17, SD=.24) indexed parent-infant interaction (Fig.1). Fisher R-to-Z transformations of the correlation coefficients were used in all analyses. A one-sample t-test revealed that the Z-transformed coefficients



were significantly higher than 0 ($M=.19$, $SD=.31$, $t(72)=5.35$, $p<.01$; Fig.2a), which indicated the presence of dyadic interaction. Levene's test indicated variances around medians were not significantly different across the 4 attachment groups, $F(3,65)=2.03$, $p>.05$. Univariate ANOVA yielded significant mean differences in the Z-transformed coefficients between secure ($M=.13$, $SD=.21$), resistant ($M=.13$, $SD=.27$), avoidant ($M=.21$, $SD=.10$), and disorganized ($M=.35$, $SD=.30$) classifications, $F(3,65)=3.02$, $p<.05$, $\eta^2=.12$ (Fig.2b). A post-hoc Hochberg's GT2 test showed that future secure infants' mean level of parent-infant SF interaction was significantly lower than that of the future disorganized infants ($p<.05$). Significant correlation coefficients between parent and infant affective valence during the SF suggest termination of dyadic interaction in the SF cannot be assumed. Extending similar findings from face-to-face interaction (Beebe et al., 2010; Wille et al., 1991) that more coordinated interaction is associated with non-optimal attachment outcomes, levels of dyadic interaction were higher for future disorganized infants than other infants. The findings indicate that parent-infant SF interaction may be associated with individual differences in developmental outcomes.

P1-H-146: Pink is a girl's colour and blue is a boy's? Early childhood norms in the UK

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Social norms and, in particular, children's knowledge and enforcement of them are a frequently examined field in developmental psychology. Children as young as two to three years old already conform to social norms and begin to enforce them actively if violated by third parties (see for example Gampe & Daum, 2018; Hardecker & Tomasello, 2017; Rakoczy, Warneken, & Tomasello, 2008; Vaish, Missana, & Tomasello, 2011). In most child studies of social norms across the world, researchers either use abstract conventional norms, such as play norms relating to novel objects they invented themselves, or norms that were taken from the researchers' own experience and knowledge. However, these norms were never assessed with the populations concerned, and little is known precisely about what social norms are the most relevant in a particular society. In this study, 21 native British parents ($M = 39.76$ years old) answered an open-ended questionnaire about the most fundamental and highly valued norms in the United Kingdom. Parents were asked to name social norms from different areas of life, such as norms related to gender, public behaviour, as well as those aimed primarily at children. Furthermore, they were asked to evaluate the importance of these norms in society, crucial contextual factors related to the norms, at what age children are aware of and follow them, and how children would be punished for a norm violation. All social norms mentioned were categorised and if stated more than once taken into analysis. Overall, we found 29 social norms belonging to different social categories which are relevant in the United Kingdom and which children between 0 and 42 months of age are presumed to know and follow (see Table 1). The results show that at an early age, children are already expected to be aware of the correct behaviour in a variety of social situations and to behave themselves accordingly. In the currently running follow-up study, we will verify the social norms mentioned in this qualitative questionnaire with a larger sample of native British people. Moreover, we are conducting further qualitative surveys investigating social norms in additional countries to assess the cultural specificity or universality of the social norms mentioned.



P1-H-147: Challenging multi-stressed families in daycare: Family histories, functioning and parenting styles

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Challenging multi-assisted families with economical constrains have less resources, are exposed to several stress agents over time. They experience interdependent problems across life family life cycle. Are considered as being disengaged, disorganized, conflicted with inconsistent or neglecting parenting. With difficulty in setting rules and boundaries, authoritarian and permissive parenting styles may alternate in child rearing, and to an unstable insecure environment. Nonetheless, parenting concerns maybe common to other no troubled families. Boden and Dekovic, (2016) pinpoint seven factors that enhance family vulnerability and family risk 1) child and 2) parents' characteristics and problems 3) child-rearing 4) family functioning 5) and other contextual factors 6) social network 7) mental health care problems. This cross-sectional mixed methods study explores domains 1, 2,3,4 with a purpose sample of 32 low-income participants - families from a daycare social project with children aged under than 3 years old. Most of the children lived with both parents (n = 13), 9 with a single parent and the 12 in blended families. Semi-structure clinical interviews to access families' clinical background were conducted and Family Adaptability and Cohesion Evaluation Scales (FACES IV), Parental Authority Questionnaire - Parents version (PAQ) were applied. Lexical analysis of interviews revealed domains considered as high risk (Harsh life experiences and traumas, complex family structures, economic constrains, dependency of social support) as well as common daily life hassles and parenting concerns. Quantitative measures revealed opposite perspectives about family functioning and parenting. Participants are satisfied with their families and consider having a good enough communication, flexible and cohesive. Parents consider themselves as more authoritative with a good sense of parenting efficacy, though with authoritarian scores above expected average. Only authoritarian parenting is correlated to family cohesion. Quantitative measures do not validate qualitative results. With low income multi-stressed families, we recommend the use of the qualitative data collection analyzed in mixed methodology to mitigate social desirability and bias. Families are often evaluated in by social services for child custody legal decisions that often result in government child custody. Along with naturalistic observation, clinical in-depth interview is indispensable to collect data and evaluating family psycho-social risk and parent's capabilities with this type of population.

P1-H-148: HealthySteps in an urban pediatric clinic: Associations with maternal depression, child development and child health indicators

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Introduction: As the first point of contact, the pediatric practice plays a crucial role in supporting families of young children starting at the newborn visit (Kaplan-Sanoff & Briggs,



2015). Parents' access to support during those initial years of parenting is vital for ensuring their baby's healthy development, particularly since children's experiences with parents have an enormous influence on development as well as on brain architecture (Shonkoff & Phillips, 2000). Extensive research shows that sensitive parenting, healthy family psychological functioning, and socioeconomic stability provide the sturdiest foundation for infant/toddler development, paving the way for lifelong healthy development. In contrast, growing up in poverty is linked to disparities in children's school-readiness skills compared to their more advantaged peers (Duncan et al., 1998). Parenting quality (Conger et al., 1992) and mental health are also vulnerable in these families. Recent data indicate that in households below the federal poverty threshold, one-quarter of mothers of infants experienced moderate-to-severe levels of depression (Reeves & Krause, 2019). Untreated, maternal depression is an early risk factor for reduced maternal sensitivity and delayed infant development across all domains (McFadden & Tamis-LeMonda, 2013). Goals/Methods: Building on research pointing to the need to provide supports that promote positive parenting and buffer young children from the effects of maternal depression and poverty, we examine whether maternal depression was associated with child development outcomes in families participating in a HealthySteps program in an outpatient pediatric clinic. 40% of residents in the community live below the federal poverty level; 57% are children under five. 73% of families identified as Black/African American, 21.5% Latinx, 2.6% white, 1.5% other, and 1.4% Asian. Maternal depression was measured at Wave1 and Wave2 using the Edinburgh Postnatal Depression Scale (Cox, Holden and Sagovsky, 1987); the Patient Health Questionnaires (PHQ2/9) (Spitzer, Williams, Kroenke et al., 1999) were used at Wave3 and Wave4. Infant development was measured across 5 domains: Communication, Gross Motor, Fine Motor, Personal-Social, and Problem Solving using the Ages & Stages Questionnaire®, Third Edition (ASQ®-3; Squires & Bricker, D., 2009). Results: Infants (N = 75) were on average 2.8 months at W1, 6.5 months at W2, and 9.6 months at W3. W1 maternal postnatal depression average was 2.9 (SD=3.46) with 8% at clinical range, while W2 postnatal depression average was 3.5 (SD=4.2) with 6% at clinical range. At W3, on average, infants' developmental scores were within normal range across the 5 indicators on the ASQ-3 (mean=49.9 to 52.9). However, 10-15% of infants were delayed across the 5 developmental indicators. Preliminary analyses indicate that W1 maternal depression was negatively associated with infant gross motor development at W3 ($r=.33$, $p<.05$). As children increase in age, we will examine if developmental delays and maternal depression are mitigated. Further analyses will examine program dosage and include W4 data. Implications: To highlight how programs within pediatrics support the health and well-being of families and children, we will further examine how HealthySteps children compare to non-HealthySteps children in terms of their well-child visits and immunization rates and examine associations with developmental outcomes and maternal depression.

P1-H-149: Infant negativity and cumulative risk as predictors of the volatility in maternal postpartum depressive symptoms

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Significant research has been devoted to understanding how to promote the well-being of mothers during the postpartum period in order to mitigate negative consequences for mothers, infants, and families. Between 33 and 53% of low-income Hispanic mothers experience



significant depressive symptoms during the postpartum (Gress-Smith et al., 2011; Heilemann, et al., 2004; Martinez-Schallmoser et al., 2003). Caring for an infant with higher temperamental irritability, fear, anger, or sadness may escalate the depressive symptoms experienced by the mother (McGrath, Records, & Rice, 2008) and greater maternal depression has been implicated in numerous maladaptive child developmental trajectories (Goodman et al., 2011). Using cutting-edge methods, this study zooms the lens further in to evaluate the extent to which infant affect negativity and cumulative risk increase or decrease a mother's own fluctuations in depressive symptoms across the first six months postpartum. This study draws from a sample of low-income, Mexican-origin mother-child dyads using data from the Las Madres Nuevas project (N = 322). During the third trimester of pregnancy, mother's (mean age = 28, SD = 6.5, 86% born in Mexico) reported on six indices of family risk (e.g., prenatal depressive symptoms, interpersonal violence, economic stress) that were used to calculate a cumulative risk index to capture the presence or absence of each individual risk factor in a single score. Mother's self-reported on their depressive symptoms at 3, 6, 9, 12, 15, 18, 21, 24, and 27 weeks postpartum using the 10-item Edinburgh Perinatal Depression Scale (Cox, Holden, & Sagovsky, 1987). At 6 weeks, mothers completed the short form of the Infant Behavior Questionnaire-Revised (Putnam, Helbig, Gartstein, Rothbart, & Leerkes, 2014). Sadness, Distress to Limitations, Fear, and Fall Reactivity subscales were averaged to create a dimension score for infant temperamental negativity. Using a dynamic structural equation modeling framework, a multilevel location scale model (see Figure 1) was fit to evaluate infant temperament- and risk-based differences in mother's mean level depressive symptomatology and intra-individual volatility in depressive symptomatology. Results of the multilevel location scale model are reported in Table 1. An examination of credible intervals revealed a significant carryover effect, meaning that mothers sustained increases or decreases in depressive symptoms from one time point to the next. Mothers differed in the volatility of their depressive symptoms, such that some mothers showed greater highs and lows in their depressive symptoms. Mothers with more negative infants exhibited greater mean levels of depressive symptoms and greater volatility in their depressive symptoms. Mothers with greater risk also exhibited greater mean levels of depressive symptoms and greater volatility in their depressive symptoms. This study provides empirical support that maternal fluctuations in postpartum depressive symptoms are not uniform across all mothers and that infant characteristics and cumulative risk contribute to these fluctuations over time. Volatility in maternal depressive symptoms across time is greater in the face of cumulative risk and infant negativity. An important next step in this line of research is to determine the impact of this early volatility, rather than simply the average experience of depressive symptoms, on later child developmental competencies.

P1-H-150: Bursting into tears: Exploring the temporal structure of infants' cry and speech-like vocalizations

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Infants' early environments are replete with statistical regularities and temporally structured information that shapes everyday learning. One metric to assess temporal patterning over longer timescales is the burstiness coefficient, which quantifies the spacing of behavioral



events over time and provides an index of event regularity (Goh & Barabási, 2008). Abney and colleagues (2017) investigated the hierarchical clustering of cry and speech-like vocalization onsets during day-long recordings of infant-caregiver interactions in the home. Infant speech-like vocalizations were less bursty than cry vocalizations suggesting that within the first 2.5 years of life, higher burstiness is associated with less complex communicative behaviors (Abney, Warlaumont, Oller, Wallot, & Kello, 2017). Still unknown, however, is the extent to which burstiness of infants' vocalizations is context- or modality-dependent or a stable property of the child. Understanding whether burstiness is a stable property of the child would allow us to make future predictions about the temporal structure of children's subsequent vocalization behavior (Bornstein & Putnick, 2012). The present study aims to fill this gap by longitudinally assessing the temporal structure of infants' cry and speech-like vocalizations in an early intervention classroom and comparing these patterns to differences in children's language input. We conducted 19 school-day recordings over 19 months among 14 infants in an early intervention childcare classroom. Audio from individual infants was recorded using Language ENvironment Analysis (LENA) recorders worn by each child in a vest. We compiled infant's vocalizations using data leveraged from each LENA's estimates of cry and speech-like vocalizations. To quantify the temporal structure of infants' vocalizations, we calculated burstiness coefficients for both cry and speech-like vocalizations. Burstiness is a metric of event regularity, which quantifies the distribution of time intervals between onsets of vocalizations. A bursty distribution is characterized by clusters of vocalizations followed by long periods with few to no vocalizations. Both infants' cry ($B=.75$) and speech-like vocalizations ($B=.72$) were highly bursty, meaning cries and speech-like vocalizations often clustered together in time rather than spacing periodically over the day. Further, cry and speech-like vocalizations were highly correlated with each other, ($r = .779$ $p<.001$), and did not change over developmental time, (cry: $b = -.00009$, $SE = .0001$, $t = -.86$, $X^2(1) = .74$, $p = .39$; speech: $b = -.00003$, $SE = .0001$, $t = -.25$, $X^2(1) = .06$, $p = .80$). Next, we examined whether temporal structure of infants' vocalization was associated with adult vocalizations. We found infant's speech-like burstiness coefficient was positively correlated with the average rate of adult speech per minute, ($r = .639$, $p=.008$), but not cry burstiness. Results suggest that infants cluster both cries and speech-like vocalizations at high and associated rates. However, only temporal clustering of speech-like vocalizations is associated with exposure to adult speech. Adults may speak more to infants who exhibit more temporal control over speech-like vocalizations, or infants may cluster their speech-like vocalizations based on more adult vocal input. The results suggest how objective measurements of classroom vocal activity can reveal subtle patterns pertinent to infant's developing vocal interactions.

I-Emotional Development

P1-I-151: Prematurity, maternal emotional distress and acculturation: The case of Bedouin mothers living in southern Israel

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Introduction: Mothers of preterm infants are at high risk for postpartum emotional distress (PPED), which is further increased for women from ethnic minority groups, such as the



Bedouin population living in Israel. This is due to several stressors: low socioeconomic status, restricted access to health providers and facilities, language difficulties, and low levels of education. Extensive research indicates that maternal PPEd has a strong effect on infant development. In this study, we investigated correlates of PPEd among Bedouin Arab mothers. An important factor when studying ethnic minority adjustment is acculturation (maternal psychological adjustment). Acculturation refers to the adaptation of minorities as they confront challenges in the dominant society. It includes two dimensions: (1) traditionalism, which refers to the extent that the original cultural identity and characteristics are maintained and (2) Western attitudes, which refer to the extent of involvement in the dominant cultural group (Berry, 1997). Our aim was to understand how maternal acculturation style was related to maternal PPEd following a premature birth and whether maternal PPEd differed if the preterm baby was a first-born or later-born. Hypotheses: (1) Mothers of preterm infants will report higher levels of PPEd than mothers of full-term infants; (2) maternal acculturation style will moderate the relation between prematurity and PPEd; and (3) the link between prematurity and PPEd will differ in families where the preterm baby is the first-born and families in which he/she is a later-born. Sample: Data were collected in the maternity ward and NICU at Soroka Medical Center. Bedouin mothers and their preterm (n=66) and full-term (n=255) infants participated in this study. Methods: Mothers completed a questionnaire on maternal postpartum depression using the Edinburg questionnaire (EPDS; Glasser & Barell, 1999) and on maternal level of anxiety using the STAI questionnaire (Spielberger et al., 1970). Additionally, maternal level of acculturation was assessed using the acculturation questionnaire (Berry, 1997; Phinney, 1990). Results: As hypothesized, mothers of preterm infants had higher levels of PPEd than mothers of full-term infants. Specifically, they indicated having more symptoms of anxiety, $t(86.2)=-9.69, p < .001$ and depression, $(t(319) = -11.29, p < .001)$. An interaction effect for Acculturation style * Group was significant, $\beta=-0.21, p < .05$. The third hypothesis was supported; an interaction effect for the preterm being first- or later-born and Group was significant ($\beta=0.39, p < .05$). Conclusions: Ethnicity, acculturation, and family size are important variables that need to be considered when studying maternal emotional distress following the birth of a premature infant, especially in ethnic minority groups such as the Bedouin. Results support the notion that mothers from an ethnic minority group having a premature birth are at higher risk for experiencing depressive and anxiety symptoms due to their complicated circumstances. However, individual difference emerged when examining maternal acculturation style and family stress. Among the premature group, some variables might be risk factors, such as acculturation style and family size, placing the Bedouin mother at a higher risk for PPEd. Implications and intervention programs will be proposed.

P1-I-152: What's the focus? Infants and parents differentially talk about distinct aspects of contexts of self-conscious emotions

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Parents play an important role in socializing children's emotion understanding (Brownell et al., 2013; Fredrickson, 1998; Knothe & Walle, 2018; Thompson, 2006). Previous research on parents' conversations with their infants about others' emotions has shown that parents differentially focus on the emoter more in sadness and anger contexts and the referent more



in joy, fear, disgust contexts (Knothe & Walle, 2018). However, there is limited research on how parents and infants discuss self-conscious emotions. The current study explored the socialization of self-conscious emotions in parent-infant conversations during a storybook task. One hundred and sixty-seven infants (77 females; Mage = 2.46 years, SD = 0.26) were observed reading a storybook with their primary caregiver. Each page was displayed in a random order and featured a unique character (gender counterbalanced) experiencing a distinct self-conscious emotion in response to an event (embarrassment, guilt, shame, awe, pride; see Figure 1). The narrations of parents and infants were transcribed using TEMI voice transcription software and word counts referencing the emoter, referent, and emotion label were extracted for parents and infants using a Python script and then analyzed using repeated measures generalized linear mixed models with picture emotion as a within-subjects factor. The total number of words spoken by the parent or child was included in each model as a covariate to account for differences in conversational speed. Our hypotheses were pre-registered on the Open Science Framework (10.17605/OSF.IO/THQRX). The results of each model and pairwise comparisons between picture emotions are displayed in Table 1. Results indicated significant effects of picture emotion for parent words referencing the emoter, referent, and emotion label. Specifically, parents focused significantly less on the emoter in embarrassment than guilt, shame, awe, and pride, and focused significantly more on the emoter in guilt and pride than shame. Parents also focused significantly more on the referent for embarrassment than guilt, shame, awe, and pride, and focused significantly less on the referent in guilt than shame, awe, and pride. Parents labeled pride significantly more than embarrassment, guilt, shame, and awe significantly less than embarrassment and guilt. Analyses of infants' verbalizations revealed a significant effect of picture emotion on references to the referent. Additionally, infants' referential emphasis mirrored that of parents ($r_{referent} = .33, p < .01$), though was less differentiated. Specifically, infants discussed the referent significantly less in guilt than embarrassment, shame, awe, and pride, and more in embarrassment than pride. The effects of picture emotion were not significant for the emoter and emotional label variables, and thus were not examined further. In summary, these results demonstrate that parents and infants differentially focus on different aspects of emotion contexts as a function of self-conscious emotion and that parental communication of emotion may serve as an emulative framework for infant understanding and interpretation of self-conscious emotions. Implications for the socialization of infant emotion understanding and additional future directions will be discussed.

P1-I-153: The impact of perceived emotions on toddlers' word learning

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Children learn word-object associations in a social context where individuals encode negative information more deeply than positive information during learning (Öhman & Mineka, 2001). Additionally, infants' neural responses are stronger towards negative than positive and neutral emotional expressions (Hoehl, 2014). This raises the possibility that emotion processing may affect children's ability to encode word-object associations. In the current study, we investigated this possibility. In Experiment 1, 30 30-month-old toddlers and 27 adults participated in an eye-tracking word learning task. We trained participants with three novel word-object associations in a referent selection training (RS) phase and tested whether they



retained these associations in two retention testing phases: after a five-minute break (RT1) and on the following day (RT2). During RS, participants saw three sets of one novel and two known objects and heard them being labeled by an on-screen experimenter. Novel objects were labeled in neutral, positive and negative emotional expressions. At test, participants saw the three familiarized novel objects. Retention of word-object associations was tested on label trials, in which target objects were labeled in neutral affect (Fig. 1). Retention of emotion-object associations was tested on no-label trials, in which targets were cued by emotional speech without labels. On label trials, adults retained word-object associations in both RTs (all p s < .001). Toddlers retained negative word-object associations at RT1 (p = .008) and RT2 (p = .01), and neutral associations at RT2 (p = .02). No retention of positive associations was found (both p s = .30). On no-label trials, adults looked at the emotionally familiarized targets after hearing corresponding emotional cues (p_{negative} < .001; p_{positive} = .01) but looked at targets randomly after hearing the neutral cue (p = .24). Toddlers looked more at the negative objects after hearing neutral cues at RT1 and negative cues in both RTs (all p s < .001) but looked at the three objects randomly after hearing positive cues at both RTs (all p s > .48). Therefore, compared with adults, toddlers allocated more attention to negative objects. In Experiment 2, to probe whether the presence of the negative object on test trials interfered with toddlers' retention, another 37 30-month-old toddlers, after participating in the RS phase, were tested with pairs of objects (positive/neutral, positive/negative, negative/neutral), hearing only the neutral voice. On label trials, despite toddlers failing to look at the neutral target when it was paired with the negative competitor at RT1, they retained all the novel word-object associations in all the pairs at RT2 (all p s < .02). On no-label trials, a bootstrapped permutation time course analyses (Fig. 2) indicated that toddlers looked predominantly at the negative objects. Thus, although the impact of the negativity bias on retention decreased when the negative competitor was eliminated from the testing trials, the negative object nonetheless attracted toddlers' visual attention. Overall, toddlers associated negative emotions perceived during learning with corresponding objects and had an attentional bias towards negative information in learning word-object associations in a social context. The attention bias in the early learning will be discussed.

P1-I-154: The potential role of emotion perception and language in early emotion understanding development

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Emotion understanding, the ability to perceive and interpret emotions, is a crucial skill to develop early in life (e.g., Izard et al., 2001). However, much remains unknown regarding how this skill develops across the first few years after birth, and what mechanisms underlie this development. These open questions were investigated through two eye tracking studies: (1) A longitudinal study investigating whether infants intermodal emotion matching ability relates to early childhood emotion understanding, and (2) A study investigating the relation between language and emotion perception in late infancy. In the longitudinal study, forty infants participated at 9, 15, 21, and 30 months. At the first three visits, infants viewed pairs of happy, sad, angry, and neutral facial expressions with silent and matching/mismatching audio while their eye movements were tracked. Emotion matching was calculated as the difference in looking time to the emotional face matching the audio relative to silence. At the 30-month visit,

children participated in the Affective Knowledge Test (AKT). Participants received an average AKT score of 14.69 with notable variability (SD=5.09), which is typical for this age (Denham, 1986). Results revealed that only 15-month emotion matching performance predicted AKT performance ($p=-.42$, $p=.016$). Relations between the AKT and 9-month ($p=-.09$, $p=.632$) and 21-month ($p=.10$, $p=.580$) emotion matching were non-significant. Therefore, 15-month emotion matching may reflect an important aspect of early emotion understanding development, but 9- and 21-month-olds may process the emotion matching task in a different manner. To follow up on these results, we conducted another eye tracking study to explore the relation between language development and emotion perception based on theories that language acquisition promotes emotion conceptualization (Barrett, 2017). Participants were 15- to 18-month-olds, as the prior study suggests that this age appears important for later emotion understanding. 40 infants viewed a woman's face depicting an emotion (afraid, angry, happy, or sad) followed immediately by two emotional faces of a new woman- One matched to the previously displayed emotion and the other mismatched. No language was involved in the task. We also assessed infants' general matching abilities using a similar paradigm with novel objects (see Figure 1). Infants' productive language abilities were reported by parents through MCDI. On average, infants spent comparable proportions of time looking to the matching face ($M=.44$, $SD=.04$) and the mismatching face ($M=.45$, $SD=.04$). This pattern also occurred for the novel objects (Match: $M=.43$, $SD=.06$; Mismatch: $M=.46$, $SD=.06$). Results revealed no significant relation between infant productive language and nonverbal emotion matching when controlling for novel object matching (R^2 change=.08, $p=.089$). Therefore, the impact of language abilities on emotion perception remains insignificant at this age. It is possible that the impact of language on emotion perception emerges later, as rapid word learning occurs in the latter half of infants' second year (Goldfield & Reznick, 1990). In sum, 15-month intermodal emotion matching predicts later emotion understanding, but the effect of language on emotion perception at this age is non-significant. The effect of language on emotion perception will be discussed in terms of infants' cognitive development.

P1-I-155: Contagious smile: The observation of dynamic happy expressions activates sensorimotor areas in 7-month-old infants

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Introduction: The ability to quickly recognize emotions from others' facial expressions is foundational for successfully managing multifaceted social interactions and for an adapted social life. 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. Neurophysiological evidence in adults documented the recruitment of sensorimotor brain areas in response to the observation and execution of facial expressions of emotions (e.g., Carr et al., 2003; Dapretto et al., 2006). In infants, the neural correlates of attentional and perceptual processing of emotional expressions are well known (e.g., Peltola et al., 2009; Quadrelli et al., 2019; Taylor-Colls & Fearon, 2015), but the role of sensorimotor processing in emotion understanding has started to be explored only recently (Rayson et al., 2016; 2017). Moreover, the little existing evidence does not allow to establish whether sensorimotor activation in the first year of life is specifically elicited by emotional expressions or if it is determined by the observation of face movements



in general. By recording μ rhythm desynchronization, the present study aimed to investigate sensorimotor activation in 7-month-olds in response to the observation of static and dynamic stimuli depicting happy and angry emotional faces. Hypotheses: Observation of significant μ rhythm suppression when both emotional expressions are posed by dynamic but not static faces would support the hypothesis that sensorimotor areas are activated in response to any facial movement. On the contrary, observation of a differential pattern of activation determined by the emotional valence of the stimuli would indicate a potential role of accumulated experience with a specific emotional expression within the first months of life in eliciting sensorimotor activation. Study population: 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. Methods: Stimuli in the dynamic condition consisted of short 1000 ms color videos of female Caucasian actresses posing angry and happy facial expressions. In the static condition, all stimuli consisted of photographs extracted from videos used in the dynamic condition, depicting the full emotional expressions presented for 1000 ms. The average activity in the 6-9 Hz range was extracted for statistical analyses from a cluster of electrodes disposed over the right (C4) and left (C3) sensorimotor cortex. Results: Happy facial expressions elicited greater sensorimotor activation compared to angry faces in the dynamic experimental condition, while no difference was found between the two emotional expressions in the static condition. Furthermore, results revealed that happy but not angry expressions elicited a significant right-lateralized activation in the dynamic condition. Overall, current results suggest that sensorimotor activity is modulated by dynamic emotional expressions as early as 7 months of age, and speak in favour of the existence of a right lateralized sensorimotor activity for the processing of happy facial expressions.

P1-I-156: Does child temperament affect attachment transmission? Testing a moderated mediation model using IPD meta-analysis

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Ever since Main et al. (1985)'s discovery that parents' attachment representations are associated with parent-child attachment, the intergenerational transmission of attachment has intrigued researchers across the globe. Research has focused on sensitive caregiver behavior as the mechanism through which attachment may be transmitted to children, but meta-analytic evidence showed that sensitive responsiveness explained only 25% of the association (Van IJzendoorn, 1995; Verhage et al., 2016). Solving this so-called 'transmission gap' has been a major focus of the last two decades, but adding mediating variables have not brought the field closer to a solution. A possible explanation is that the mediating pathway may differ between parent-child dyads based on their background characteristics. Several moderators have been found to affect the association between parents' attachment representations and parent-child attachment, such as high-risk background, teenage parenthood, and age of the children (Verhage et al., 2018). More recently, the impact of high-risk background on the mediational pathways of attachment transmission has been shown as well (Verhage et al., 2019): within high-risk dyads, the association between parental sensitivity and secure attachment was weaker than in low-risk dyads (Figure 1). Based on the differential susceptibility hypothesis



that children are not all equally susceptible to their rearing environment (Ellis et al., 2011), the current study aims to extend this moderated mediation model of attachment transmission by including individual differences in child temperament. We hypothesize that the association between parental sensitivity and parent-child attachment is stronger for children with higher negative emotionality than for children with lower negative emotionality. The current study is performed with the Collaboration on Attachment Transmission Synthesis (CATS) dataset (Verhage et al., 2018), in which 59 studies (total N=4,498 parent-child dyads) with data on parental attachment representations and parent-child attachment were collated. The analyses for this research question will be based on a subset of approximately 1,800 parent-child dyads (from 15 studies) for whom additional data on parental sensitivity and child temperament was reported. Before conducting the analyses, data on child temperament needed to be harmonized across studies. We did this by comparing the different theoretical dimensions underlying temperament assessments to evaluate whether different operationalizations of temperament could be considered operationalizations of the same underlying construct. We found a common denominator in the dimension of 'negative emotionality', which was defined (under different names) similarly in each approach to temperament. We are currently in the process of reformatting all temperament data in the different studies to a common 7-point scale to be used in the analyses. Next, within-study missing data on parental sensitivity and child temperament will be imputed. As a final step, the same analysis strategy of multilevel moderated mediation modeling as used to determine the moderating effect of risk background (Verhage et al., 2019) will be employed to determine moderation of the mediating pathways by child temperament. Knowledge on how children can be differentially affected by the sensitivity of their parents in the development of the attachment relationship may help to tailor support for new parents.

P1-I-157: The neurobehavioral structure of fear, sadness, and anger in Infancy

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Temperament is manifest as biologically based and relatively stable emotional dispositions beginning in early infancy (Goldsmith et al., 1987). Infants express negativity as a sign of distress to novelty or uncertainty, as with fear, or distress due to goal blockage, as with sadness and anger. Each of these emotions serves to motivate behavior and are expressive, communicative, and evolutionarily adaptive. Affective expressions are strongly rooted in the brain. Research in humans and animals emphasizes the involvement of limbic brain regions with fear and anger, including the amygdala and hippocampus. White matter (WM) microstructure may be particularly salient in our early understanding of emotional and brain development. Because limbic areas of the brain are earlier developing, we might expect to see variation in microstructure as early as one month of age. Indeed, the amygdala and hippocampus, which are often associated with affective behavior, undergo rapid and robust growth during the first years of life (Uematsu et al., 2012), continuing into later childhood and adolescence (Giedd & Rapaport, 2010; Lenroot & Giedd, 2006). WM comprises bundles of myelinated nerve fibers necessary for neural communication and higher order brain organization (Fields, 2008). These microstructural neural differences can be measured using Diffusion Tensor Imaging (DTI), a non-invasive technique sensitive to water movement, which helps identify cellular shape and coherence, and axon myelination (Alexander et al., 2007;



Alexander et al., 2011). Here, we examine mother-infant dyads from pregnancy through infancy to differentiate neurodevelopment of discrete negative emotional dispositions in infancy. The focal questions are: 1) how do fear, sadness, and anger relate in infancy, and 2) does the structural microstructure of white matter tracts at 1 month of age foreshadow the expression of each temperamental disposition later in infancy? Infants ($n=149$) underwent neuroimaging at 1 month of age, and mothers reported on infant fear, sadness, and anger at 12 months using the Infant Behavior Questionnaire (Gartstein & Rothbart, 2003). As anticipated, results indicate stronger relations between fear and sadness ($r=.25$, $p<.01$) and sadness and anger ($r=.54$, $p<.01$) than fear and anger ($r=.17$, $p<.05$). Neuroimaging analyses used a voxel based approach to compare regions of significance relating to each of the emotional dispositions. Results indicate that 1-month white matter microstructure is differentially associated with 12-month temperamental negativity, depending on emotion and region. Specifically, fear, but not anger or sadness, was related to lower integrity in the superior longitudinal fasciculus, a tract that connects frontal and tempo-parietal regions. Anger, on the other hand, was associated with increased neuronal dispersion in the posterior limb of the internal capsule, one of the earliest white matter tracts to develop. Sadness was not significantly associated with microstructural measures after correction for multiple comparisons. Results reinforce the neurobehavioral uniqueness of fear, sadness, and anger as early as 1 month of age, even though these emotions are often not differentiated behaviorally until later in development.

P1-I-158: Sleep during toddlerhood: The distinct roles of amount and context of media use

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Heavy consumption of screen media in early childhood has been associated with sleep disturbances, including shorter night-time sleep duration and longer sleep latency (Cheung et al., 2017; Chindamo et al., 2019). However, previous research has mainly focused on the implications of the amount of media exposure for children's sleep, while neglecting broader aspects of media use such as context (Garrison et al., 2011). To address this gap in the literature, the main goal of the current study was to examine how the family media ecology (i.e., how media is used in the household; Barr, 2019) is related to children's sleep. We specifically focused on maternal use of media to regulate child distress and its implications for children's sleep disturbances. An additional goal was to examine whether the amount and context of media use predict distinct aspects of children's sleep. We hypothesized that higher parental use of media to regulate child distress will be associated with difficulties in sleep regulation (i.e., longer sleep latency), while higher screen time will be associated with shorter sleep duration. Participants were 140 mothers that completed questionnaires at two time points; 22 months (T1) and 26 months (T2) of children's age. Maternal use of media to regulate child distress was measured using a modified version of the Coping with Toddlers' Negative Emotion Scale (CTNES; Spinrad et al., 2007). Children's night time sleep duration and latency were assessed using the Brief Screening Questionnaire for Infant Sleep Problems (BISQ; Sadeh, 2004). In addition, mothers reported on their children's average daily screen time. Maternal education and additional strategies to regulate child distress (CTNES; Spinrad et al., 2007) were included as covariates. Two path models were estimated to examine the unique effects



of context (media to regulate distress) and amount (child screen time) of media use on sleep duration and sleep latency. In the first model predicting sleep latency (Figure 1), we found that media to regulate distress at T1 significantly predicted longer sleep latency at T2 ($\beta = .19$, $p = .04$). However, screen time at T1 did not significantly predicted sleep latency at T2 ($\beta = -.01$, ns). In the second model predicting sleep duration (Figure 2), elevated screen time at T1 significantly predicted lower sleep duration at T2 ($\beta = -.18$, $p = .008$), while media to regulate distress at T1 did not significantly predicted sleep duration ($\beta = .01$, $p = ns$). Sleep duration and latency at T1 did not significantly predict screen time and use of media to regulate at T2. The results show that different aspects of media use have unique effects on specific components of sleep. While toddlers' longer screen time predicted shorter sleep duration, maternal use of media to regulate child distress was linked to the regulatory component of sleep (i.e., length of time required for the child to fall asleep). These finding suggests that media-based regulation strategies may interfere with the development of toddler's ability to self-sooth and regulate arousal in contexts that require the use of regulatory skills.

P1-I-159: Delayed responsiveness to infant crying - some problems go away if you ignore them

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Background: Whereas attachment research shows that consistent and timely responses to infant crying promotes attachment security and overall child development, there may also be benefits of delayed response to a crying infant, especially among older infants. Community, observational and clinical studies suggest that delayed responsiveness to infant crying is commonly used by parents, although its appropriateness, consequences, and implications remain controversial. Objective: The primary objective was to identify characteristic of parents and infants, and parenting practices associated with delayed responsiveness to infant crying during the first year of infant life. A secondary objective was to evaluate, in a subsample of maternal-infant pairs, the associations between delayed responsiveness to infant crying and observational measures of maternal-infant interaction and infant-maternal attachment. Method: This is secondary analysis of data from a community sample of pregnant women recruited to the Alberta Pregnancy Outcomes and Nutrition (APrON) Study. Mothers completed questionnaires during the first year of infant life ($n=1826$), and a convenience subsample of maternal-infant pairs ($n=137$) participated in laboratory assessments of maternal-infant interaction at 6-months of age, and infant-maternal attachment at 20-months. Results: Parental use of 'cry out' as a strategy to deal with a crying infant was associated with parental characteristics (being White and having a relatively higher income), infant characteristics (higher problematic behavior at 3-months and reduced problematic behavior at 12-months), sleep ecology (infants sleeping alone), and parental soothing strategies (less frequently taking the infant into the parent's bed, cuddling, or carrying the crying infant), see Figure 1. Cry out was not associated with observational measures of maternal sensitivity, $F(1,133) = .24$, $p = .62$, or infant-maternal attachment, $\chi^2(1) = 2.59$, $p = .11$. Conclusion: When used selectively and in response to the specific needs and characteristics of the infant, delayed responsiveness may reduce problematic behavior and does not harm infant socioemotional development.



P1-I-160: The role of motor representations for infants sensitivity to emotional information in action kinematics

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By the end of the first year of life, infants display sensitivity to the emotional valence of action kinematics (Addabbo et al., 2019). Whilst the underlying mechanisms of this sensitivity remains unclear, it is widely accepted that our motor system represents observed actions of others (e.g. Blakemore & Decety, 2001). Recent evidence showed that adults use deviations from their own action kinematics as an indicator of the affective state of others (Edey et al., 2017). This suggests that infants may become sensitive to emotional information conveyed by kinematics, once they have sufficiently detailed motor representations that allow them to detect deviations in others' movement kinematics. Infants are still very variable in their movement, but with practice, movement becomes more fine-tuned (Konczak et al., 1995). Thus, through motor experience, infants' motor representations might become more detailed, allowing them to detect deviations in others' movements. Hence, this study investigated whether infants' motor representations play a role in deciphering emotions in another person's actions. In particular, we hypothesize that infants who have a more detailed motor representation of their own actions are more sensitive to deviations in another person's action that carry emotional information. Eighty-three 12-month-olds were tested in this study, and data of 34 infants was included in the final analysis. Infant's action kinematics were investigated in a transport task using optical motion capture (Figure 1). Variability in movement was taken as a measure of detailedness of the infant's motor representation. In a separate task, infants' sensitivity to other's angry and happy action kinematics was examined using facial electromyography (EMG, following Addabbo et al., 2019), by measuring the activation of the zygomaticus major ("smiling muscle", ZM), and of the corrugator supercilli ("frowning muscle", CS). We analyzed the EMG data with a 2 x 2 ANOVA with Stimulus Emotion (Happy, Angry) and EMG Muscle (ZM, CS) as within-subject factor, that showed a marginal significant Emotion x Muscle interaction effect ($F(1,33) = 3.46, p = .072, \eta^2 = .095$). Paired sample t-tests were executed for each emotion condition. In the happy condition, the ZM muscle ($M = 0.091, SD = 0.44$) showed a higher activation than the CS muscle ($M = -0.077, SD = 0.39$) ($t(34) = -1.87, p = .070$). In the angry condition, the CS muscle ($M = 0.071, SD = 0.44$) showed a higher activation than the ZM muscle ($M = -0.084, SD = 0.41$) ($t(34) = 1.76, p = .087$). These results replicate the activation in each emotional condition for the corresponding muscle found in the earlier study (Addabbo et al., 2019). Preliminary analyses on the relationship of infants' performance on both task revealed a correlation between variability in their own movements and their sensitivity to emotional information in others' actions. This study provides evidence that for infants, action kinematics are a meaningful source of information to pick up upon the emotional state of another person. Moreover, we provide first evidence that infants' sensitivity to others' kinematic is dependent on their own motor ability.



P1-I-161: Dyadic to self regulation

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Self-regulation refers to intrinsic processes that monitor, enact, and inhibit behavior in compliance with rules (Kopp, 1982). Its counterpart, dyadic regulation denotes the coordinated modulation of shared rhythms as interactive partners dynamically adapt to each other's cues on a moment-to-moment time scale (Beebe, 2006; Feldman, 2012; Provenzi, Scotto di Minico, Giusti, Guida, & Müller, 2018). Due to the inchoate nature of self-regulation during infancy, infants rely on dyadic regulation with caregivers to assist with regulation in the moment and promote the development of increasingly independent regulatory skills (e.g., Feldman, Greenbaum, & Yirmiya, 1999; Feldman, Greenbaum, Yirmiya, & Mayes, 1996). The present study examines whether dyadic infant-caregiver regulation at 6 months predicts toddler self-regulation at 2 years. Participants were drawn from the Emotional Beginnings study of child emotional development over the first 10 years of life. The current study used $N = 115$ mother-child dyads who provided data at both 6 months and 2 years. At 6 months, mothers and infants were videotaped while the infant received inoculations in the community setting (Stifter & Rovine, 2015). Infant crying intensity and maternal soothing behaviors were coded. At 2 years, the toddler participated in a toy delay procedure during a laboratory visit (Putnam, Spritz, & Stifter, 2002). Toddler regulatory behaviors (attention orienting, self-soothing) and compliance (i.e., not touching the forbidden toy) were coded. Prior work applied a hidden Markov model to pattern dyadic behavioral states as the infant and caregiver worked together to soothe distress post inoculation (Stifter & Rovine, 2015). Subsequently, cluster analysis was used to group dyads who showed similar trajectories of behavior post inoculation (Backer, Quigley, & Stifter, 2018). Well Regulated dyads quickly and effectively soothed infant distress via maternal holding, rocking, and vocalizing; Moderately Well Regulated dyads took longer to soothe infant distress via maternal holding, rocking, and vocalizing; Poorly Regulated dyads struggled to soothe infant distress; Effective Food to Soothe (FTS) dyads quickly and effectively soothed infant distress via oral soothing strategies; Moderately Effective FTS dyads took longer to soothe infant distress via oral soothing strategies. The present study extends these findings by testing whether membership in dyadic group predicts subsequent toddler self-regulation. Results indicate that Well Regulated dyads produce toddlers with better self-regulation. Toddlers who had been members of Well-Regulated dyads spent less time touching the forbidden toy ($M = 0.25$, $SD = 0.36$) than toddlers who had been members of other dyads ($M = 0.54$, $SD = 0.42$), $F(1,93) = 7.785$, $p < 0.01$. Additionally, toddlers from Well-Regulated dyads displayed significantly more attention orienting ($M = 0.42$, $SD = 0.29$) than children from other dyads ($M = 0.27$, $SD = 0.30$), $F(1,93) = 4.092$, $p < 0.05$. Interestingly, toddlers who had experienced dyadic FTS showed marginally less self-soothing ($M = 0.01$, $SD = 0.05$) than children who had not experience dyadic FTS ($M = 0.08$, $SD = 0.22$), $F(1,94) = 3.13$, $p = 0.08$. These findings suggest that early dyadic regulatory experiences set the stage for subsequent self-regulatory development.

P1-I-162: Infants' longitudinal patterns of attention to threat and their relation to anxiety risk factors



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Attention bias to threat has been linked to heightened anxiety across adolescence and adulthood (Pérez-Edgar et al., 2010). A small, but rapidly growing literature is investigating attention to threat starting in infancy (see Burris et al., 2019 for review), given that we do not yet know how early, or through what specific mechanisms, attention becomes linked to anxiety (Field & Lester, 2010). Recently, Burris and Rivera (2020) reported that infants who showed a persistent threat bias pattern across a two-year longitudinal study had significantly higher levels of parent-reported anxiety. These findings indicate that the presence of an attention bias to threat is not the sole marker of anxiety risk. Rather, the persistence of a biased pattern of attention is more predictive of anxiety levels. Unfortunately, that initial sample had too large of an age range (38-72 months) to specifically speak to the development of these patterns in early infancy. The current study aimed to investigate the stability of attention bias patterns over time in a new longitudinal sample of young infants. We also examined the link between attention patterns and maternal anxiety levels--a known risk factors for anxiety--given that anxiety cannot be directly measured in young infants. The current study assessed infants (N=35, data collection ongoing) longitudinally at 4-months and again at 8-months of age. Participants were shown a passive viewing emotional vigilance task on an eye tracker. In this task, a face (neutral, angry, happy) appeared in one of the four corners of the screen until fixated by the infant. We measured infants' latency to fixate each target face, and averaged latencies across emotion conditions. To investigate the individual patterns of attention bias to threat, we then grouped the infants using a median split of latency to specifically threatening (angry) faces, with participants falling into either a fast or slow group at 4 months and again at 8 months. We then categorized the participants based on whether they remained in the same group, maintaining the same attention pattern, across the two time points (persistent threat pattern group; N=22) or showed variability between the time points (variable threat pattern group; N=13). We measured maternal anxiety using the State/Trait anxiety questionnaire (Spielberger, et al., 1983). Neither angry bias scores at 4-months or 8-months were independently correlated with parental anxiety levels (all r 's<.22, all p 's>.1). Importantly, the participants in the persistent threat pattern group had mothers who reported significantly higher trait anxiety levels than those within the variable threat pattern group ($F(1,32)=8.97$, $p<.01$). These preliminary analyses extend and confirm the findings of Burris et al. (2020) suggesting that infants who show persistent patterns of attention in relation to threat across time have mothers with higher anxiety levels, possibly indicating an increased risk for anxiety development. These preliminary findings provide a promising avenue for continued investigation into the link between attention and anxiety risk in infancy and beyond.

P1-I-163: Social exclusion affects infants' neural processing of emotions

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Social exclusion is a very aversive feeling, as it 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; Iffland et al., 2014),



cognitive (Kawamoto et al., 2014) and behavioral (Bourgeois & Hess, 2008; Lakin et al., 2008) changes in adults. Yet, only few studies investigated children and infants' cognitive capacities (Marinović & Träuble, 2018) and behavior (Over & Carpenter, 2009; 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 aims to investigate the influence of self-experienced social exclusion on 13-month-olds' neural processing of emotional faces. To do so, each infant first participated in a live ball-tossing game with two experimenters, named Cyberball game (Scheithauer et al., 2013), during which he/she was either included or excluded 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. Just after the exposure to the Cyberball game, event-related potentials (ERPs) and looking times were recorded while infants observed dynamic stimuli of faces expressing anger, fear and happiness. Preliminary analyses did not reveal any significant differences in ERP responses between the inclusion and the exclusion condition. However, in the inclusion condition, both angry and fearful faces evoked a faster attentional negative central (Nc) component as compared to happy faces ($p = 0.047$ and $p = 0.055$ respectively) (Figure 1). This was not the case for the exclusion condition, for which no difference in Nc latency was found between the different emotions. Looking time analyses revealed that infants looked significantly longer to angry and fearful faces as compared to Happy ones ($p = 0.043$ and $p = 0.014$ respectively) in the inclusion condition, while no difference was found in the exclusion condition. Moreover, infants' looking times were overall longer in the exclusion condition than in the inclusion one ($p = 0.07$), suggesting that exclusion condition increased infants' attention to emotional faces (Figure 2). The faster Nc component and longer looking times to angry and fearful faces as compared to happy faces in the inclusion condition are consistent with previous research demonstrating that, from 7 months of age, infants show an attentional bias towards negative as compared to positive emotions (Leppänen et al., 2007; Nelson & de Haan, 1996; Vaish et al., 2008). Conversely, the lack of difference between the emotions in the exclusion condition seem to indicate that the experience of exclusion dissipated this negativity bias, making infants allocate their attention equally towards fearful, angry and happy faces. These preliminary results suggest that self-experienced social exclusion can influence infants' visual and neural processing of emotional faces.

P1-I-164: A multi-method approach to the study of emotion regulation in infants at risk for autism spectrum disorder

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INTRODUCTION: Emotion regulation (ER), the ability to maintain homeostasis in response to environmental events, develops in the first years of life and is fundamental to the development of behavior and social competence (Calkins, 1994). Research on the early development of autism spectrum disorder (ASD) suggest that difficulties in ER are characteristic of infants at risk for ASD, who have difficulty regulating their emotions and display increased negative affect, reduced positive affect, and atypical arousal (Garon et al., 2009, 2016). Similarly,



physiological response to stress is thought to be altered in ASD (Lydon et al., 2006). As the early control of emotion may be critical to the development of later social-communicative abilities, it may affect the onset and progression of ASD symptoms. Given that ER is a multicomponent process, a behavioral-physiological approach is warranted. **OBJECTIVE:** To examine if behavioral affect and/or physiological response to emotion-eliciting activities predict subsequent ASD symptoms in a sample of infants at high-risk (HR) for ASD. **METHODS:** Participants, drawn from an ongoing longitudinal study of early ASD development, were 51 HR infants (i.e., have an older sibling with ASD) and 13 low-risk (LR) infants (i.e., no family ASD history). At 12 months, infants were tested on an ER task, adapted from the Laboratory Temperament Assessment Battery, comprised of activities designed to elicit positive (i.e., bubbles, toy play) and negative (i.e., toy removal, masks, grooming) emotions (Goldsmith et al., 1996). Behavioral affect was coded offline using Noldus Observer for valence (positive, negative, or neutral) and intensity (differentiate mild from intense displays of affect) based on facial and vocal cues. Physiological data consisted of heart rate variability (HRV), which was extracted from electrocardiogram signals using Porges method (natural logarithm of total power in the frequency band 0.24 to 1.04Hz). Baseline-corrected affect and HRV were computed and averaged for the positive and negative emotion-eliciting activities. At 18 months, the Autism Diagnostic Observation Schedule Toddler Module (ADOS-T), a clinician-led observational assessment, was administered to measure ASD symptom expression using total algorithm score. Linear regression was used to examine the association between behavioral affect and HRV during positive and negative emotion-eliciting activities and ASD symptoms. **RESULTS:** Among HR infants, an association between HRV and ADOS-T total score was significant for positive activities ($r^2=0.39$, $p\leq 0.01$), and marginal for negative activities ($r^2=0.14$, $p=0.06$), where higher HRV was associated with greater ASD symptoms. No significant associations were found between behavioral affect and ADOS-T score in HR infants. Among LR infants, no significant associations were found between HRV, behavioral affect, and ADOS-T scores. **CONCLUSION:** Although preliminary, increased levels of HRV were associated with greater ASD symptoms at 18 months in HR infants. These findings highlight that - at least within HR infants - HRV may be an 'internal' indicator of ER, providing important information that may be not observed behaviorally. Using a behavioral-physiological approach may help us not only characterize the early development of emotions in ASD, but also inform theoretical and clinical approaches regarding ER in ASD. Future work with larger sample sizes will clarify these associations.

P1-I-165: Mother late positive potential as a state, but not trait, marker predicts infant temperament

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The late positive potential (LPP) is a neural marker of individual differences in emotional reactivity (Cuthbert et al., 2000). Infant temperament, reflecting individual differences in propensities for experiencing and expressing the primary emotions (Goldsmith et al., 1989), is predicted by maternal LPP (Brooker et al., in press). Adult LPP is discussed as a trait-level marker given demonstrated associations between dispositional reactivity and LPP amplitudes (Schupp et al., 2006). Thus, existing work assumes that LPP is a between-subject factor, with



mean-level differences between mothers representing trait-level characteristics that predict infant outcomes. Recent work has demonstrated that state-level processes influence LPP amplitudes (MacNamara et al., 2011) and fluctuations in LPP during pregnancy, a time of substantial between and within-person variation in emotional reactivity that are linked to child emotion outcomes (Brooker et al., in press). The question remains whether infant outcomes are linked with variation in maternal LPP amplitudes reflecting trait level characteristics or within-person state-level variation. Such work could increase our understanding of the influence of maternal state- and trait-level emotional reactivity on infant outcomes. We conducted a test of trait and state LPP during pregnancy and postpartum as predictors of infant temperamental negativity. We measured LPP amplitudes in 80 mothers during the third trimester of pregnancy (M=35.92 weeks, SD=1.47) and at 4 months postpartum (M=4.27; SD=0.62). At both assessments, mothers passively viewed 40 negative and 40 neutral images from the IAPS (Lang et al., 2008) while recording EEG. LPP was quantified for negative and neutral trials as mean amplitudes at electrode PZ between 300 and 100 ms following stimulus presentation. At 4 months, we observed infant temperamental negativity (fear and sadness) during a standardized laboratory paradigm meant to elicit infant negativity by presenting infants with a series of four masks that increased in degree of threat and novelty (Lab-TAB). Orthogonal estimates of observed fear and sadness were derived for each infant according to standardized coding procedures (Goldsmith & Rothbart, 1999). We used a random intercepts latent variable model to simultaneously estimate trait-level variation in emotional reactivity (variance in LPP common across assessments and valence) and state-level variation in emotional reactivity (variance in LPP that is more or less than would be explained by trait level measures alone). We found that state (controlling for trait), but not trait (controlling for state) level estimates of reactivity predicted infant temperament (Figure 1). Specifically, greater observed negative affect in infants was associated with greater trait-level neural reactivity to both negative (fear: $\beta=0.376$, $p=0.033$; sad: $\beta=0.680$, $p<0.001$) and neutral (fear: $\beta=0.512$, $p<0.001$; sad: $\beta=0.651$, $p<0.001$) images. In contrast, when accounting for state-level variation, maternal trait-level LPP did not predict infant temperament (fear: $\beta=0.026$, $p=0.888$; sad: $\beta=0.234$, $p=0.373$). Results suggest that infant temperament may be strongly influenced by state-level variation in maternal affect during pregnancy than by trait-level individual differences. This work has potential implications for basic science understanding of the association between maternal characteristics and infant outcomes and clinical interventions.

P1-I-166: A longitudinal study of associations between temperament and psychopathology in early childhood

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Temperamental characteristics emerge early and are associated with current and future mental health. Developmental psychopathology research has provided support for associations between child temperament and anxiety disorders, with much of this work investigating the role of behavioral inhibition. Researchers have also discovered connections between temperamental traits and externalizing disorders. Identifying early temperamental indicators of vulnerability for the development of psychopathology may inform preventive efforts to maximize children's mental health. Due to our study's longitudinal design, we are well-equipped to investigate the stability of temperamental predictors for the development of



psychopathology over the first several years of life. In a longitudinal community cohort of mother-child dyads (N=185) recruited in infancy, mothers completed questionnaires rating their child's temperament at infancy (IBQ-R), ages 2 and 3 years (ECBQ short form), and 5 years (CBQ very short form). At 5 years, mothers completed the Diagnostic Infant and Preschool Assessment (DIPA), a semi-structured clinical interview for caregivers of young children that provides ratings of lifetime psychiatric diagnoses. At each timepoint, we employed Mann-Whitney U tests to determine if temperament scores at each age were associated with anxiety (separation anxiety, social anxiety, general anxiety disorder) or externalizing (ADHD, ODD, CD) disorders by age 5. We focused on over-arching temperament factor scores (Negative Affectivity, Surgency/Extraversion, Regulation/Effortful Control) and select individual scales that we hypothesized would be associated with increased risk for an anxiety disorder (Fear, Shyness, Falling Reactivity) or externalizing disorder (Inhibitory Control, Falling Reactivity, Anger/Frustration). By age 5 years, 43 children (23% of sample) met criteria for a lifetime anxiety disorder and 14 children (8%) for a lifetime externalizing disorder. Children with a lifetime anxiety diagnosis had higher scores on Fear at infancy ($z=-2.705, p=.007$) and 3 years ($z=-2.331, p=.02$), Shyness at 2 years ($z=-2.858, p=.004$) and 3 years ($z=-3.299, p=.001$), and Negative Affectivity at 3 years ($z=-2.756, p=.006$); and lower scores on Surgency/Extraversion at 5 years ($z=-2.118, p=.03$). Children with a lifetime externalizing diagnosis had higher scores on Anger/Frustration at 2 years ($z=-2.151, p=.03$) and 3 years ($z=-3.183, p=.001$), Surgency/Extraversion at 3 years ($z=-2.613, p=.009$) and 5 years ($z=-2.058, p=.04$), and Negative Affectivity at 5 years ($z=-3.744, p<.001$); and lower scores on Inhibitory Control at 2 years ($z=-2.613, p=.009$), Falling Reactivity at 2 years ($z=-1.989, p=.05$) and 3 years ($z=-3.103, p=.002$), and Effortful Control at 2 years ($z=-2.741, p=.006$), 3 years ($z=-2.741, p=.006$), and 5 years ($z=-2.574, p=.01$). Temperamental traits measured as early as infancy were associated with the development of psychiatric disorders by age 5 years. Moreover, temperamental traits were associated in specific, hypothesized directions, discriminating between anxiety versus externalizing disorders. Elucidating individual differences in social-emotional and behavioral tendencies that predict mental health problems is important for understanding disease etiology. Exploring how these temperamental traits interact with other risk and protective factors in early life to increase/decrease a child's risk for developing psychopathology is an important next step for our project.

P1-I-167: Prevalence of infant ACEs

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Researchers have explored the effects of early adverse life experiences (ACEs) on children's developmental outcomes for decades. The original ACEs survey employed by Felitti et al. found that people with multiple categories of exposure were more likely to have multiple health risk factors later in their lives. People with four or more categories of adverse childhood experiences had a 4 to 12 times higher risk of alcoholism, drug abuse, mental illness (such as depression), and suicide attempts in comparison to those with no categories of adverse childhood experiences. In the present study, we wanted to see whether we could identify the presence of ACEs in a sample of infants. Because most ACEs research is based on adult retrospective accounts, and because almost no research has investigated ACEs as they are accruing in infancy, we assessed ACEs in infancy via anonymous parent-reported survey.



Mothers of 66 infants (28 girls) completed online surveys when their children were approximately 7 months old ($M = 7.65$ months, $SD = 3.34$ months). To assess the number of ACEs infants experienced, mothers completed a modified version of the original ACEs survey on behalf of their children. A sample item was for verbal abuse was, "Has your child ever been sworn at, insulted, humiliated, or put down in the home." We assessed 19 categories of ACEs, thus supplementing the original 10 employed in the Felitti study. Twenty-one (31.8%) of the infants were reported to have one or more ACEs (see Table 1), which is consistent with national data recently released by the Health Resources and Services Administration (HRSA; October, 2019). To the best of our knowledge, this is one of the first investigations to explore the prevalence of ACEs in infants. Other studies have inferred the presence of ACEs in infants using ancillary data such as public health information and other state records, but ours is the first to document the presence of ACEs via first-person reports. On the other hand, our employment of anonymous data, intended to facilitate accuracy of parental reporting, cannot ensure it. Future attempts at identifying the prevalence rate of ACEs in various age groups may influence the development of efforts to mitigate the many deleterious associated with early adversity.

P1-J-168: Maternal income and education predict different trajectories of mother-toddler dyadic reciprocity across tasks

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Higher-quality parent-child interactions predict better developmental outcomes and fewer behavior problems in childhood (e.g., Delonis et al., 2017). Furthermore, specific features of dyadic parent-child interactions such as reciprocity may function as protective factors in challenging contexts. Although dyadic reciprocity is associated with more positive outcomes (Kochanska & Murray, 2000), there is a dearth of research examining changes in reciprocity across tasks. The present study explored whether there are different trajectories of reciprocity as tasks become more challenging. For example, there may be dyads who demonstrate consistently high levels of reciprocity even during challenging tasks, whereas other dyads may show a decline in reciprocity as interaction contexts become more challenging. It is also possible that some dyads struggle with reciprocity even during less challenging tasks. This study also explored whether family factors (e.g., maternal education) and child factors (e.g., behavior problems) predicted trajectory group membership. Participants were 122 at-risk, low-income mother-child dyads recruited in a large city as part of an ongoing study of child social, emotional, and cognitive development. During the 3-year-old lab visit, mothers completed measures of demographics, including annual household income rated on a scale of 1 (<\$10,000) to 16 (>\$250,000) and maternal education rated on a scale of 1 (<7th grade) to 8 (graduate degree), household chaos (The Confusion, Hubbub, and Order Scale; CHAOS; Matheny et al., 1995), and toddler internalizing, externalizing, and overall behavior problems (the Child Behavior Checklist; CBCL; Achenbach & Rescorla, 2001). Further, the mother-child dyads were videotaped during a series of parent-child interaction tasks, including free play coded in two halves, clean up, and two difficult teaching tasks. Coders scored the videotapes for multiple dimensions of maternal, child, and dyadic behavior, including reciprocity, which was rated on a 1 to 7 scale and assessed shared positive affect, harmony, and synchrony



during the interaction ($M ICC = 0.74$). Using a person-centered growth mixture model approach to predict class membership, the 2-group model was supported (entropy = 0.79). Group 1 ($N = 102$) initially showed moderate levels of reciprocity (Mintercept = 4.25) that decreased across tasks (Mslope = -0.56). Group 2 ($N = 20$) also showed moderate levels of initial reciprocity (Mintercept = 4.04), but reciprocity remained consistent across tasks (Mslope = -0.08) (See Figure 1). Household chaos and child behavior problems were not associated with class membership. Maternal education and household income both predicted class membership. Participants in Group 2 had a higher level of education ($M = 5.30$, $SD = 1.625$) than those in Group 1 ($M = 4.43$, $SD = 1.05$), $t = -2.32$, $p < .05$. Similarly, participants in Group 2 had greater household income ($M = 3.90$, $SD = 3.37$) than those in Group 1 ($M = 2.20$, $SD = 1.88$), $t = -2.19$, $p < .05$. The findings of the present study suggest that the quality of the parent-child relationship varies across both interaction context and family demographic context, highlighting the importance of studying dyadic relationships across diverse populations. Furthermore, parenting programs aimed at helping families strengthen shared positive affect and harmony during challenging situations may be especially helpful for dyads of lower socioeconomic position.

J-Translational Science and Policy

P1-J-169: Neighborhood socioeconomic disadvantage as a predictor of family stress in families of at-risk infants and toddlers

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Facing multiple risk factors can negatively impact the developmental trajectories of infants and toddlers (Evans, Li, & Whipple, 2013). One US program aimed at improving outcomes for children and families facing risk is Early Head Start (EHS). Previous research shows that EHS families have high levels of economic and demographic risk (Vogel et al., 2011) but may perceive and experience these stressors differently. This study examined the relationship between a measure of neighborhood socioeconomic disadvantage, the Area Deprivation Index, and family stress in Early Head Start families. Recent research, primarily in public health, suggests that aggregate neighborhood-level measures of socioeconomic disadvantage are related to social and medical outcomes (Gordon et al., 2018; Lantos et al., 2018). Neighborhood-level measures are publicly available and are efficient to collect and analyze. Therefore, they are promising for inclusion in research and practice related to infant and toddler developmental outcomes. We examined the following research question: What is the relationship between the Area Deprivation Index (ADI), a measure of neighborhood socioeconomic disadvantage, and family stress? Participants included 247 caregivers with children under 36 months enrolled in EHS. Participant characteristics are shown in Table 1. Caregivers completed a demographic questionnaire and the Parenting Stress Index-Short Form (PSI-SF; Abidin, 1995), measuring caregivers' parenting stress. We matched family home address to the state decile ranking of the ADI (University of Wisconsin School of Medicine and Public Health, 2015), a factor-based metric that ranks neighborhoods by socioeconomic disadvantage. The ADI was recently refined, validated, and adapted to the



Census block group level (Kind & Buckingham, 2018). ADI state decile rankings range from 1 (lowest disadvantage) to 10 (highest disadvantage). We ran multiple regression models, with the PSI-SF subscales Difficult Child, Parent-Child Dysfunctional Interaction, and Parental Distress as outcomes and ADI state decile ranking as a predictor. Control variables included child age, caregiver race/ethnicity, caregiver level of education, and family monthly income. Missing data were handled using listwise deletion. Results of the regression models are shown in Table 2. The ADI significant predicted caregivers' scores on the Difficult Child subscale of the PSI, with families living in areas with higher neighborhood disadvantage reporting higher levels of stress related to their child's temperament and challenging behaviors such as defiance. The model predicting Difficult Child scores explained 13% of the variance in the outcome. In this model, reporting ethnicity as Hispanic was associated with lower levels of stress; increased child age was associated with higher levels of stress. Given that the ADI predicted scores on the Difficult Child subscale of the PSI-SF, controlling for family and child characteristics, neighborhood disadvantage may be important to consider when implementing interventions to support low-income families, especially given that it is an efficient way to operationalize risk for infants and toddlers and provides additional predictive power above other demographic indicators. Our results suggest that neighborhood measures of risk may be important to include when considering how to support parents in responding to children's behavior and temperament.

P1-J-170: Looking deeper into the toy box: Understanding caregivers' toy selection decisions

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Children's caregivers are their first play partners, and the quality of caregiver-child interactions are influenced by toys (Miller et al., 2017; Wooldridge & Shapka, 2012). Toy retailers are motivated to present their toys as "baby brain boosters" due to the increase of caregivers' and educators' awareness of the impact of toys on children's development (Hirsh-Pasek, 2008). But an unanswered question remains: What do caregivers pay attention to when selecting toys for their children? In this study, we investigated how caregivers make decisions about toy purchases and how those decisions relate to their reports about play. Sixty-three primary caregivers (female=60) of infants (female=37; Mage=12.18 months) were recruited to participate in the study. In both online and in-person surveys, caregivers were asked to report how often their infant engages in playing with blocks, dolls or stuffed animals, electronic toys, electronic and non-electronic books, electronic and non-electronic puzzles, and with other toys. Next, caregivers viewed eight images of infant toys (four electronic) without descriptions (Figure 1). Caregivers were then asked to identify four of those toys they would be interested in buying. Then, caregivers answered questions about their toy purchasing behaviors and opinions about toy marketing. Then, the same eight toys were shown again (in different order), but they featured retailer descriptions. Half of the descriptions featured the toys' developmental benefits. All descriptions disclosed whether the toys were electronic. Finally, caregivers were again asked to select four toys they would be interested in buying and answered the same set of questions about toy buying (see Figure 2). First, caregivers who reported that their child more frequently used electronic toys were more likely to select electronic toys from the initial set of toys ($F(1, 59)=3.888, p<.001$). Next, by examining



caregivers' change in answers to the toy purchasing questions, we gauged the effects of the toy descriptions. In response to, "Toy descriptions are accurate representations of toys," results revealed that caregivers were more likely to disagree with the statement after exposure to toy descriptions ($z=-2.333$, $p=.020$). For "My toy purchasing decisions are impacted by the developmental benefits of toys," caregivers were more likely to agree with the statement after reading descriptions ($z=-2.500$, $p=.012$). For the statement, "Toys positively impact the cognitive development of infants," caregivers were more likely to agree with the statement after being exposed to descriptions ($z=-3.162$, $p=.002$). Before being exposed to the toy descriptions, caregivers were significantly more likely to select traditional toys for their child ($t(58)=-3.957$, $p<.001$), but after reading the descriptions, there was no significant difference between caregivers' choices of traditional and electronic toys ($t(55)=.000$, $p=1.00$)--in fact, the means were equal. This study demonstrates the potential of toy descriptions to impact caregivers' toy purchasing decisions. Interestingly, by highlighting toys' developmental benefits, caregivers became more likely to select electronic toys for their infant. Given preliminary evidence that electronic toys may negatively impact caregiver-child interactions (Wooldridge & Shapka 2012, Authors, 2015), it is crucial that toy benefits are correctly represented so that caregivers can make informed decisions for their children.

P1-J-172: 42 years and counting: History of infancy research and researchers in the ICIS Flagship Journal

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The International Congress of Infant Studies debuted in 1978 along with a flagship journal, *Infant Behavior and Development*. The journal endures but was replaced as the flagship by a new journal, *Infancy*, in 2000. The articles in the flagship journal(s) are a trove of information regarding trends in author demography and research topics. We have undertaken a quantitative analysis of the content of all articles from 1978 to the present. This analysis complements existing anecdotes, remembrances, and qualitative analyses; perhaps, it will help to inform the future. Text files, created for each of the nearly 1650 articles across the 42 years, were processed using Python 2.7 to create two spreadsheets. One sheet included information pulled directly from predefined fields in the text files (e.g., title of the publication, year, author affiliations). The second spreadsheet contained words from all the titles, abstracts, and keywords. (Words that occurred only once were eliminated, and common words were excluded using the corpus of stopwords from Python Natural Language Toolkit v2.0.4.) These words were then sorted alphabetically and examined for high frequencies and thematic clusters. For example, a content area called "neuroscience" was created from the following words: brain, cardiac, cortex, cortical, cortisol, electrophysiological, EEG, EMG, eye-tracking, heartrate, neural, neurobehavioral, neurodevelopmental, neurological, and vagal. 17 such content areas were created, and each text file was reanalyzed with Python to determine whether it contained any of the words from each of the content areas. As befits the journal of an "international" society, the predominance of first authors from the United States is waning (Figure 1A), and the number of different countries represented has grown significantly. (The 1978 volume included only one paper from outside the USA!) Converging results suggest that infancy research is becoming more and more collaborative: significant increases (by ANOVA) across the years in mean number of authors per article; mean number of affiliations per article;



mean number of different countries per article; and (for articles that list any US states) mean number of different states per article. A finding to provoke discussion is the steady increase in the percent of first authors who are women (Figure 1B). We will attempt to provide an overall picture of predominant research topics in each of six 7-year epochs (Figure 2). To date, content analyses reveal overall upward trends in the percent of articles that used terms related to language/communication, attention, cognition, and neuroscience. Most of our other categories showed more complicated trends (e.g., behavior and perception were U-shaped over time). Furthermore, within some categories (e.g., learning), there were temporal shifts in the specific words used (e.g., habituation, imitation, classical and operant). It is noteworthy that while mothers are often mentioned, the proportion of text files that make explicit mention of fathers has remained stubbornly low, on par with mention of peers and nonhuman organisms. At the broad level, our analyses will showcase the eclectic nature of infancy research -- across specific content areas and methods, over time, and in many countries around the world.

Poster Session 2

A-Motor and Sensorimotor Processes

P2-A-1: Causal links between child-directed speech and language development: A systematic review of reporting habits

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Since the well-known study by Hart and Risley in the 1990s, a substantial literature has arisen investigating the relationship between a child's language development and the speech they hear from their caregivers. In these studies, a recording of the child's auditory environment is analysed for the quantity and quality of parental input to the child (e.g., Quantity: number of word tokens, conversational turns; Quality: mean length of utterance, vocabulary diversity). The child's linguistic development is also assessed, using standardized measures, and correlations are used to establish whether higher quantity and quality of linguistic input in the early years is associated with higher language skills. When a positive relationship is observed, there is a tacit assumption that higher quantity or richer parental speech has been instrumental in the child's language development. However in correlational designs like this, other causal pathways are possible. We investigated the prevalence of different causal interpretations in the published literature, to find out whether the literature contains an interpretative bias. We conducted a systematic review of peer reviewed journal articles from 1977 to 2018 that used a recording of parent/child interactions to establish input characteristics of the child's language environment, and independently assessed the language development of the child. A team of raters independently assessed and cross checked each peer reviewed article that met the inclusion criteria, looking for three causal pathways: Pathway A - the quantity/quality of parent talk influences child language outcomes (e.g., talking more helps a baby develop language skills); Pathway B - endogenous child language skills influence the quantity/quality of caregiver talk (e.g., a chatty child elicits more speech); Pathway C - external factors influence both parent talk and child language development independently (e.g., environmental factors such as



poverty-induced stress). As in any correlation between two measured variables, all three pathways are possible, and it is not possible to establish which causal pathway (or which combination) is correct without direct intervention studies (Bishop 2014). The systematic review assessed which pathways were discussed as possible interpretations in each paper. Following a preregistered PRISMA pathway, database searches returned 2,446 articles, of which 54 were eligible for inclusion (see Figure 1). Overall, 37 articles discussed just one possible causal pathway, 15 discussed two pathways, and only 2 discussed all three pathways. Figure 2 shows that Pathway A was the most commonly discussed interpretation, followed by Pathway B, then Pathway C. This pattern was observed most clearly from the 2000s onward, when publication rates on this topic began to increase. This finding demonstrates that reporting habits in this field are biased towards the interpretation that 'speaking more to a baby will enhance their language development'. This interpretive bias has potential implications for parents, educators and policy makers, as scarce resources may be invested in interventions targeting one causal pathway (e.g., talking more to babies), while others are overlooked (e.g., alleviating poverty in families most at risk). We argue that controlled studies of talk-based interventions will be critical for establishing the effectiveness of this causal pathway.

P2-A-2: Hand proximity speeds object recognition to a greater extent in children than adults

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Peri-hand space is characterized by altered visual processing of objects near the hands and is thought to be mediated by neural networks in the dorsal visual stream. Despite the proposition that peri-hand space evolved to facilitate the development of visually-guided reach and grasp movements in young primates, no studies have investigated whether or not peri-hand space is operational in human children. To test this, adults and 5- to 8-year-old children completed a visual search task while wearing eye-tracking glasses. Participants controlled the timing of visual stimuli presented on a touchscreen by pressing a pushbutton with their left index finger. A central crosshair appeared on the screen for 1000 ms, followed by a target image for 2000 ms, followed by an array containing the target image and 11 distractor images. When the participant identified the target in the array they released the pushbutton and touched the target with their left index finger. Participants completed the task with their right hand beside the visual array (hand close) and in their lap (hand far) and half of the arrays contained images of objects that strongly afforded grasping (graspable) while the other half did not (ungraspable). The results revealed that both adults and children were faster at recognizing the target image when their right hand was positioned near the array, but the magnitude of this near-hand effect was greater in children than adults. These findings provide preliminary support for the idea that peri-hand space is operational in children and could aid in the development of visually-guided reach and grasp movements.

P2-A-3: The relation between tool-use skills and gross motor development during infancy

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INTRODUCTION. Tool-use is a sophisticated behavior that tests infants' ability to: 1) recognize the goal of a task, 2) understand means-end relations between objects (using one object to act on another one), and 3) plan and execute an appropriate sequence of actions to achieve the goal (Fagard, Rat-Fischer, & O'Regan, 2014; Rat-Fischer, O'Regan, & Fagard, 2014). In addition to these cognitive components, successful tool-use also requires adequate postural control and well-developed fine and gross motor skills (Lobo & Galloway, 2008; Thelen, 1990). Therefore, we propose that successful tool-use depends on the level of infants' gross motor development. We hypothesized that more advanced postural and locomotor skills would be associated with higher levels of success in tool-use tasks. **METHODS.** The following data were collected from eighty-five typically-developing infants (52 males): 1) number of tool-use attempts (manipulating the tool without performing the intended tool-use action) and number of tool-use successful actions (performing the intended tool-use action) during play with 11 tool-use toys, monthly from 10 to 14 months; 2) onsets (in months) of gross-motor developmental milestones (sitting, crawling, standing, and walking) using Touwen's (1976) Group III Neurological Assessment Scale, monthly from 6 to 14 months. Statistical analyses relating tool-use skills to gross motor developmental milestones were conducted in HLM. **RESULTS.** Higher number of tool-use attempts was found for infants with earlier onsets of crawling, standing, and walking skills, whereas success in tool-use was associated with early development of sitting, crawling, and standing skills (see Table 1 for detailed statistical results). **DISCUSSION.** Results of multilevel modeling suggested a significant relation between more successful tool-use skills and early onset of postural and locomotor skills. Early onset of sitting, crawling, standing, and walking was associated with higher numbers of tool-use attempts and successful implementation of the intended tool-use actions. Therefore, facilitating gross motor development during infancy might be an effective way to promote sophisticated cognitive skills, such as those involved in tool-use.

P2-A-4: Crawling uniquely predicts age of first word

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Recent research has demonstrated that infants' language development is tied to changes in their motor skills, likely mediated by exploration of the environment and/or changes in parental responses (Adolph & Hoch, 2019; Oudgenoeg-Paz, Volman, & Leseman, 2016). Specifically, Libertus and Violi (2016) found that sitting development predicts vocabulary size, and other recent studies have linked language development to the onset of walking (Walle & Campos, 2014, He, Walle, & Campos, 2015). As predicted, Oudgenoeg et al. (2016) found that the relation between walking and language was indeed mediated by infants' exploration of the environment. Infants' earliest self-locomotion (often in the form of hands-and-knees crawling or "creeping,") has been shown to predict numerous psychological changes (Campos, 2000) and changes in parental speech to infants (Campos, Kermoian, & Zumbahlen, 1992). We suspect that infants' first locomotion would provide a salient change to infants' exploratory behaviors and parental responses, and thus might provide a unique boost to their language development. Therefore, we hypothesized that the age at which infants achieve their first word might be uniquely related to each of several motor milestones, including crawling. In this study, parents reported dates at which their infants began exhibiting certain behaviors. A total of 304



parents of infants (160 female) between 6-12 months completed an online survey asking them to report a variety of milestones including date at which their infants sat without support, crawled on hands and knees more than two body lengths, walked three or more steps without support, and said their first word. We found that age of first word (in days) was correlated with emergence of hands and knees crawling, $r(125) = 0.30$, $p = 0.001$, and walking, $r(85) = 0.36$, $p = 0.001$, but not with age of sitting independently, $r(130) = -0.15$, $p = 0.10$. To explore the unique relations between first words and the various motor milestones, a hierarchical linear regression predicting age at first word by sitting, walking, and crawling was conducted. Sitting was entered in the first step and did not significantly predict age at first word, $p > 0.10$. Adding walking age to the model with sitting predicted 14.8% of the variance, $\beta = 0.385$, $p = 0.004$. With both sitting and walking in the model, crawling uniquely predicted an additional 9% of the variance in age of first word, $\beta = 0.309$, $p = 0.006$. To our knowledge, these data represent the first findings that crawling significantly and uniquely predicts age of first word. As Oudgenoeg-Paz et al. (2016) argued, each motor milestone might be expected to provide an immediate, but not necessarily long-lasting, impact on language, which could help explain why the appearance of the first word, which tends to happen at about one year, would be related to walking onset and crawling onset (average age 7-8 months), but not to sitting, which tends to be mastered by about 6 months (Libertus & Violi, 2016).

P2-A-5: Transition from crawling to walking and gaze communication in everyday lives

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Recent advances in wearable eye-tracker have made it possible to evaluate how learning to walk develops infants' visual exploration and gaze communication in natural situations. While moving on a walkway, walking infants have higher and more distant visual fields than crawling infants, with parents' faces being more often in walking infants' view than they are in crawling infants' view (Kretch et al., 2014). During unconstrained free play, infants with an upright or sitting posture are more likely to look at their parents' faces and engage in eye contact than those in a prone position (Franchak et al., 2018). These studies suggest that the change in infants' first-person perspective accompanied by the development of locomotion or posture affects the frequency of their social looking behavior and eye contact. However, these studies were conducted in a laboratory and little is known about a free-moving dyad's gaze communication in infants' everyday lives. Accordingly, the purpose of this study was to investigate how the transition from crawling to walking changes the frequency of gaze communication and the visual environment where gaze communication occurs in infant's daily lives. In general, infant-parent distance and object clutter in a visual environment influence gaze communication by interacting with an infant's age (Flom et al., 2004, Yamamoto et al., 2019). To assess developmental change of the visual environment where gaze communication occurs, we focused on interpersonal distance and number of objects between the dyad at the time of gaze communication. We analyzed longitudinal data of daily eye contact scenes of five infants aged 10-15.5 months. The data were recorded from head-mounted eye trackers worn by the parents. By employing a Bayesian state-space model, we estimated the effect of the time ratio of walking to crawling for each observation day by the frequency of, interpersonal distance at the time of, and the number of objects between the dyad at the time of, eye contact.



The frequency of eye contact was positively associated with the time ratio of walking to crawling, but this effect was not clear. While the interpersonal distance at which infants initiated eye contact increased clearly with the time ratio of walking to crawling, while that at which parents initiated eye contact did not change. This finding suggests that the space where gaze communication is initiated by the infant, not the parent, expands with infants' walking development. The number of objects on the floor between the dyad at the time of eye contact increased clearly with infant-parent distance but not with the time ratio of walking to crawling. In essence, the present study demonstrates that the transition from crawling to walking increases the frequency of eye contact and changes the ecological context where infants initiate gaze communication with a visual environment characterized by a larger interpersonal distance and therefore more objects cluttered between the dyad. These results have implications for the developmental change of shared attention in conjunction with walking development.

P2-A-6: An open-source, wireless vest for measuring autonomic function in infants

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Behavior is the aggregate product of many nested processes operating and interacting over multiple time scales (Byrge, Sporns, & Smith, 2014; Smith & Thelen, 2003) resulting in a tangle of inter-related causes and effects. For example, a child's ability to visually sustain their attention to objects is not just about looking. It is a complex state that includes holding objects and body stillness (Yu & Smith, 2012), likely inducing changes in heart rate and breathing (Lansink, Mintz, & Richards, 2000). Thus, efforts in identifying the mechanisms supporting infant behavior require the development and advancement of new technologies that can accurately and densely capture behavior's multiple branches. The present study describes an open-source, wireless autonomic vest specifically designed for use in infants 8-24 months of age (Figure 1a). The schematics of the vest, instructions for its construction, and a suite of software designed for its use is made freely available. While the use of such autonomic measures has many applications in the study of infant behavior, the present study will utilize the vest to demonstrate an infant in a state of infant sustained attention (Ruff & Lawson, 1990). The vest weighs 174 grams with a battery box that weighs 98 grams. It is 15.5 inches wide and 4 inches tall. A set of buckles gives room for size adjustment and cloth straps allow it to be secured safely around the neck of the subject. It is made of a 4-way stretch material comprised of nylon and spandex and equipped with several biosensors. Cardiac activity is recorded using three patches of conductive cloth: two on the ventral side of the chest and one on the dorsal to serve as a ground. Trunk motion and posture is measured using a 3-axis accelerometer located in the center of the chest. Respiration is recorded using a force sensitive resistor. Data is both written locally to an SD card and wirelessly streamed from the vest to a computer using Bluetooth. The authors estimate the cost of construction for a single vest to be approximately \$170 USD. A 5-second portion of the collected raw data can be seen in Figure 1b. One validation of the vest is to compare the collected data to known clinical landmarks. The P, Q, R, S, and T components of the heartbeat can be clearly identified in Figure 1b. In addition to these physiological components, clear inhalation and



exhalation can be observed along with variations in movement across the three axes of the accelerometer. A second validation was to capture a period of sustained attention (Figure 1a). This period begins with a brief shift in posture (bottom row, Figure 2). This shift of posture occurs during a period of low respiratory rate and a simultaneous increase in heart rate. Movement, heart rate, and respiratory rate stabilize shortly after these changes.

The described vest supports the measurement of three indices of autonomic function through time. The use of this vest to study child behavior has implications across the field of developmental psychology.

P2-A-7: Development of vocal temporal parameters as a basis of acquiring species-specific sequential sounds in human infants and songbirds

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Infants learn the motor pattern for speech within their first few years. Generally, vocalization utilizes the respiratory airflow for gas exchange. The respiratory and vocal organs should be coordinated to produce vocalizations, especially the more sophisticated coordination in the temporal domain required for vocal sequences that are formed by a series of vocal units. Infants produce cries and spontaneous vocal sequences in the pre-babbling stage. Infants cry immediately upon birth, indicating that respiratory-vocal coordination is capable of innate vocalizations. This study aimed to determine whether the mechanisms for respiratory-vocal coordination are shared by pre-babbling vocalizations and innate vocalizations. To do so, we analyzed the temporal parameters of early vocalizations of infants and neonatal cries. Furthermore, we analyzed song development in birds, another vocal learner, to clarify whether the respiratory-vocal coordination occurred as the foundation to acquire vocal sequence. Bird songs involve the use of several song notes in the appropriate order; with young birds learning songs from adults during their first few months. If respiratory-vocal coordination is the biological foundation for sequential vocalizations, human infants and young birds might share a similar development to learn speech/song. We measured three temporal parameters of early vocalizations from 0 to 11-month-olds in a published database in which five human infants were longitudinally recorded (Amano et al. 2002): Note Duration (ND), which is correspondent to sound duration; Inter-Onset-Interval (IOI), which is the duration between the onset of the preceding and the onset of the following notes; and Inter-Note-Interval (INI), which is the silent gap between two notes (Fig.1). Cries from the same infants during the first two months after birth were also analyzed in relation to the temporal parameters. Finally, we applied the same analysis to the song development of six male Bengalese finches, a member of the songbird species, as another vocal learner. In spontaneous vocalizations, the mean duration of ND was shorter than that of INI at the early stage and gradually increased up to 6 months of age (Fig.2). In the neonates' cries, the mean durations of ND and INI were similar. In Bengalese finches, we found the same tendency in the mean durations of ND and INI; although they differed at the beginning, they gradually converged by 60 days post-hatching. However, while the mean duration of INI gradually became short in birds, this was not seen in human infants (Fig. 2). We found different temporal patterns in spontaneous vocalizations and cries in infants. ND was shorter than INI at the early stage and the mean durations of ND and INI gradually converged in spontaneous vocalizations, although cries showed a similar duration between ND and INI. Furthermore, the developmental change of temporal parameters is shared by the distantly



related songbirds. These results suggest that the early vocal development in the temporal domain could be a foundation for acquiring species-specific sequential vocalizations.

P2-A-8: Development of head-turn from 2 to 12 weeks of age: The influence of environmental contexts

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The development of head control in early infancy has been studied for quite a long time (e.g. Turkewitz, 1965; Rönqvist, Hopkins, 1998; Lima-Alvarez, Tudella, van der Kamp, Savelsbergh, 2014). Two overarching conclusions from these studies are that prior to 2 months of age, infants' head control is weak, especially when in the supine position, and that the majority of infants prefer turning their head to the right side. In most of these studies, an experimenter momentarily held the infants head at midline before releasing it, or presented a visual stimulus to induce head turn. Very little is known, however, about the development of infants' spontaneous head movements during this early period. The present study explored spontaneous head movements in 6 infants followed weekly from the age of 3 to 12 weeks. Infants were observed in 5 conditions: baseline, toys-in-view on the side of preferred head turn, musical toys out-of-view on the non-preferred head turn side, mobile overhead, and mother reading to infant. Each condition lasted 5 minutes while infants laid in supine on a white padded surface surrounded by two vertical white panels to block distractions from the surroundings. Two synched cameras, placed overhead and to the side, recorded the whole session. Head movements were coded with respect to the frontal plane at a frequency of 30 Hz with a custom software (VideoAnalyser, Mare, 2010, figure 1) which provided 2D kinematic data of selected points on the video. The infants' nose was the body point of interest selected to describe head turns. The rate of change, direction, and duration of head turns were extracted and compared across conditions within each session. The coding of the head turn is still in progress; however, preliminary data on 3 infants already suggested a high rate of movement variability across infants. Descriptively, the mean amplitude of spontaneous head displacement appeared already large at 3 weeks and did not vary with age, whereas, the percentage of time the infant was motionless tended to decrease. Infants did not move their head the same depending of the context. Infants were motionless for longer periods of time and moved the head more slowly in the musical toys and mother conditions as compared to the other conditions ($p < .05$). The amplitude of the infant's nose displacement however did not differ significantly according to the condition. These preliminary results show that, when in supine, infants are capable of some head turn activity well before they have acquired head control and can modulate their head turn activity differentially depending on the environmental context. However, we did not see any developmental trend. Infants were more still in the mother condition, possibly due to a motor inhibition mechanism triggered when attention is engaged (Robertson & Johnston, 2009). This study will help further our understanding of how infants' spontaneous head-turn develop in the first 2 months of life, how they may use it to explore their surroundings, and learn how to orient their head to neighboring environmental cues.

P2-A-9: Exuberance in play: Infants' interactions with objects at home



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Most of what researchers know about infant object interactions is based on structured observations with small sets of objects and few distractions. Typically, researchers determine the objects for play (mostly toys), the time available for play (a few minutes), and the places where play occurs (usually at a table with toys within reach). But, the rigor of experimental control comes at a cost. It leaves unanswered questions about the characteristics of infants' natural play at home, where untold objects vie for attention and learning typically occurs. So, we aimed to characterize how much infants play with objects during natural activity at home and what objects infants choose for play. We video recorded 40 singleton, firstborn infants during everyday activity at home for 4 hours across two visits (within a week): 20 13-month-olds (10 crawlers, 9 girls), 10 18-month-olds (6 girls), and 10 23-month-olds (4 girls). Home visits were scheduled between meals and naps. Mothers were instructed to behave as they normally would. They sometimes joined infants' play, but often did chores, cooked, and worked. We obtained the frequency, duration, and distribution of infants' object interactions by frame-by-frame coding videos to identify each manual displacement of an object. Each object bout was classified as involving toys (objects designed for child play; e.g., ball, book, stuffed animal), non-toys (household objects; e.g., spoon, food, door), or mixed (combination of toys and non-toys). Infants' natural object play is exuberant. Their object interactions are brief, abundant, and diverse, as shown by the individual timelines in Figure 1A. Frequent transitions between object interaction and time off objects and among different types of objects held at every time unit (nested timelines of exemplar infant in Figure 1B). Infants averaged 61.2% of each hour interacting with objects (range: 40%-80%). Most infants (80%) spent more time interacting with objects than not, $t(39)=6.45$, $p<.001$. Immense amounts of playtime with objects/hour resulted from the accumulation of dozens of brief object bouts: 85.3% of bouts lasted less than a minute; 13% lasted 1-5 minutes; and only 1.5% lasted more than 5 minutes. In other words, infants quickly and continually transitioned between interacting and not interacting with objects, and they flitted from one object to another. Infants did not fatigue over the two-hour sessions. They spent equivalent amounts of time with objects during each of the four hours. Infants selected every type of object for play. They spent $M=48\%$ of their time in mixed bouts, 32% with toys, and 19.9% with non-toys, and this pattern held across age groups and between crawlers and walkers, all $ps>.265$. For toy interactions, most infants (>50%) played with children's books, plush animals, and balls (Figure 2A). For non-toy interactions, most infants (>50%) played with boxes, food, and cups (Figure 2B). Findings point to exuberance in infants' spontaneous interactions with objects. Infants' natural object play is not characterized by highly regulated, focused attention to single objects for extended time periods. Indeed, infants' natural schedule of massive, time-distributed, variable object experience is likely to be highly conducive for learning.

P2-A-10: Automatic movement quantification in siblings of children with ASD at 10 months relates to developmental outcomes at 36 months

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Background: Learning to move facilitates learning and development across a wide range of psychological domains (Adolph & Hoch, 2019). As infants progress in mastering their fine and gross motor skills, they begin exploring objects in detail and engaging in object play with their caregivers (e.g., Yu and Smith, 2017). However, any disruption in early motor development could have cascading effects on social and language learning later in life (LeBarton & Landa, 2019). Normally, motor development is assessed using general observational measures that focus on milestones. Here, we present an automatic approach to quantify infant movement from videos as a novel measure of atypical motor development. Methods: We tracked body movements (head and part of the trunk together) in parent-infant interactions using Tracking-Leaning-Detection (TLD, Kalal et al., 2011), previously employed for analysing face-to-face parent-infant interactions (López Pérez et al., 2017). We analysed the average amount of movement in a sample of 44 infants at 10 months, who had an older sibling (Sibs) with diagnosis of autism spectrum disorder (Sibs-ASD) or typically developing (Sibs-TD). For some analysis the Sibs-ASD group was also divided into groups according to diagnostic outcome at 36 months (infants that were diagnosed with ASD or had an elevated ADOS score at 36 months (SibsA+ = 8) and those who did not get a diagnosis (SibsA- = 18). We related movement measures to follow-up assessments (e.g., VABS, ECBQ, CDI, MSEL) at 36 months. Due to participant drop out, the final sample for those correlations varied depending on the scale. Results: Differences in the average amount of movement at 10 months of age were not found when comparing Sibs-ASD and Sibs-TD ($t(42) = .15, p = .87$). However, differences in movement were significant after splitting the Sibs-ASD group based on diagnosis ($H(2) = 10.6, p = .005$), where the SibsA+ showed on average more head movement in comparison with other groups. We found significant correlations with developmental outcomes at 36 months in language: VABScom ($r(28) = -.45, p = .01$), CDIprod ($r(27) = -.40, p = .03$); social: VABSsoc ($r(25) = -.49, p = .02$), ECBQsoc ($r(25) = -.54, p = .005$) attention: ECBQats ($r(25) = -.58, p = .002$), and self-regulatory skills :ECBQreg ($r(27) = -.45, p = 0.01$). Discussion: The rapid evolution of computer vision methods opens new doors for the analysis of motor development in infancy. Using a video tracker we were able to quantify head and trunk movements of infants during parent-infant interactions. We found that more movement at 10 months was negatively correlated with social, attention and communication skills at 36 months. These results are in line with current ideas suggesting that a disruption in early motor development could have cascading effects on later cognitive development (LeBarton & Landa, 2019) and highlight the importance of identifying early differences to better understand different pathways in cognitive development. Further research is needed to disentangle the nature of these motor movements into finer categories, that can help understand the developmental trajectories of the motor domains and its relation to developmental outcomes.

P2-A-11: Gamified face and body mark test: A new method for revealing topographical maps of young children's body parts

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Introduction: In 2019, we proposed a new methodology to evaluate topological maps of children's bodies by incorporating gamification into the mark tests (i.e., a virtual mark test). A motion-sensing input device (Microsoft, Kinect v2) was used to track participants' faces in 3D, and six digital target marks were displayed on their face parts (nose, right/left cheek, lower/upper forehead, and chin). We asked them to touch the real parts of their faces corresponding to the displayed target marks, and quantitatively evaluated the development of topological knowledge of these parts (Miyazaki, Asai, and Mugitani, 2019). In the present study, we improved this version of the face task to evaluate topological maps of children's body parts more easily. An image processing technique (CMU-Perceptual-Computing-Lab, Openpose) was used to track participants' kinematic information in 2D. Method: Participants: Twenty-one children aged 2.5 to 3.5 years old (10 females and 11 males; mean age: 34.6 months; range: 27-43 months). Apparatus and task: An image of the whole body of each participant was recorded via a USB camera, and projected onto the screen (see Figure 1: it was presented in a mirror-like, or ipsilateral, relationship). The 2D coordinates of their body parts were detected by Openpose image processing and recorded. Digital marks were displayed individually on 20 body parts (upper forehead, forehead, eyes, cheeks, ears, nose, mouth, chin, middle of neck and shoulder, shoulders, upper arm, elbow, forearm, wrist, hand, neck, thigh, knee, ankle, and toe) and the reference point (navel). We observed whether the participants could touch the actual body part corresponding to the mark position correctly. If children could touch the correct body part, a cheerful visual and auditory reward was presented. In total, we prepared 80 trials for each participant; 20 trials for each body part and 20 navel trials (reference) were conducted alternatively. This block was repeated two times. Additionally, we asked their parents about the vocabulary acquisition status of their children using a questionnaire. Results and Discussion: Overall, the average number of executed trials was 31.6. Even though our request was a simple repetition of touching the mark, participants could perform a relatively large number of trials compared with previous studies. Accordingly, we were able to maintain participants' motivation for this whole-body version. It seems that the effect of gamification (i.e., producing a pleasant animation and sound) was demonstrated. The overall correct rate for touch was 48% for 2-year-olds and 62% for 3-year-olds. The questionnaire results revealed that, for the 60 words we asked, 59% (2-year-olds) and 69% (3-year-olds) of the words were able to be said as well as comprehended. We examined whether the correct rate of touch increases if the child has acquired more body part names. However, such a tendency was not seen. Rather, there was a tendency for children with a high vocabulary acquisition to keep executing many tasks (partial correlation coefficient $r = 0.53$, $p < .05$). Furthermore, using rich 2D skeleton data, it is expected that the reaching patterns could be categorized from reaching trajectories (see Figure 2). In our presentation, we would like to report details of the results and discuss the possibilities of gamification and development of a topological map.

P2-A-12: Is the mouth a focal point of activity? A look at facial contacts in the first weeks of life

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The mouth has been considered as a focal point of early self-contact activity in both fetuses and newborns. Fetal hand movements towards the mouth were found to be slower as compared to movements towards other body locations (Zoia et al. 2007). Additionally, frequent



hand to mouth movements have been observed soon after birth, showing that these touches continue postnatally (Butterworth and Hopkins, 1988). The present study aims to examine spontaneous early hand to mouth contacts in the larger context of infants' generalized body self-touch experiences. We aim to determine if the mouth is a greater focal point of self-touch activity compared to other body parts. Five infants aged 3-weeks-old were observed weekly until they gained head control (between 9 and 13 weeks of age). Infants laid supine while their movements were recorded during five 5-minute-conditions (baseline, toys-in-view, caregiver-speaking, unseen musical toy, mobile overhead). Contacts to the infants' bodies and surrounding area were hand coded as a function of 20 body areas and three floor regions. These areas represent the different locations that an infant could reach to. Contacts to the mouth and lower face contacts were also selected. Regions contacted prior to the lower face were identified to determine how far the hand was prior to lower face contact. Contacts to the mouth represented only 17.86% of head contacts and were significantly below chance level when considering all touches to the lower face, head, and body/floor ($p < .015$); they were at chance level when mouth contacts were compared to body self-touches. Touches to the lower face were also at chance level in comparison to the whole head, the body, and the body and floor combined ($p > .05$). Further analyses revealed an effect of hand location proximity prior to making contacts to the lower face area ($p = .011$). Specifically, if the hand was on the floor above the shoulder line, infants were more likely to contact the lower face area next ($p = .007$), suggesting that infants are more likely to touch their lower face if their hand is already in relative proximity to the head. These findings indicate that spontaneous hand contacts to the mouth occur rather infrequently in the first 2 postnatal months of life when examined in the larger context of other body and floor areas contacts. Thus, at this early age, the mouth may not be such a high focal point of early self-touch. Additionally, when lower face contacts did occur, they mostly originated from proximal locations on the body or floor. This suggests that the infrequent mouth touches may be facilitated when the hand is located nearby, but moving the hand to the mouth from a more distal region may be more unlikely.

P2-A-13: Factors affecting learning to use a new tool in the second year of life

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Infants learn about tools from hands-on experience and from observing the actions of others. Existing research shows that infants struggle to successfully complete tasks that require them to be flexible in their thinking about tools (e.g., spoons), but little is known about the specific factors that contribute to infants' learning about tools. In the present study, we gave 147 13-17-month-old infants experience with a novel tool (learning phase) and then gave them a challenging task: turning on a lightbox with one end of the tool (test phase). We manipulated various aspects of what infants experienced during the learning phase to see which would lead to higher rates of success at test. These factors included (1) the properties of the tool, (2) whether or not the infant received an active (hands-on) or passive (watching only) tool-learning experience, and (3) whether or not the manner of using the tool (which part of the tool was grasped) during the learning phase matched that which would lead to success in test ("matched" vs. "mismatched" learning experience). Data were analyzed using multilevel logistic regression with task success (binary) as the outcome variable. We found that the manner of tool use (matched vs. mismatched) during learning significantly predicted success



in the test task, such that infants with matched training were more likely to succeed, $B = -4.195$, $SE = 1.194$, $p < .001$. Overall, hands-on learning did not seem to improve task success above passive/observational learning. However, there was a significant 3-way interaction between tool properties, active/passive training, and matched/mismatched training ($B = -5.219$, $SE = 2.028$, $p = .010$), such that matched, hands-on experience with a weighted tool (a tool with an uneven weight distribution that was only apparent once the tool was held) produced the highest rate of task success. These results indicate that, in general, infants can successfully learn about a new tool either using their own hands-on experiences or by watching others use the tool to accomplish a goal. However, hands-on experience may be critical for tool-use success when the tool has an unexpected property (e.g., our weighted tool). Perhaps unexpected tool properties direct infants' attention to their grasp of the tool, which is an important component of effective tool use. Promoting infants' learning about tools thus includes providing opportunities for observation of others' successful use of tools and hands-on practice with tools that have unexpected properties.

P2-A-14: Distal adjustments of reaching in infants at socioenvironmental and biological risk

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Introduction: Reaching is a skill acquired during the third and fifth month of age in infants with typical development and is considered one of the first phases of voluntary motor development. Through reach the infant explores and interacts with the environment favoring cognitive, perceptual and social development. Thus, infants exposed to risk factors may have this ability impaired. Objective: To analyze the frequency and distal adjustments of manual reach in infants at socioenvironmental risk, biological risk and infants without risk at 6 months of age. Methods: Eighteen infants were divided into three groups:six full-term infants without risk (196.5 ± 9.95 months) (G1); six full-term infants at socioenvironmental risk (195.66 ± 1.18 months) (G2) and six very preterm infants (188.83 ± 5.45 months, corrected age) (G3). A descriptive analysis of the following variables was performed: range frequency and distal adjustment (palm orientation: horizontal, oblique or vertical hand). Results: It was observed that the average range frequency was higher in G1 (7.16 ± 2.13) when compared to G2 (3.33 ± 2.25) and G3 (5.66 ± 3.44). Regarding the orientation of the palm, the G1 reached more ranges with oblique (57.03%), horizontal (26.71%) and vertical (16.25%) hands; G2 reached with oblique hand (63.01%) and horizontal hand (36.98%), and G3 achieved the most reaches with vertical (44.48%), oblique (44.44%) and horizontal (9.07%) hands. Conclusion: G2 infants had lower frequency of reach, which may be related to timing and variety of stimuli. Regarding to palm orientation G3 infants performed more vertical hand reaches than G1 and G2. The G2 infants did not reach with their hands vertically, which are considered more functional. Socioenvironmental risk seems to negatively impact the development of reaching ability, which may impair the interaction and exploration of infants with the environment.

P2-B-15: Lip and tongue ties: Impact on infants' sleep before and after a frenectomy



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Altered lingual frenulum, colloquially known as "tongue tie" causes the discordance of the tongue's position at rest and of movement and restricts movement of the tongue which impairs infants' ability to feed, decreases quality of sleep, promotes snoring, and has been linked to sleep apnea (Guilleminault et al., 2016). Additionally, lip and tongue ties were seen in asphyxiated infants, and considered markers to identify infants who are at higher risk of Sudden Infant Death Syndrome (SIDS)(Haller & Brown, 2016). Both tongue and lip ties affect the suck- swallow and breathing coordination, and infants experience apneas during the feeding process(Praborini et al., 2015). These feeding difficulties associated with colic and reflux are linked to poor sleep in infants (Cohen et al., 2014). Poor sleep during infancy may lead to neurodevelopmental disabilities, cognitive delays, and behavioral transgressions. Thus, we investigated whether a frenectomy, a procedure to correct lip and tongue tie, improves sleep. Two parents of infants with lip and tongue ties completed the Brief Infant Sleep Questionnaire (BISQ), a validated measure used to assess sleep duration, times of nocturnal waking, and methods used to help the infant fall asleep both pre-frenectomy and 4-6 weeks post-frenectomy. The measures reviewed were night sleep duration, night waking, duration of time awake at night, night sleep time and time to settle the infant to sleep. To corroborate parent report, infants wore an actigraph, a wristwatch-like activity monitor that measures sleep quality, on their left ankle for 7 nights 4-6 weeks post-frenectomy. We found that sleep duration improved from 6hrs of sleep to 8-11 hours of sleep post frenectomy. The increase in sleep duration moved the infants into a normative duration of sleep, which is generally seen in infants between 0-6 months(Galland et al., 2012). The Post BISQ questionnaire and actigraphy demonstrated that there were still small sleep problems present 4-6 weeks after the frenectomies. As expected, the actigraph recorded more night waking and time spent awake than parental report (see Table 1).The findings for pre- to post- BISQ showed night waking and time spent awake at night decreased, sleep duration increased, and one infant went to sleep earlier (see Table 1). Although night-wakings decreased, they were higher than the 0-3 night wakings, seen in typical infants' sleep (Galland et al., 2012). The 7 days of actigraphy provided a visual of the elevated levels of activity that continued through the night, after 4-6 weeks post- frenectomy, which were evident in both infants (see Figure 1). These results are a glimpse into our understanding of the systemic stress that lack of sleep has on all systems of the body. Recovery of sleep is a process that does not happen immediately, and currently we do not know how long it will take for infants to recover from disturbed sleep related to restricted movement of the tongue. Ongoing data collection will shed light on the recovery of sleep post-frenectomy in infants 1-7 months, and clarify whether age and severity pre-frenectomy influence the speed of recovery.

B-Developmental Neuroscience

P2-B-16: Parental influences on childrens' attention operate via autonomic arousal



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Children are more attentive towards play objects when they are engaged in joint play together with an adult, compared to when playing alone (Yu & Smith, 2016; Wass et al., 2018). This finding has led researchers to conclude that social influences exert an immediate beneficial effect on children's attention. In this presentation, we present some findings that appear initially to be inconsistent with this conclusion. Our data are from N=46 infants (mean age: 11.5 months) and their parents collected in two settings. In condition 1 ('Joint Play'), children played jointly across a tabletop with toys. In condition 2 ('Solo Play') the setting was identical except that a small 40cm barrier was present between child and parent, and both played in parallel but separately with two identical sets of toys. Gaze data was micro-coded at 30 frames per second; physiological data was collected by recording dual electro-cardiograms. Firstly, we will show that everything about the specific moments of adults' gaze to children during joint play suggests that, around the moments when the parent is gazing at the child, the child is less attentive towards the play objects (see Figure 1a). Secondly, we will show that, in dyads where the parent gazes more at the child during the interaction, the child is less attentive (Figure 1b). These findings appear inconsistent with the hypothesis that social influences exert an immediate beneficial effect on children's attention. Then, we will present a way to reconcile these findings with previous findings which suggest that children are, overall, more attentive during joint play. We argue that the role that adults play in social attention is to help to stop the child from 'fussing out' at times when they otherwise would. Through this, they help the child to maintain allostasis in arousal, increasing their attentiveness. In support of this, we present analyses suggesting that parents dynamically adapt their orienting style to the arousal state of the infant. When examining fluctuations in children's arousal within a testing session, we find that parents take a more 'child-led' approach at times when their infant's autonomic arousal is higher (see Figure 2a). We also find that parents' look durations to play objects correlated with their child's level of arousal ($p=.04$), but not their own ($p=.36$). Finally, we will present evidence suggesting that parents, by adaptively responding to their infants during joint play, effectively manipulate their infants' arousal. By calculating auto-correlation functions we find that both look duration and autonomic arousal showed a slower rate of change during solo play than during joint play ($p=.002/<.001$) (Figure 2b). Average levels of autonomic arousal were also non-significantly lower during joint play ($p=.28$), and attentiveness was higher ($p<.001$). Overall, these results suggest that parents dynamically and adaptively respond to changes in their child's arousal during joint play and that this process of dynamic adaptation contributes to reducing the child's overall levels of arousal, with concomitant increases in attentiveness.

P2-B-17: Household income but not psychosocial stress moderates mother-infant heart rate synchrony

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The parent-infant relationship is a complex, dynamic system in which parents and infants continuously co-regulate each other for better and for worse. Increasingly, research and theory suggest that the co-regulation of physiological activity--a process often referred to as synchrony--is an important component of the parent-infant relationship supporting the



development of self-regulation (Feldman, 2012). However, synchrony does not operate in a simple, predictable manner. Several studies indicate that mother-infant physiological synchrony is dependent on psychosocial factors such as stress and depression (Suveg et al., 2015; Woody et al., 2016). Environmental factors, such as low socioeconomic status (SES), likely also impact mother-infant physiological synchrony, given extensive research showing that SES can affect mother and infant neurophysiological functioning (Lupien et al., 2009). Yet, relations between SES and mother-infant physiological synchrony remain understudied. Thus, in the present analysis, we investigate the extent to which household income as well as maternal psychosocial stress moderate mother-infant physiological synchrony. Parents and their infants were recruited from a wide range of economic backgrounds (annual household income: \$13k - \$350k). At three months of age, infants and their mothers (N = 37 dyads) participated in a variety of lab tasks and mothers completed surveys and questionnaires. Electrocardiography (ECG) was recorded continuously for five minutes from mothers and infants while they sat passively viewing non-arousing stimuli on a computer screen. Trained coders edited ECG data for movement artifacts. Interbeat intervals (IBI) were calculated from ECG. Mothers also reported socioeconomic information and completed surveys on their own levels of perceived stress (Perceived Stress Scale; Cohen et al., 1983) and depression (Edinburgh Postnatal Depression Scale; Cox et al., 1987). Results from multilevel models revealed that there was a significant positive within-dyad association between mothers' and infants' IBIs ($p < .01$), indicating heart rate synchrony on average across the sample. Additionally, this synchrony was moderated by household income such that there was a strong positive association between mother and infant IBI at higher income ($p < .01$), but no association at lower income ($p = .30$; see Figure 1). Importantly, this moderation was present regardless of whether mother or infant IBIs were used as the outcome. Furthermore, IBI synchrony was not associated with maternal perceived stress or depression. These results were observed while controlling for numerous potential confounds such as mother and infant race/ethnicity, gender, age, maternal and paternal education, household density, average mother and infant IBI, and gestational age at birth. Our study provides further support for the idea that mother's and infant's cardiac physiology is interdependent and that heart rate synchrony is contingent on environmental factors, namely household income. These results suggest that higher income households may support mother-infant IBI synchrony, whereas lower income households may interrupt synchrony. These findings are consistent with studies that have found decreased cardiac synchrony related to negative psychosocial factors. However, more research is needed to understand the extent to which the absence or presence of synchrony confers advantage or disadvantage in the mother-infant relationship.

P2-B-18: Emotional valence modulates the topology of the parent-infant inter-brain network

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Emotional communication between parents and children is crucial during early life, yet little is known about its neural underpinnings. Recent approaches have used connectivity-based measures to examine how networks of brain regions coordinate their activity during emotion processing. In particular, graph theory-based indices are widely used to capture complex



hierarchical features of neural networks, and to pinpoint important local network nodes that influence global function. However, graph theoretic measures of network topology have not yet been adapted to study the parent-infant interbrain network. Here, we adapt and apply graph network measures to assess how positive and negative emotions modulate the interpersonal neural network between infants and their mothers during naturalistic interaction. Fifteen mothers were asked to model positive and negative emotions towards pairs of objects during social interaction with their infants whilst the neural activity of both mothers and infants was concurrently measured using dual electroencephalography (EEG). Mothers' and infants' intra-brain and inter-brain connectivity during maternal expression of positive and negative emotions were computed using Partial directed coherence (PDC) as a directed metric and Phase-Locking Value (PLV) as a non-directed measure. Graph theory-based metrics were then used to quantify differences in intra- and inter-brain network topology as a function of emotional valence. The within-brain network indices computed were Strength, Transitivity, Global Efficiency and Betweenness Centrality. Inter-brain network topology was assessed using adapted measures of (interbrain) Density, Strength and Divisibility. We found that inter-brain network indices (Density, Strength and Divisibility) consistently revealed strong effects of emotional valence on the topology of the parent-child neural network. Mother and infant showed stronger integration of their neural processes during positive than negative emotional states (i.e. higher interbrain Density and Strength, lower Divisibility). Furthermore, directed inter-brain connectivity metrics (based on PDC) revealed that mothers had a stronger directional influence on the dyadic network during positive than negative emotional states. By contrast, infants had a stronger influence on the network during negative emotional states (see Figure 1). Conversely, for intra-brain networks, only weak effects of valence were detected on maternal intra-brain network topology, whilst infant intra-brain networks showed no significant valence-related changes in topology. These results indicate that parent-infant synchrony (i.e. the inter-brain network) is strongly modulated by the emotional tone of dyadic social interactions. Additionally, our results demonstrate that inter-brain graph metrics may be successfully applied to elucidate these effects.

P2-B-19: Infant face individuation: FPVS evidence

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While adults are very good at recognizing faces, face individuation may be challenging for young infants. Evidence indicates that under certain circumstances, infants can recognize their mother's face and also unfamiliar faces (Coulon et al., 2011; de Haan & Nelson, 1997; Peykarjou et al., 2016). However, previous studies have tested recognition using the same image of each face repeatedly, and very few studies investigate the process of becoming familiar with a face. Thus, it remains unclear how proficient infants are at recognizing faces. In the current study, we tested individuation of the mother's face and an unfamiliar face using a Fast Periodic Visual Stimulation (FPVS) paradigm. Following a 30 second familiarization trial in which an image of either the mother or the unfamiliar face was displayed, 12 different images of this target face were presented among four unfamiliar stranger faces (48 different images) in an oddball paradigm. Trials with mother or unfamiliar face targets were compared within-



subjects. Images were presented at a high rate of 6 images per second (6Hz) with the oddball appearing as every 5th image, corresponding to a frequency of 1.2 Hz. We contrasted conditions where the target face appeared as oddball (S = stranger, T = target; SSSSTSSSST...) or as base stimulus (TTTTSTTTTS...). 18 infants (10 males, average age 5 months 10 days) were tested with target faces presented as standards, 21 infants (10 males, average age 5 months 19 days) with target faces as oddballs. When target faces were presented as standards, novel stranger faces elicited an individuation response among both mothers (SNR = 1.11, $Z > 2.33$, $p < .01$) and unfamiliar strangers (SNR = 1.12, $Z > 2.33$, $p < .01$). When target faces were presented as oddballs, similarly both mother (SNR = 1.20, $Z > 3.74$, $p < .0001$) and unfamiliar stranger (SNR = 1.21, $Z > 3.74$, $p < .0001$) oddballs elicited an individuation response. The individuation response was strongest in harmonics 6-9 on medial-occipital channels (O1, O2, Oz, Iz). Mixed ANOVAs revealed that there was no effect of experiment (target standard/oddball, $F = 2.52$, $p > .05$) or condition (target mother/familiarized stranger, $F = .07$, $p > .05$). Thus, infants individuated faces similarly across all conditions. Together, these data show that infants are able to recognize familiar and familiarized faces across different images and at a high speed. To assess the effect of the familiarization trial on individuation, we are also testing infants with stranger faces without prior exposure to the face. This will help us to clarify the role of experience in infant face individuation.

P2-B-20: Testing three hypotheses about effects of sensitive-insensitive parenting on telomeres

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Extensive evidence indicates that prenatal stress is a risk factor for a variety of detrimental outcomes. Although the former evidence suggests that prenatal stress disrupts "optimal" development, Pluess and Belsky (2009) advanced a radically different interpretation. Based on research with human infants showing (a) that prenatal stress is associated with heightened negative emotionality and (b) that this phenotype is itself associated with increased susceptibility to both positive and negative environmental exposures, they hypothesized that prenatal stress programs postnatal plasticity, making prenatally stressed infants especially susceptible to effects of both positive and negative rearing. This study tested this hypothesis, and focused hereby on telomeres. Telomeres are the protective DNA-protein sequences appearing at the ends of chromosomes; they shorten with each cell division and are considered a biomarker of aging. Shorter telomere length and greater erosion have been associated with compromised physical and mental health, and are hypothesized to be affected by early-life stress. In the latter case, most work has relied on retrospective measures of early-life stressors. (XX). The lack or loss of sensitive and responsive parental caregiving is among the most potent stressors early in life. We hypothesized that (1) less sensitive parenting would predict shorter telomeres and greater erosion; and that such effects would be most pronounced in children (2) exposed to prenatal stress and/or (3) who were highly negatively emotional as infants. Results revealed, only, that prenatal stress amplified parenting effects on telomere change--in a differential-susceptibility-related manner: prenatally stressed children



displayed more erosion when they experienced insensitive parenting and less erosion when they experienced sensitive parenting. Mechanisms that might initiate greater postnatal plasticity as a result of prenatal stress are highlighted and future work outlined.

P2-B-21: Different dimensions of prenatal distress have shared and unique effects on neonatal hippocampal connectivity and infant memory

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Prenatal maternal distress--an umbrella concept encompassing multiple negative psychological states including stress, anxiety, and depression--is a substantial prenatal exposure. Consistent across preclinical and human studies, the hippocampus displays alterations due to prenatal distress. Nevertheless, most prenatal distress studies do not focus on multiple dimensions of, have not examined hippocampal functional connectivity in association with, and do not consider observer-based functional outcomes related to distress. We investigated the shared and unique effects of different dimensions of prenatal distress in pregnant adolescents, a population at high risk for distress, in association to neonatal hippocampal connectivity and infant memory. In pregnant adolescents ($n=42$), we collected three measures of distress (perceived stress, pregnancy specific distress, and 24-hour ambulatory salivary cortisol) during the 2nd and 3rd trimesters. Resting-state imaging data were acquired in their infants at 40-44 weeks post-menstrual age. Standard functional connectivity preprocessing was applied. Functional connectivity was measured from hippocampal seeds. Memory abilities were obtained at 4-months using the mobile conjugate reinforcement task. Shared across different dimensions of maternal distress, increased 3rd trimester maternal distress associated with weaker hippocampal-cingulate cortex connectivity ($p<0.05$, corrected) and stronger hippocampal-temporal lobe connectivity ($p<0.05$, corrected). Yet, each dimension mapped onto unique spatial locations in each region. Perceived stress inversely correlated while hippocampal-cingulate cortex connectivity positively correlated with infant memory. Increased cortisol--collected during the 2nd, but not the 3rd, trimester--associated with weaker hippocampal-cingulate cortex connectivity and stronger hippocampal-temporal lobe connectivity. Perceived stress correlated inversely and hippocampal connectivity correlated positively with infant memory ($p<0.05$). Consistent across multiple dimensions of maternal distress collected during pregnancy, we showed that 3rd trimester distress likely influences the developing brain. Our findings provide evidence that prenatal distress is associated with hippocampal networks implicated in stress, long-term memory formation, and psychiatric illness. Together, these results suggest that effects in the cingulate cortex and temporal lobes are shared across different dimensions of maternal distress, yet each dimension maps onto spatial unique locations in the cingulate cortex and temporal lobes. Future studies should continue to clarify the shared and unique ways that different dimensions of distress map onto the developing brain, possibly using outcome measures collected longitudinally and predictive modeling methods.



P2-B-22: Prenatal predictors of infant and maternal sleep

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Adequate sleep quality is essential for neurological development, learning, immune system functioning, and socioemotional development among infants (Huhdanpää et al., 2019). Relatedly, sleep disturbances are implicated in numerous health challenges across the lifespan, including depression and anxiety among mothers (Field et al., 2007; Matenchuk et al., 2019), irritability and negative emotionality among infants (Field et al., 2007), and externalizing behaviors among children (Moore & Bonuck, 2013). Despite well-established associations between sleep and a range of health outcomes across the lifespan, there is a paucity of research extending beyond single-diagnostic investigations to identify transdiagnostic predictors of sleep outcomes. We aimed to address this gap in the literature within the framework of the Research Domain Criteria (RDoC). We tested whether prenatal maternal emotion dysregulation (ED) predicted infant and maternal sleep outcomes at 7 months postpartum. We also examined whether maternal prenatal hair cortisol and newborn neurobehavior mediated the relation between prenatal ED and 7-month sleep outcomes. We recruited 162 English- and Spanish-speaking pregnant women (Mage = 29, SDage = 5.16 years) based on a uniform distribution of self-reported ED. Pregnant women provided hair samples after their 25th week of pregnancy. Newborn neurobehavior was assessed using the NICU Network Neurobehavioral Scale (NNNS) between 24 hours and 2 months after birth. Two RDoC-informed NNNS factors, arousal and attention, were derived in this sample. At 7 months postpartum, participants reported on their and their infants' sleep duration and quality. Contrary to pre-registered hypotheses (<https://osf.io/bmct3/>), prenatal ED did not predict infant or maternal sleep outcomes above and beyond maternal ED at 7 months postpartum. Maternal hair cortisol and newborn neurobehavior also did not mediate the relation between prenatal ED and 7-month sleep outcomes, though newborn attention predicted infant sleep duration (Figure 1). Newborns with higher attention went to sleep earlier and slept longer at night than their less attentive peers. Our findings underscore the importance of integrating perinatal neurobehavioral development into the RDoC framework to promote understanding of transdiagnostic risk across the lifespan.

P2-B-23: Neural correlates of improved mother-infant attachment in teenage mothers and their babies living in adverse conditions in Brazil

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Adolescent motherhood remains common in low-and-middle-income countries (LMICs) and is associated with a range of factors that negatively impact infant neurodevelopment, including poverty, low maternal education, maternal socio-emotional immaturity, and maternal psychopathology. Early interventions to prevent such adverse effects on infant neurodevelopment are crucial. Interventions that focus on enhancing the mother-infant



relationship may be particularly helpful, since secure attachment relationships and good socio-emotional skills have been shown to act as protective factors against developmental problems for children growing up in adversity. In a recent randomized controlled trial of a nurse home-visitation intervention targeting maternal parenting skills and mother-infant attachment for adolescent mothers and their babies in Brazil, we found that this form of intervention improved mother-infant attachment behaviour at age 12 months, with infants of mothers who received the intervention ($n=28$) showing better socio-emotional behaviours and a larger proportion of these infants displaying secure attachment relationships with their mothers compared to control infants ($n=28$) who received care-as-usual (Alarcão et al., In preparation). The purpose of the current analysis was to investigate the neurocognitive mechanisms involved in improved attachment and socio-emotional behaviours associated with the intervention, and whether these can be observed earlier in life than overt behavioural changes. We used electroencephalography (EEG) to measure infants' neurophysiological activity while they completed a task designed to engage socio-emotional processing (viewing images of their mother's face and a stranger's face) when they were 6 months old. We derived a neurophysiological index of social attention and attachment development, the Nc event-related potential (ERP) component, for mother and stranger face trials at frontal and central scalp sites. We first compared amplitude and latency of the Nc between infants in the intervention and control groups to test whether the intervention was associated with improved neurocognitive socio-emotional processing in the first 6 months of life. Second, we computed correlations between the Nc at age 6-months and overt measures of socio-emotional behaviour at age 12-months to test whether neurophysiological correlates of earlier-life socio-emotional processing longitudinally predicted later behaviourally-observable socio-emotional skills. Our results showed, firstly, that infants in the intervention group had significantly faster Nc latencies at frontal scalp than control infants ($p=.005$, $\eta^2=.270$, Figure 1), suggestive of less effortful socio-emotional processing in the intervention infants. Second, smaller frontal Nc amplitudes to the mother's face at 6-months were significantly associated with better socio-emotional behaviours at 12-months ($p=.009$, $r^2=.25$, Figure 2), a pattern that has previously been reported in infants with better attachment relationships with their adult mothers in high-income countries. These findings support the effectiveness of this early intervention in improving early socio-emotional skills and mother-infant attachment relationships for infants of adolescent mothers living in adverse environments, and suggest that positive effects of the intervention begin as early as age 6 months and may be mediated by enhanced processing in socio-emotional neural circuitry.

P2-B-24: How maternal guidance of attention shapes infants' basic visual perception. A cross-cultural neuroscience approach

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Human visual perception differs profoundly between cultures. 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. Köster & Kärtner (2018) found that inter-individual differences in context-sensitivity were explained by parental verbal guidance of attention in early childhood. In the present cross-cultural electroencephalogram



(EEG) study, we assess whether maternal guidance of attention affects 11- to 13-month-olds' (N=80) context-sensitivity in a culture specific way. To measure context-sensitivity non-verbally, we established that visual cortical processing of object versus background could be assessed in the EEG of children by using a frequency tagging approach, in a former EEG study (Köster et al., 2017). This is, presenting object and background at different driving frequencies elicits separate evoked responses for each, object and background. In the present study, mother-infant dyads from an urban context in Kyoto, Japan and in Vienna, Austria were shown visual scenes with an object in front of a background (Figure A). Object and background were flickered at different driving frequencies (5.66 and 8.5 Hz, counterbalanced) while infants' visual cortical processing was measured with EEG (Figure B). We applied a pre-post design with a training phase in between: in the pre- and post-phases, infants observed the scenes. During training, mothers pointed out elements to their infants, which they considered interesting. When comparing maternal attention styles between cultures (N=27 per culture), we found that Austrian mothers guided their infants' attention more frequently to the object versus the background, compared to Japanese mothers ($p < 0.001$, $t = 3.73$) (Figure C). Further, we will assess if maternal attention guidance increases infants' visual cortical processing (evoked responses) to the element pointed out during the training phase; and if infants' visual processing changes from the pre- to the post-phase, by comparing respective evoked responses to object versus background. We will present our findings regarding the main hypothesis that maternal guidance of attention shapes infants' early perceptual processing in visual cortical networks.

P2-B-25: Neonatal white matter microstructure and emotional outcomes in school-age children who were born very preterm

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Background and Aims: Children born very preterm (<33 weeks of gestation) are at a higher risk of developing emotional difficulties than their term-born peers. Such difficulties not only affect children's daily lives, but also contribute to the development of later mental health problems, including anxiety and depression. These problems may, at least in part, be due to neurodevelopmental alterations that have been associated with very preterm birth. This study had two main aims: 1. to investigate differences in emotional outcomes between very preterm and term-born children at school age; 2. in the very preterm group only, to study the association between neonatal white matter characteristics and childhood emotional outcomes. **Methods:** Very preterm participants took part in the Evaluation of Preterm Imaging study and were recruited from hospitals within the North and Southwest London Perinatal Network at birth. Infants underwent diffusion MRI at 40 weeks term-equivalent age. 37 very preterm children were subsequently followed up at school-age. 18 control participants were recruited from the community (overall median age=8.5 years). Emotional outcomes were measured with the Negative Affectivity Subscale of the Children's Behavioural Questionnaire and the Emotional Symptoms Subscale of the Strengths and Difficulties Questionnaire. Between-group differences were investigated using analysis of covariance, with age at assessment and sex as confounders. Fractional anisotropy (FA), a measure of white matter microstructural characteristics, was extracted from the uncinate fasciculus (UF). This is a white matter tract



that connects the amygdala to the prefrontal cortex and was chosen due to its implication in emotional development in both clinical and normative samples. Diffusion data were analysed using Tract-Specific Analysis (TSA). Neonatal UF FA values were investigated in relation to childhood emotional outcomes using linear regression, with gestational age at birth, age at scan, age at childhood assessment, sex, socio-economic status and intelligence quotient as confounders. Results: Very preterm children were more likely than controls to exhibit poorer emotional outcomes (Negative Affectivity: $F(1,56)=9.34$, $p=0.003$; Emotional Symptoms: $F(1,56)=9.3383$, $p=0.003$). Very preterm infants' lower FA in the bilateral UF was associated with higher Negative Affectivity scores (right: $t = -3.791$, $p = 0.001$; left: $t = -3.445$, $p = 0.002$) and with higher Emotional Symptoms scores (right: $t = -6.328$, $p = 0.00001$; left: $t=-3.559$, $p = 0.002$), indicating greater level of emotional difficulties. Conclusions: This study highlights the importance of white matter microstructural alterations following very preterm birth, and the long-term implications this may exert on children's emotional well-being.

P2-B-26: Enhanced regulatory brain responses to threat among infants with more sensitive mothers

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The experience of positive caring behaviors characterized by high maternal sensitivity during infancy has been linked to infants' improved emotion and self-regulatory abilities and a host of long-term positive developmental outcomes (De Wolff & van Ijzendoorn, 1997; Hane & Fox, 2006; Leerkes, Blankson & O'Brien, 2009). However, only little is known about how maternal sensitivity affects the early development of the brain systems involved in the regulation of emotion and behavioral (self) control (see Bernier, Calkins & Bell, 2016). We tested the hypothesis that, when experiencing threat (viewing an angry face), infants with more sensitive mothers show enhanced responses in left dorso-lateral prefrontal cortex (dlPFC), previously linked to better attentional and behavioral control when viewing angry faces in adults (d'Alfonso et al., 2000; De Raedt et al., 2010; Sanchez-Lopez et al., 2018). We tested this hypothesis in a sample of $N = 80$ infant-caregiver dyads. Participants completed a free-play session when the infant was five months of age, from which we coded for maternal sensitivity, including how much the caregiver talked to the infant, maintained close proximity to the infant, and attended to the infant's needs (see Krol et al., 2019). At 7 months of age, dlPFC responses were measured using functional near infrared spectroscopy (fNIRS) while the infants sat on their mother's lap and viewed visual displays of dynamic happy, angry, and fearful emotional facial expressions. Our analysis revealed that infants with mothers displaying greater maternal sensitivity (measured at 5 months of age) showed greater recruitment of the left dlPFC when viewing angry (threatening) faces (measured at 7 months of age, $r = .264$, $p = 0.018$, see Figure 1). This positive association confirms our hypothesis and indicates that higher maternal sensitivity is indeed linked to greater recruitment of self-regulatory brain systems. Critically, this association was specific to when infants viewed angry faces and not seen in response to either happy faces ($r = -.034$, $p = .762$) or fearful faces ($r = -.155$, $p = .168$). This suggests that enhanced neuroregulatory control is specific to angry faces and does not generalize to other threatening (fearful faces) or nonthreatening (happy faces) social signals. These correlational results point to a potential role of maternal sensitivity in helping infants' emotional self-regulation under threat. An important question for future work is to determine whether these



neuroregulatory effects only occur during close contact with their mothers, as seen in the current study, or can also be observed when the primary caregiver is not directly available.

P2-B-27: Sensory behaviors in infants and toddlers with autism spectrum disorder

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BkgrdThe Diagnostic and Statistical Manual, 5th Edition (DSM-5, APA 2013) incorporated sensory symptoms as a new diagnostic criterion for autism spectrum disorder (ASD) under the Restricted and Repetitive Behaviors (RRB) domain. This created a research and clinical challenge due to current lack of clarity over construct definition and lack of instruments with strong psychometrics (Cascio et al., 2016; Schaaf & Lane, 2015). "Sensory issues" are often considered a unitary construct, even though the term refers to sensory over- and under-reactions across all the senses. In addition, many RRB scales include sensory behaviors under motor stereotypy scales, rather than measuring them separately. This study applied a new instrument for RRBs in infants and toddlers with ASD that considers unusual sensory reactions (SR) as a separate domain, treating sensory seeking vs. avoiding individually for each sense. These symptom components were then examined for relative frequency and relationship to child characteristics of age and developmental level. Objectives: To examine 1) the relative prominence of seeking vs. avoiding behaviors in each sensory area, 2) the relative frequency of specific behaviors within each sensory area, 3) the relationship between Sensory Reactions (SR) and chronological age, cognitive, and adaptive levels. Method: This archival, cross-sectional study used diagnostic evaluation reports from 58 children with ASD, ages 17 to 48 months (M= 2.4 years, SD=1.2, 82% male, 84% White/Non-Hispanic). Instruments. Sensory Reactions. The SR domain of the Infant-Toddler Restricted and Repetitive Behavior Inventory (IRRBI) was used. Its sensory items are based on Seeking and Avoiding in Motoric/Proprioceptive, Auditory, Visual, Tactile, and Olfactory areas. Cognitive Scores. Diagnostic Assessment Scale; Mullen Scales of Early Development. Adaptive Behavior Scores. Vineland Adaptive Behavior Scales, 2nd and 3rd Editions (VABS). Procedure. Two raters coded the evaluation materials for 28 charts using the IRRBI. Mean Cohen's kappa for inter-rater reliability across scales averaged .58, and for SR total, .75. The remaining charts were coded by one coder. Analyses. Pearson correlations were conducted to examine the association between variables. Results: Seeking vs. Avoiding: The five sense categories had different patterns regarding whether seeking or avoiding was more prominent. For example, problems with avoidance were more typical for the auditory area, whereas visual, vestibular, and tactile behaviors were more typically seeking. The most commonly endorsed behaviors will be presented. Chronologic Age. There was no significant relationship to chronological age across all senses. Cognitive and Adaptive Scores. Several SR areas showed significant relationships with VIQ (r ranging from -.20 [Spinning Wheels] to -.36 [Visual Inspection/Objects]) and total adaptive skills (r =-.32 [Visual Inspection/Objects]). Some subdomains under SR were also significantly associated with specific adaptive skills: Daily Living Skills (DLS) and Total Full Body Motor Stereotypies r=-.31; DLS and Visual Object Total r=-.37; Social and Visual Object Total r=-.29. Conclusions: This study provides new details about patterns of sensory symptoms for very young children with ASD in the context of the



DSM-5 criteria. The results are considered in light of previous mixed findings for associations between sensory behaviors and developmental levels.

P2-B-28: The relation between environmental stress and looking behavior in early infancy

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The ability to detect and interpret facial expressions early in life is important for healthy social interactions. Several studies have documented that infants display a preference for human faces over other stimuli (e.g. Frank et al., 2009). Importantly, research has also shown that environmental stressors and maternal factors (i.e. anxiety) can impact the emotional input infants are exposed to in their daily lives, which may in turn impact early face processing (Perez-Edgar et al., 2017). Here, we used data from an on-going longitudinal study of infants at 4 months of age to examine the relation between environmental stressors and patterns of looking behavior to emotional faces. Using eye tracking, infants completed a passive viewing overlap task, in which infants' attention was directed to the center of the screen, followed by a face (neutral, angry, happy), and then a geometric figure appeared shortly after the presentation of the face either to the left or right of the face at the periphery of the screen. We measured infant's latency to disengage from the face and shift to fixate the geometric figure. To measure household stress, we examined maternal report of perceived chaos in the household using the CHAOS scale (Matheny et al., 1995) and the parenting daily hassles scale revised (PDHSR; Cronin & Greenberg, 1990) as an additional measure of stress related to parenting. We found a negative correlation between parenting stress, as measured by the PDHSR and the CHAOS questionnaire, and infant latency to disengage from emotional faces (PDHSR; $n = 51$, $r = -.39$, $p < .05$; CHAOS; $n = 37$, $r = -.32$, $p < .05$). Higher maternal reports of environmental stress (highly chaotic environments and higher perception of parenting hassles) were associated with faster disengagement from emotional faces. While data collection is ongoing, these preliminary findings suggest that factors in the environment impact emotional face processing early in development.

P2-B-29: Neurophysiological and sensory processing differences in infants with and without a family history of ADHD

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Background: ADHD is a heritable disorder characterised by persistent symptoms of inattention, hyperactivity, and impulsivity. Research has shown that children with ADHD are more likely to experience extreme patterns of sensory processing relative to typically developing peers. Sensory processing difficulties are associated with limited social participation, increased delinquent behaviours, and functional impairments in children with ADHD. Aims: This study aimed to examine auditory attention and sensory processing



differences in infants aged between 10 and 20 months with and without a family history of ADHD. Methodology: To measure auditory attention, event-related potentials were recorded while infants listened to an auditory oddball paradigm with standard (80%) and deviant (20%) tones. Eight infants with a diagnosis of ADHD in their immediate family (Mean age= 12.38 months, SD=3.5) and twenty infants with no family history of ADHD (Mean age= 13.0 months, SD= 1.95) were recruited for the study. After pre-processing of the data, six high-risk infants (Mean age= 13.0, SD= 3.90) and 18 low-risk infants (Mean age= 13.17, SD= 1.92) were included in the analyses. To behaviourally measure sensory processing, infants also completed the Test of Sensory Functions in Infants. Results: In terms of sensory processing, children from the high-risk group were more likely to show deficits in terms of tactile reactivity ($t(42)=-2.135, p=.039, \text{Hedges' } g=.89$). The high-risk and low-risk groups did not significantly differ on scores for any other sensory processing subscale. Based on research with older children who have a diagnosis of ADHD, it is expected that children from the high-risk group will show a decreased discrimination between standard and deviant sounds in the oddball paradigm, along with greater variability within the group relative to the low-risk group when data processing is complete. It is also expected that those with poorer discrimination on the oddball task will show greater difficulties in terms of performance on the sensory processing assessment.

P2-B-30: Modulation of somatosensory processing by visually observed tactile events in early infancy

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Research with adults shows that the somatosensory cortex is involved not only in the personal experience of touch, but also in the observation of other people and other objects being touched (Keyser et al., 2004; Bufalari, Aprile, Avenanti, Di Russo & Aglioti, 2007; Ebisch et al., 2008). This vicarious mapping phenomenon was recently documented in a sample of 4-month-olds responding to body-related tactile events (Rigato et al., 2017). This study showed that the early somatosensory evoked responses to a touch on the hands were modulated by whether the infant was observing a touch to a hand vs the surface on which this was resting. The present study investigated whether this neural mechanism responds specifically to sight of body-related touch, or whether it extends to observed tactile events involving inanimate objects. Across two experiments, we recorded somatosensory evoked potentials of thirty 4- and 6-month-old infants (fifteen per age group), who received a vibrotactile stimulation to their hands while observing a paintbrush touching either a block of wood or the surface next to it. Contrary to what Rigato and colleagues found, preliminary analyses of the present experiments revealed no significant differences between the average amplitude of the 4-month-olds' somatosensory evoked potentials when observing touch to the block and surface. These findings suggest that observing touch to an object does not modulate 4-month-olds' early somatosensory processing. Interestingly, preliminary analyses of the 6-month-old infants' somatosensory evoked potentials suggest a suppression of the response to the touch when observing a block of wood being touched. If confirmed, these findings suggest developmental changes in the influences of visual events on somatosensory processing during the first half year of life. More specifically, it is possible that, at four months of age, visual influences on somatosensory processing are more specifically related to the observation of body parts, but



over the next two months (and with the onset of visually-targeted reaching) it may be that such interactions become generalised to inanimate objects also. The implications of encoding visual tactile events for the development of multisensory perception of objects and people will be discussed. Additionally, data from a replication of the original study design will be presented, where 4- and 6-month-olds experience tactile stimuli on the hands, paired with the observation of visual body-related touch.

P2-B-31: Assessing neural sensitivity for mother's face in 5-month old preterm and term infants with fast periodic visual stimulation

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Infants communicate with others by 'reading' faces. They discriminate familiar from unfamiliar faces, and derive information about their feelings and intentions. Preterm infants are at risk for socio-emotional difficulties and an increased prevalence of ASD. Therefore, detailed monitoring of early socio-emotional development in this high risk population is a valuable avenue for early detection and prevention of future psychopathology. Methods used in previous studies are generally complex, inconclusive and time-consuming. Here, we apply frequency-tagging EEG to assess the neural sensitivity for detecting a familiar face among unfamiliar faces. This approach is reliable and robust, and allows obtaining data without complex analyses. The basic principle of this approach is that the brain responds at exactly the same periodicity as the frequency of visual stimulation. Based on this principle, an oddball familiar face discrimination paradigm was designed and administered to a group of adults, a group of 5-month old preterm infants, and a group of 5-month old term infants. We present a stream of different unknown faces, all within their natural background, at a base frequency of 3 Hz. In between these faces, every third face, thus at 1 Hz oddball rate, is an image of a familiar person (in case of the infants the face of their mother). All these images differed largely in terms of viewpoint, background, haircut, clothing, expression, etc. The EEG amplitude at the oddball frequency reflects the sensitivity for recognizing the familiar face at a single glance. A selective oddball response is observed in almost every individual participant, situated along occipitotemporal regions. We expect adults and term infants to be able to detect the familiar face better than preterm infants. In the future, we will use retrospective analysis to compare typically developing infants to infants who develop autism and socio-emotional difficulties. We expect that differences in attachment styles of the infants may also modulate their performance and sensitivity.

P2-B-32: Neurohormonal influence on the mother-infant relationship: A study of oxytocin, cortisol, and maternal attachment

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Early mother-infant attachment sets the trajectory for infant development (Bowlby, 1958; Carter et al., 2005), but attachment is complex, involving behavioral, psychological and



biological components. Two of the most widely studied neurohormones involved in infant development are oxytocin and cortisol. Whereas oxytocin is associated with maternal bonding and caregiving (Feldman, 2012; Tops, Van Peer, et al., 2007), cortisol plays a role in stress regulation and a range of mother-infant affiliative behaviors (Gunnar, 1998; Fleming, Steiner, & Corter, 1997). Relatively little is known about how early infant oxytocin functions in relation to attachment and infant cortisol. Here we examined the role of these neurohormones in mother-infant attachment. Thirty-two mother-infant dyads were assessed prenatally (third trimester), soon after birth and at 3 months. Mothers completed the Postpartum Bonding (PBQ) questionnaire at the 3-month visit. Urinary oxytocin was collected from mothers at prenatal and 3-month visits and from infants at newborn and 3-month visits. Infants underwent a mild stress task (still-face paradigm with arm restraint) during the 3-month visit. Saliva samples were collected before and after the stress task and later analyzed for salivary cortisol. We hypothesized that (1) mother and infant oxytocin levels would be correlated across the study duration, (2) mothers who have more secure perceptions of pre- and postnatal attachment would have higher levels of oxytocin and their 3-month-old infants would have lower levels of cortisol post-stress task, (3) infants would have lower cortisol levels when both mother and infant have higher levels of oxytocin. Maternal prenatal oxytocin was strongly positively correlated with infant oxytocin at the 3-month visit, $r(22) = 0.54$, $p < 0.01$. Similarly, maternal and infant oxytocin levels were moderately positively correlated at the 3-month visit, $r(23) = 0.43$, $p = 0.04$. While maternal perceptions of attachment were unrelated to either maternal or infant oxytocin levels, level of maternal attachment at the 3-month visit was strongly positively correlated to post-stress task infant cortisol level, $r(26) = 0.59$, $p = 0.002$. Finally, neither pre- nor post-stressor infant cortisol levels were related to either mother or infant oxytocin levels. Mother and infant oxytocin appear tightly linked, but unrelated to infant cortisol response (see Figure 1). Greater feelings of attachment were unexpectedly associated with greater infant cortisol reactivity. This finding should be studied further as the relationship between cortisol function and maternal attunement can depend on factors such as infant neurophysiological patterns (Sloan, 2017). Maternal attachment and oxytocin appear unassociated here, however, a large body of evidence links maternal oxytocin to attachment (see Galbally, et al., 2011 for review). Our null findings may reflect some difference between the PBQ and other measures of attachment. Others have reported no relationship between PBQ scores and maternal oxytocin (Lara-Cinisomo, Zhu, Fei, et al., 2018; McErlean, 2012). However, PBQ scores are differentially associated with various oxytocin receptor polymorphisms (Julian, et al., 2019), suggesting that receptor type should be considered alongside oxytocin concentration. The seemingly contradictory findings likely reflect the complexity of interactions between mother-infant bonding, hormone concentration and neurobiological structure.

P2-B-33: Perception at a glance: The development of high-level categorization

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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 this process, 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 the development of underlying brain processes. We employed the Fast Periodic Visual Stimulation (FPVS; Rossion, 2015) approach to characterize the development of superordinate-level categorization from infancy to adulthood. We presented highly heterogeneous pictures of animals and furniture items and recorded electroencephalogram (EEG). 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. Infants (11-month-olds, N = 20, 8 males), children (5-year-olds, N = 13, 10 males, 6-year-olds, N = 14, 12 males) and adults (N = 20; 6 males) were presented with sequences of animal and furniture stimuli (80 different items/category). Each trial consisted of short stimulus 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. Every 5th stimulus belonged to the other (oddball) category. Base stimulation frequency F was 6 Hz (i.e., 6 images/second), and the oddball response and harmonics (1.2 Hz; F/5; nF/5) were used to measure discrimination between categories. We tested how well participants of different ages were able to categorize animal and furniture stimuli when each picture is presented for a very short time only (i.e., ~ 170 ms), but with periodic regularity. Strongest categorization responses across age-groups were observed at PO9/PO10. Significant harmonics (F = 1.2 Hz, 2F = 2.4 Hz...) were selected for each age group and the number of participants in whom a significant categorization response could be observed was compared. To this end, Z-scores were computed per participant to determine the presence of a categorization response at the bin of stimulation and harmonics compared to surrounding bins. All age groups categorized animal and furniture items. 18 out of 20 adults showed a significant response (harmonics 1-12). In children, categorization responses were observed in 13 out of 14 6-year-olds (harmonics 1-14) and 10 out of 13 5-year-olds (harmonics 1-6). In 11-month-old infants, 8 out of 20 categorized the images (harmonics 2-4). There were systematic differences between age-groups, Kruskal-Wallis test $\chi^2 = 18.03$, $p < .001$. Post-hoc Dunn-Bonferroni tests revealed that in the 11-month-old group, fewer infants categorized the stimuli, all $z_s > -14.90$, $p < .05$. There was no difference between the other age groups, all $p_s > .5$. These data demonstrate high-level visual categorization of animal and furniture stimuli in children and adults. Corresponding skills seem to first emerge towards the end of infancy. This implicates that high-level categorization at a glance, characterizing the adult visual system, develops from the end of infancy.

P2-B-34: Relationship quality, depressive symptoms and maternal-fetal attachment during pregnancy and after childbirth

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INTRODUCTION Maternal Stress and mental health problems during pregnancy may have detrimental effects on both the mother and the fetus. One factor which seems to be of particular importance is the quality of partner relationship. A dysfunctional partnership during that critical time of life may increase the risk of maternal pre- and postpartum depressive symptoms which is a known risk factor for impaired infant attachment and development. The current study aims to assess the potential impact of relationship quality on maternal depressive symptoms before and after childbirth as well as on maternal-fetal attachment. **METHODS** This



longitudinal study has been conducted at Heidelberg University, Germany. A total of N = 597 pregnant women were recruited from University Gynaecological Hospitals Heidelberg from the 20th week of gestation on. Exclusion criteria were a genetic disorder of the unborn child or a multiple pregnancy. Participants were regularly assessed by online questionnaires applied at 5 prenatal and 3 postnatal assessments. To assess the quality of partner relationship the "Questionnaire of Relationship Quality" (PFB, Hahlweg, 1996) has been applied. The PFB was completed at 24th week of gestation and 6 months postpartum. Depressive symptoms have been assessed by the "Edinburgh Postnatal Depression Scale" (EPDS, Cox et al., 1987) at each online assessment (T1-T8) and maternal-fetal attachment has been assessed by the "Maternal Fetal Attachment Scale" (MFAS, Cranley, 1982). **RESULTS** We found a significant association of poor relationship quality and depressive symptoms both pre- ($p < .01$) and postnatally ($p < .01$). Self-report relationship quality during pregnancy predicted maternal depressive symptoms after childbirth ($\beta = -.28$, $p < .01$), as well as 3 months postpartum ($\beta = -.33$, $p < .01$) and 6 months postpartum ($\beta = -.39$, $p < .01$). Even when controlling for potential confounders, relationship quality remained a significant predictor for depressive symptoms after childbirth. A mediation model revealed that the association of relationship quality during pregnancy and depressive symptoms after child birth were mediated by postnatal relationship quality ($p < .001$). Furthermore, maternal-fetal attachment was predicted by the quality of partner relationship ($p < .01$). **CONCLUSION** The results obtained in the present study outline the importance of relationship quality for mother's well-being and mental health during pregnancy and after child birth as well as the attachment to her unborn child. The data suggest that the relationship of young parents is affected by the quality of their relationship even before child birth. Furthermore, prenatal partnership quality is associated with maternal-fetal attachment. These findings support the importance of providing early intervention and support for pregnant women and young families to prevent the development of manifest postpartum depressive disorders and impaired attachment between mother and infant.

P2-B-35: Neonatal clinical risk, developmental care, stress and self-regulation behaviors of preterm neonates in neonatal intensive care

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A lower gestational age is associated with a higher risk for developmental problems, demonstrating the impact of the organism's immaturity in the neonatal phase on later developmental outcomes (Mansson & Stjernqvist, 2014). The Neonatal Intensive Care Unit (NICU) is the initial context of survival of the preterm neonate. The early micro-context of the NICU is a relevant protective environment; paradoxically, NICU represents a risk factor for infants' development because of multiple painful and stressful procedures inherent to the intensive treatment (Anand & Whit Hall, 2007, Grunau & Tu, 2007). The present study aimed to examine the associations between clinical health status, developmental care approaches, and stress and self-regulatory behaviors of preterm neonates during NICU hospitalization. The sample included 40 neonates born preterm (gestational age mean = 29 weeks \pm 2]; birth weight mean = 1,364 grams \pm 432]; post-natal age mean = 3 days \pm 1]), who were admitted after birth in a NICU with a developmental care protocol, including non-pharmacological management for pain relief using oral sucrose before acute painful procedures. The neonatal clinical risk at 12 first hours was assessed by the Clinical Risk Index for Babies (CRIB)



(Cockburn et al., 1993). The developmental care approaches of the NICU and the stress and self-regulation behaviors of the preterm neonates were evaluated through observation protocols. The descriptive statistical analysis and the Spearman correlation test were performed. The data were analyzed using SPSS (version 25.0, Chicago, IL, USA), and the significance level of the study was $p \leq 0.05$. The results showed that preterm neonates with higher neonatal clinical risk had lower total self-regulation behavior ($r = -0.60$; $p = 0.03$), and specifically in the autonomic system self-regulation behaviors ($r = -0.35$; $p = 0.04$). Also, the more developmental care approaches to pain and stress management, the fewer stress behaviors of the autonomic system were presented by preterm neonates ($r = -0.35$; $p = 0.02$). Finally, the more developmental care approaches related to the sleep of the preterm neonates, the more total self-regulating behaviors were presented by them ($r = 0.48$; $p = 0.05$). The associations between the NICU protective approaches and self-regulation behaviors of the vulnerable preterm neonates indicate the importance of these strategies to neutralize the negative impacts of the stressful events in the NICU.

P2-B-36: Infants' use of communicative gestures from human and robotic informants

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Infants as young as 4 months follow the direction of a dynamic pointing gesture and between 6 and 12 months interpret pointing as a social signal meant to communicate the importance of an object or location to which it is directed. However, it is unclear whether infants' interpretation of pointing as possessing communicative intent is reserved for a human informant. Robotics has advanced to include varying levels of anthropomorphism, or human-like qualities. Robots with especially high anthropomorphism are considered "social robots". There is a critical need to identify the efficacy of using social robots as learning platforms. This study was designed to fill this gap in knowledge by assessing infants' perceived communicative intent from human and robotic informants. A novel eye-tracking paradigm was developed and infants (M age = 9 months, 14 days) were randomly assigned to one of three conditions: human ($n = 9$), highly anthropomorphic robot ($n = 13$), or non-anthropomorphic robot ($n = 7$). Infants in each condition saw 8 test trials, 4 trials each of a pointing and control pointing gesture, on alternating trials (Figure 1). Each trial was composed of three phases: initial, prediction, and event. In the initial phase, the hand produced the gesture appropriate for that trial (pointing or control pointing) and then exited the apparatus. During the prediction phase, the boxes sat alone on the platform. In the event phase, a feathered wand popped out of the box to which the gesture had been directed. The side to which the gesture was directed was randomized. To investigate whether infants interpreted the pointing gesture as communicative (i.e., used it to predict where the event would occur) duration of looking (ms) to two areas of interest, target box and non-target box, was extracted. A trial type (point, control point) x AOI (target box, non-target box) x hand type (human, anthropomorphic, non-anthropomorphic) MANOVA revealed a significant three-way interaction, $F(2,26)=3.37$, $p=.05$. Paired t-tests revealed that the infants in the human condition looked reliably longer to the target box after the pointing than control pointing gesture ($p < .05$). In no other condition did infants look longer at the target box after viewing a pointing as compared to control pointing gesture. These results show, for the first time, that infants interpret pointing by human but not robotic entities (even one that is highly



anthropomorphic) as a communicative gesture. Finally, we collected fNIRS data from a subset of infants in the human (n=3) and high-anthropomorphic (n=3) condition. Infants saw the test events for the condition to which they were assigned; a fireworks display was the baseline event. Activation was identified in 7 contiguous channels in the left hemisphere to the human but not the highly anthropomorphic robotic informant (Figure 2). Although we interpret these preliminary fNIRS results with caution, they are consistent with the behavioral results demonstrating the infants perceive human and non-human robotic entities, even when they engage in the same activities, quite differently.

P2-C-37: The maturing functional connectivity of the language network in the developing brain

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The acquisition of language is a hallmark of human development. Emerging data demonstrate that although the scaffolding for language is present as early as one month of age, the functional connectivity between the two key regions for language in the developing brain, Broca's and Wernicke's regions, is not present at birth. Thus, although both Broca's and Wernicke's regions activate to language-based stimuli, show expected lateralization patterns in the left hemisphere, and demonstrate activation patterns resembling those in older children and even adults, the functional connectivity or the temporal correlation of activity between these regions does not. In infants, Broca's and Wernicke's show little connectivity, suggesting that, while these regions respond to language, they are functionally segregated rather than contributing to an integrated network. Further, the developmental trajectory of functional connectivity of the language network remains largely unknown. In this study, we examine cross-sectionally the development of functional connectivity between Broca's and Wernicke's region from birth into toddlerhood and examine links between strength of the connectivity at birth and language outcomes at 6 months. Resting-state functional MRI data were acquired in 49 one month-old infants (M=1.0 months, SD=.35), 52 nine months-old infants (M=9.1 months, SD=.24), and 19 toddlers between 16-36 months (M=26.6 months, SD=6.7). Standard seed connectivity from seeds placed in Broca's and Wernicke's regions in the left hemisphere and their right hemisphere homologues were performed. A sub-sample of 16 one-month-olds were tested for language level at 6 months (M=6.25, SD=.13) using the Ages and Stages Questionnaires (ASQ) Communication scale. While significant cross hemisphere connectivity between L and R homologues was observed at all age levels, significant connectivity between L Broca's region and L Wernicke's region was only observed for toddler participants (Table 1). Importantly, the correlation of the L Wernicke's-L Broca and R Wernicke's-R Broca connectivity strength in the neonatal period was $r(26)=.469$, $p=.02$, suggesting parallel development of these critical regions. Finally, the strength of connectivity between homologous Broca's regions and between homologous Wernicke's regions at one month was significantly correlated with the ASQ Communication score at six months [$r(15)=.65$, $p=.02$; $r(15)=.52$, $p=.05$, respectively]. Linear regression analysis predicting ASQ score at 6 months indicated that strength of connectivity between the homologous regions of Broca's [B=43.02, $t(14)=3.05$, $p=.010$] and Wernicke's [B=47.8, $t(14)=2.52$, $p=.027$] regions



contributed independently to the ASQ score, with adjusted R Square of .524. The homologs of Broca's and Wernicke's regions are connected already at birth and the strength of connectivity between these homologous regions predicts language at 6 months. Nevertheless, neural connectivity between Broca's and Wernicke's regions does not develop until years 2-3 of life. In addition, intrahemispheric connectivity between these key regions for language develops in parallel during the neonatal period, suggesting an early lack of lateralization for language.

C-Perception

P2-C-38: Stable gaze in 12- to 24-month old infants requires a still head and eye-head alignment

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During sustained attention, infants exhibit long looks with a stilled head, body, and a "seriousness of purpose (Ruff & Capozzoli, 2003; Ruff & Lawson, 1990). Coding of this behavior has proven to be reliable and a valid predictor of individual differences in later cognitive development (Lansink & Richards, 1997, Yu, Suanda, & Smith, 2019). Here we ask whether stillness of the head, and by extension the body on which it rests, contributes more directly to the duration of gaze directed to an object. Our reinterpretation derives from the extensive literature demonstrating the bias in adults to look at the world with their head and eyes aligned (Lappi, 2016). The present study concerns how, and whether, this bias plays out from 12-24 months of age, a period of rapid sensorimotor development, during continuous looking to a single target in the active context of object play. A total of 43 unique dyads were examined in 3-month increments during naturalistic free play with their parent for a total of 107 sessions. Infant gaze was captured using a head-mounted eye-tracker and head movement was measured using a motion-capture sensor affixed to the child's head. The distribution of accumulated infant gaze across all individuals for each age level was plotted using a kernel density estimate (Figure 1a). The proportion of gaze within a 5° radius of the center of the head camera image was calculated for each subject. At every age level, over half of the participants' gaze fell into the calculated area (Figure 1b) with no changes across development. Further, looks longer than 3 seconds, indicative of sustained attention, were just as centered as short looks and also exhibited to changes across development (Figure 1c-e). Thus, both long and short looks are equally centered, with infants aligning their head and eyes towards the object of interest. Both the head and eyes move to the target, with variable leads and lags, resulting in the onset of a look typically at the center of the head-centered frame of reference. At this point, for short and long looks and for all age groups, the head stops moving for the duration of the look (Figure 2). The mean rotational velocity of the head was aligned to the onset of a look to an object, beginning 3-seconds before the look's onset and ending 5-seconds after. Across all look durations, the head stabilizes at the onset of the look and typically ends just prior to the look's offset. In sum, infants between the ages of



12 and 24 months consistently and uniformly look to objects with their eyes and head aligned and they maintain that alignment throughout the look by not moving their head.

The present study provides evidence that stilled heads characterize all looking behavior, both short looks and long looks which have been indicative of sustained attention. Thus, a still head and body may be less indicative of an internal state of concentration, than a core property of how looking behavior works given a freely moving body and its multiple frames of spatial reference.

P2-C-39: Discrete social looks and skin conductance response but not duration of looks index epistemic violation of expectation events in 11-month-olds

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Epistemic violations of expectation have been shown to elicit infants' enhanced attention, both to the actual events (Stahl & Feigenson, 2015; Sim & Xu, 2017) and to their social partners (e.g., Brooker & Poulin-Dubois, 2013; Dunn & Bremner, 2017; Koenig & Echols, 2003). Infant-generated discrete social looks (social referencing) are proposed to be an active non-verbal communicative cue serving an epistemic information-seeking function (Bazhydai, Westermann, & Parise, in press; Begus & Southgate, 2018; Harris & Lane, 2014), with looks interpreted as seeking explanations, clarifications, and other disambiguating testimony. However, measures such as discrete number of social looks and duration of looks have often been used indiscriminately, causing inconsistencies in interpretations (Aslin, 2007; Sim & Xu, 2019) and leading to a proposal that differential cognitive mechanisms index the length and frequency of social looks in such contexts (Dunn & Bremner, 2017). A related line of research linked infants' changes in autonomic arousal, such as electrodermal activity (EDA), to attentional shifts, gaze following and look duration (de Barbaro, Clackson, & Wass, 2017; Ishikawa & Itakura 2019; Wass, de Barbaro, & Clackson, 2015; 2016), and to information seeking, cognitive engagement, problem solving, exploration and curiosity in adults (Berlyne, Craw, Salapatek, & Lewis, 1963; Hughes & Hutt, 1979), especially in response to novel, unexpected and complex stimuli (Spinks, Blowers, & Shek, 1985). To provide a more nuanced understanding of infants' social cognition in epistemic ambiguity, we explored infants' social looking in response to epistemic violation of expectation events, distinguishing between looks frequency and duration, and recorded changes in autonomic arousal derived from EDA's tonic and phasic measures. 11-month-olds (N = 48) saw ten screen-presented familiar objects, with caregivers enabling three between-subject conditions: Congruent (caregiver providing a matching label to the object), Incongruent (mismatching label, e.g., calling a cat a dog), and No label (caregiver not providing any label but instead saying: "Look at this!"). Upon the caregiver's utterance, infants' frequency, onset and duration of social looks were coded. Infants' EDA was continuously recorded with a wearable physiological monitor (E4; Empatica, Boston, MA). Infants engaged in more social referencing in Incongruent compared to No label and Congruent conditions, but there were no differences in duration or onset of their social looks (Figure 1). Infants' EDA (measured as the baseline-corrected proportion of non-specific skin conductance responses frequency) increased during Incongruent, decreased during Congruent, and showed no change during No Label condition (Figure 2), but was unrelated to any measures of social looking. Here, preverbal infants expected their caregivers to provide



congruent semantic information - an expectation violated by instead receiving false labels. Caregivers' incongruent labelling elicited more discrete social looks but not longer looking, as well as changes in electrodermal activity, which were not related to the frequency of social referencing or the duration of looking, suggesting independence and differential role of behavioral and autonomic arousal mechanisms. This study supports the proposition that discrete social looks (but not looking duration) index infants' response to epistemic violation of expectation events and

P2-C-40: The face inversion effect: Cortical responses during the first year of life

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The face inversion effect has been considered the marker for expert perceptual processing (Valentine, 1988). It affects face-specific components of event-related brain potentials (ERPs). In adults, the N170 component shows larger amplitude and delayed latency to inverted than upright faces (Rossion et al. 1999). Such inversion effect does not occur for non-face stimuli (Eimer 2000; Rossion et al. 1999). Two distinct ERP components, the N290 and the P400, become increasingly sensitive to upright human faces between 3 and 12 months of age (De Haan, Johnson, & Halit, 2002; Guy, Richards, Tonnesen, & Roberts, 2018; Guy, Zieber, & Richards, 2016). An inversion effect for human faces has been reported to modulate the amplitude of the N290 in 3- month-old infants (Peykarjou and Hoehl, 2013). We systematically investigated the development of the inversion effect on the N290 and P400 responses to faces and houses during the first year of life. We hypothesized that faces would elicit larger N290 and P400 responses compared to houses. An inversion effect on N290 amplitude would be elicited by faces but not houses. Developmental change could influence the characteristics of this inversion effect. We examined infants' neural responses to upright and inverted faces and houses in a cross-sectional study with infants at 3 (n = 6, mean age = 103 days), 4.5 (n=9, mean age=143 days), 6 (n=7, mean age=191 days), 7.5 (n=5, mean age=235 days), and 12 (n=12, mean age=379 days) months of age. Amplitude values around the N290 peak over left and right posterior-lateral channels (TP7-10, P7-10, and PO7-10) and the P400 peak over medial posterior channels (P7-10, PO7-10, Iz, I1-2, Oz, O1-2) were analysed as a function Stimulus Type and Orientation as within-subject factors and Age as a between-subject factor. Results showed significant interactions between Stimulus Type, Orientation and Age for both ERP components (N290: $F(1,4) = 13.16, p < .001$; P400: $F(1,34) = 3.17, p = .013$). Univariate ANOVAs were conducted at each age group to further explore these interactions. Figure 1a shows the scalp maps for the N290 response to faces as a function of Stimulus Orientation across ages. Infants at 3 and 4.5 months of age showed a larger negativity in response to faces than houses (main effect of Stimulus Type: $ps < .001$). Starting at 6 months of age, the N290 responses were larger for inverted than upright faces. There were significant Type x Orientation interaction effects at later ages ($ps < .006$). Figure 1b depicts the amplitude at the peak of the N290 as a function of Stimulus Type and Orientation across ages. Six- and 7.5-month-old infants showed larger N290 amplitudes in response to inverted than upright faces, and upright than inverted houses ($ps < .037$). At 12 months of age, there was a significant inversion effect for faces ($p = .007$), but not for houses ($p = .179$). Figure 2 shows the amplitude around the P400 peak as a function of Stimulus Type and Orientation across ages. For all age



groups the P400 showed a larger amplitude in response to faces than houses ($p < .001$). Starting at 6 months of age, the P400 was also larger in response to inverted than upright stimuli ($p < .0001$). These results suggest that both N290 and P400 show a stimulus inversion effect in the second half of the first year of life. Interestingly, only the N290 shows a specific inversion effect for faces in 12-month-old infants.

P2-C-41: Gras on gravel: Visual segregation of naturalistic images in an infant eye-tracking search task

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The segregation of structures within a naturalistic scene is a prerequisite for the categorization of its elements. In their first year of life, infants are already able to visually categorize entities within their environment. However, although perceptual abilities underlying image segmentation like pictorial depth cues, contour detection, or sensitivity to characteristics of spatial frequencies start to emerge within the first year of life, they are not adultlike until childhood or adolescence. This raises the question: Which visual information young infants use to differentiate naturalistic entities? To test this, we conducted a gaze contingent eye-tracking search task with 8-month-old infants. Stimuli were monochromatic images of naturalistic structures taken from one of the three categories vegetation, manmade artifacts, and non-living natural elements (e.g., stones or water surfaces). Each image included a patch of a different image taken from the same or another category, and the eye-tracker presented a reward when it registered the infant's gaze on the patch. In order to investigate visual information influencing target detection, we controlled physical salience of the targets and assessed a set of visual properties of the images which had been found to be relevant for categorization decisions of children (age: 4-5 years) and adults in a previous study using the same images (Figure 1a). Our hypotheses were that (1) infants would detect a target faster if its category differs from the category of the background image, and that (2) infants' detection performance would be better predicted by visual properties relevant for the categorization decisions of children than by those of adult participants in our previous study. In contrast to our first hypothesis, infants showed a tendency to detect a target faster when it belonged to the same superordinate category as the background image. However, consistent with our second hypothesis, infants detected a target faster if it had been perceived as visually more dissimilar to the background image by preschool children in the previous study, while adults' dissimilarity perception was not predictive for infants' detection latency. This finding points to an overlap of sensitivities for visual properties of naturalistic images in children below 5 years of age, which differ from adult perception. In additional analysis of our infant data, we found that larger target-background differences in the level of some visual properties facilitated target detection (see Figure 1b). This was true for characteristics of the luminance distribution (i.e. grey-level entropy) and of the spatial frequency distribution (i.e. the smoothness of the power spectrum). These findings demonstrate sensitivity for characteristics beyond low-level physical salience. Taken together, these results provide examples of visual information young infants draw upon when segregating monochromatic naturalistic images. Future studies should investigate the relationship of these visual properties to the development of the visual system and categorization abilities.



P2-C-42: Maternal odor selectively enhances the categorization of face(like) stimuli in the 4 month-old infant brain

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In the 4-month-old infant brain, the visual categorization of natural face images is enhanced by concomitant maternal odor (Leleu et al., 2019), providing support for the early perception of congruent associations between co-occurring inputs from multiple senses. Here, we further explore whether this maternal odor effect is selective to faces or if it can be explained by a more general influence of salient odor cues on the perception of any visual object category. In Experiment 1, scalp electroencephalogram was recorded during a fast periodic visual stimulation (FPVS-EEG) while 4-month-old infants were exposed to the maternal vs. a control odor. In rapid 6-Hz streams of natural images (i.e., 6 stimuli per second), images of cars instead of faces were interspersed every 6th stimulus among other nonface objects (i.e., at 1 Hz). We isolated a neural categorization response to cars at the predefined 1-Hz frequency over the right occipital region in both odor contexts, showing the ability of infants to categorize variable exemplars of cars at a glance. However, maternal odor did not enhance this response, supporting its face-selective influence. In Experiment 2, images of nonface objects resembling faces (i.e., facelike stimuli) were used as the target category, i.e., interleaved every 6th image in the stream of stimulation. The brain response to facelike objects was faint yet clearly identifiable over bilateral occipito-temporal sites in the control odor condition, revealing infants' sensitivity to facelike patterns in a fast train of various categories of living and nonliving objects. More importantly, we observed that maternal odor magnified the facelike categorization response over the right hemisphere in a majority of infants, showing that this highly relevant odor triggers a face-selective neural activity even in the absence of genuine human faces. In both experiments, the general visual response elicited by the rapid 6-Hz stimulation was immune to the maternal odor effect, excluding any account in terms of an undifferentiated increase of visual attention or arousal in the maternal odor context. Altogether, these experiments provide evidence for the tuning of face(like) categorization from multisensory inputs in the developing brain. They accord with the view that perceptual development integrates information across the senses for efficient category acquisition, with early-maturing systems, such as olfaction, providing assistance to later-developing systems, such as vision.

P2-C-43: Exploring infants' sensitivity to low-level visual information across the visual field

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Information processing at early stages of development has been primarily studied using simplified images centrally presented on computer displays. Even though the most acute vision occurs in the foveal area and we rely heavily on central vision for everyday tasks, a large



amount of visual information is delivered to the peripheral field, extending to over 90° in eccentricity in the mature visual field (e.g. To, Regan, Wood, & Mollon, 2011). Peripheral vision is crucial in our everyday life to plan eye movements and orient our attention, to detect an incoming threat or a sudden change in the environment, and it also plays a role in balance and postural adjustments. Previous research suggests that peripheral vision is still developing during the first postnatal year and the ability to perceive objects across the visual field may be influenced by the characteristics of the stimuli (e.g. Lewis & Maurer, 1992). Thus far, peripheral vision has been primarily studied using flashing lights, which might have misleadingly overestimated the visual field extent due to the abrupt luminance change that they cause. The present study is the first to examine information processing at high eccentricities with a careful and controlled choice of the low-level visual features which may affect infant orienting behaviour. The aim of this experiment is to determine how far in the visual periphery infants detect basic visual targets. In Experiment 1a, 19 full term 9-month-old infants are presented with Gabor patches (FIG.1) appearing on each trial at one of 12 locations in their mid-peripheral visual field: 35°, 40°, 45°, 50°, 55°, and 60° to the left or to the right of a central stimulus. One participant is excluded from the analysis for not providing any valid trial and the final sample consist of 18 infants (12 males, Mage=278 days; SD=9.3). In order to obtain an informative measure of visual field sensitivities, we ensured that the overall luminance of the peripheral targets is comparable with the background luminance (within 25 cd/m²). In Experiment 1b, 20 control adults are tested with the same paradigm. Head/eyes orientation and key press responses to the peripheral targets are measured for infants and adults, respectively. Results reveal that, unlike adult data (Exp.1b), where performance is consistently at ceiling level across eccentricities, 9-month-old infants' detection rate (Exp.1a) differs significantly across eccentricities ($F(5,55)=4.419$, $p<.003$). The present results show that infants can successfully detect visual targets up until 50° in their peripheral visual field, whereas their performance declines below chance level for targets presented at 55° and 60° (FIG.2). In addition, no significant side differences in detecting peripheral targets across the left and the right hemifield have been found. This information is key to setting the scene for further infant studies across the perceptual and social domains.

P2-C-44: A neural marker of rapid discrimination of facial expression in 3.5 and 7-month-old infants

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Little is known about infants' ability to rapidly discriminate a facial expression against many others. Here, we investigated the development of facial expression discrimination in infancy with fast periodic visual stimulation coupled with scalp electroencephalography (EEG). EEG was recorded in 3.5- and 7-month-old infants (n=18 per group) displayed with an expressive (disgust or happy) or neutral female face at a base stimulation frequency of 6 Hz. Pictures of the same individual randomly expressing other expressions (either anger, disgust, fear, happiness, sadness, or neutrality) were introduced every 6 stimuli (i.e., at 6/6 = 1 Hz) to directly



isolate a discrimination response between the base expression and all other expressions. Frequency-domain analysis revealed an objective (i.e., at the predefined 1-Hz frequency) expression-change brain response at both 3.5- and 7-month-olds, indicating visual discrimination of disgust, happiness and neutrality from these early ages. At 3.5 months, the brain responses to disgust and happiness were mainly on medial-occipital sites, suggesting a mere discrimination based on facial features. A more lateral topography was found for the response to neutrality and suggests that the discrimination of this category relies on distinct visual cues, potentially reflecting the discrimination of expressive vs. unexpressive faces based on the whole face configuration. Finally, an age effect was found for happiness, translating into less activity over posterior areas and an additional response over fronto-central scalp regions at 7 months. This pattern of results might reflect critical developmental changes in the processing of the emotional content of happiness, with the attribution of meaning subtended by brain structures involved in cognitive, affective or social appraisal.

P2-C-45: Using robotic hens to explore the origins of neonatal social responsiveness in bobwhite quail hatchlings

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The Intersensory Redundancy Hypothesis (IRH, Bahrick & Lickliter, 2000) predicts that early in development information presented redundantly (the same amodal information temporally synchronized across two or more senses) recruits selective attention and facilitates learning of amodal stimulus properties (e.g. tempo, rhythm, duration) at the expense of unimodal properties of stimulation. Previous studies with bobwhite quail chicks as well as human infants have supported this prediction using audio-visual redundancy (Bahrick & Lickliter, 2014). We have proposed that the "grabbing" of attention by redundant information facilitates perceptual processing, learning, and memory for temporal and spatial features of stimuli, thereby selectively educating attention to specific stimulus properties during early development. It is not known to what extent this sensitivity to redundancy across the senses contributes to the early development of infant social responsiveness. Social events provide particularly high amounts of sensory redundancy relative to most non-social events, and our prediction is that a neonatal bias to redundancy across the senses can contribute to the development of early social responsiveness. Specifically, we expected that audio-visual redundancy made available by the mother during early postnatal development could facilitate neonates' social orientation and social preferences. We tested this by placing neonatal quail chicks (aged 48 hr, 72 hr, or 96 hr following hatching) at the center of a circular arena with two robotic hens placed at opposing ends of the arena. Using a servo motor and a custom computer program we controlled each robot's head motion, moving up and down in synchrony with the notes of a bobwhite maternal call. The synchrony between the robotic hen's biologically-relevant head motion and species-typical vocalization was manipulated by adding a delay between the notes of the maternal call and the hen's head movements. All chicks were tested individually in a five minute choice trial, with one robotic hen's vocalizations and head movements synchronized and the other robot having either a 250 ms or 1000 ms delay between vocalizations and head movement. An overhead camera and custom computer program measured the chick's proximity to each robot during testing. Side and robot pairings were randomized across test trials to control for robot or side preferences. As they aged, chicks demonstrated greater



asynchrony avoidance and deliberation when the delay was 1000 ms, but not 250 ms (see Figure 1). This finding suggests that quail neonates were not able to discriminate the 250 ms. audio-visual delay, even by four days following hatching. Chicks were more likely to prefer robotic hens when their vocalizations and head movements were in synchrony, more likely to avoid hens who were out of detectable audio-visual synchrony, and showed an increased ability to distinguish between the two as they aged. It appears that chicks' audio-visual synchrony detection improved in the days following hatching and contributed to their emerging social preferences. Our initial results expand our knowledge of maternal factors that can contribute to early social development and suggest future research directions for identifying the origins of neonatal preferences for social information.

P2-C-46: Recognizing threat: Infants' processing of threat-relevant body expressions

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Faces may be considered the most salient emotion cue, but emotions expressed via other modalities, such as bodies and voices, are also key sources of emotion information. Even 5-month-olds recognize the contrast between bodily emotions from opposite valences (e.g., happy vs. angry; Heck, Chroust, White, Jubran, & Bhatt, 2018). However, no study has examined infants' perception of within-valence bodily emotions. This is important because some have argued that language is required for such knowledge (e.g., Widen & Russell, 2008), while others have suggested this knowledge is inborn or develops early (e.g., Ekman & Cordaro, 2011). Therefore, the current experiments explored infants' processing of two negatively-valenced bodily emotions (fear vs. anger), which are threat-relevant and evolutionarily important. Experiment 1 tested infants' emotion recognition by examining whether infants match vocalizations to bodies when fearful and angry videos are presented side-by-side while a fearful or angry vocalization plays simultaneously. However, matching may be affected by a priori preferences, so a spontaneous preference procedure (i.e., without any sounds) was presented first. Matching was indicated by greater looking to the appropriate body during the matching trials than in the spontaneous trials. This was calculated by subtracting the percentage of looking to the respective bodily emotion (e.g., fear) during four spontaneous preference trials from the percentage of looking to the target body (e.g., the fearful body matching the corresponding fearful vocalization) during four matching trials. Results from 17 5-month-olds (9 males; $M=151.88$ days, $SD=5.97$) and 18 9-month-olds (10 males; $M=266$ days, $SD=7.61$) indicate that the 9-month-olds' mean difference score ($M=7.71\%$, $SE=2.51$) was significantly different from 0 ($t(17)=3.07$, $p=.007$), but the 5-month-olds' score ($M=.001\%$, $SE=2.81$) was not ($t(16)=0.00$, $p=1.00$). Also, there was a significant between-group age difference ($F(1,33)=4.21$; $p=.048$). Therefore, 9-month-olds significantly increased their looking to the congruent body from the spontaneous to the matching trials, thus exhibiting evidence of intermodal recognition, but 5-month-olds failed to match. In Experiment 2, 9-month-olds (12 males; $M=270$ days, $SD=5.37$) were presented with inverted bodies. Inversion controls for irrelevant stimulus features (e.g., movement) and disrupts processing of social stimuli. An inversion effect would indicate that infants were responding to the emotion itself in Experiment 1. In Experiment 2, infants exhibited an inversion effect; that is, their difference score ($M=-3.70\%$, $SE=2.90$) was not significantly different from 0 ($t(16)=-$



1.28, $p=.22$). Also, this score was significantly different from the upright condition ($F(1,33)=8.93$; $p=.005$), suggesting that 9-month-olds were responding to the emotion itself in Experiment 1. These results indicate that by 9 months, infants intermodally match bodily and vocal emotions from within the same negative valence, but 5-month-olds cannot. This contrasts with prior findings that even 5-month-olds match bodily and vocal emotions across the positive and negative valence categories. Thus, within-valence intermodal matching takes longer to develop than across-valence matching. However, even within-valence matching is available early in life before language development. This finding supports theories that posit early development of emotion knowledge.

P2-D-47: Visual attention to emotional facial expressions by toddlers with Williams syndrome

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Williams syndrome (WS) is a rare (1 in 7,500 live births) neurodevelopmental disorder caused by a hemideletion of 26-28 genes on chromosome 7q11.23. WS is associated with specific physical, medical, and cognitive characteristics, and a unique social-personality profile. Infants with WS look more often, for longer, and with an unusually higher intensity to faces compared to typically developing (TD) infants--an early manifestation of the WS personality phenotype (Mervis et al., 2003). Children with WS show little to no stranger anxiety, approaching strangers much more readily than controls do (Klein-Tasman & Mervis, 2003; Mervis et al., 2003). It has been hypothesized that their distinct tendency to approach strangers may be related to atypical processing of emotional facial expressions, particularly fearful or threatening expressions (Jarvinen et al., 2013). The effects of emotional facial expression on visual attention to faces by toddlers with WS has never been explored. In the present study, the visual attention of toddlers with WS ($N = 11$, 7 girls; Mage = 32.13 mos., range: 24.05-36.63; Mullen ELC $M = 68.82$, $SD = 15.97$, range: 50-102) to fearful, angry, happy, and neutral facial expressions was examined in a preferential looking task. On each trial, participants were shown two faces displaying different expressions (happy, angry, fearful, or neutral) side-by-side on a monitor for 10 seconds (12 trials total: 2 blocks of 6 expression pairs, side counterbalanced). Looking behaviors were coded offline. Proportion of first looks toward each expression, number of attention shifts between expressions, and preference scores per trial were measured for each toddler. Friedman's tests revealed that facial expression did not affect the direction of first looks (Fear $Mdn = 0.25$, Angry $Mdn = 0.25$, Neutral $Mdn = 0.26$, Happy $Mdn = 0.25$; $Z = 2.392$, $p = .495$) or number of attention shifts (A/F $Mdn = 4.5$, A/H $Mdn = 4.0$, A/N $Mdn = 4.5$, F/H $Mdn = 4.5$, N/H $Mdn = 4.5$, F/N $Mdn = 4.0$; $Z = 9.266$, $p = .099$) that occurred during each trial. Wilcoxon signed-rank tests conducted on each expression pair (Figure 1) revealed a statistically significant preference for fearful over neutral ($Mdn = 5.92$ and $Mdn = 2.69$, $Z = -2.94$, $p < .001$) and happy faces ($Mdn = 5.53$ and $Mdn = 3.37$, $Z = -2.40$, $p = .014$). No other significant preferences were found ($ps > .15$). Results indicate that toddlers with WS between the ages of 24 and 36 months have an overall visual preference for fearful over happy and neutral faces. However, the direction of their first looks and how often they shifted their attention between facial expressions during each trial were not affected by facial expression. This study provides an important first step in understanding early emotion perception by



infants and toddlers with WS. Results will be discussed in light of typical development of emotional facial expression preference. Data collection is ongoing.

D-Communication 1 (speech perception, phonology and word-level processes)

P2-D-48: The relation between speed of processing and parental input complexity

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We know that parental speech input plays a vital role in infant's language acquisition as well as cognitive development. However, we know less about which aspects of parental speech play the biggest role. For example, the impact of parental mean length of utterance (MLU) is still unclear. Parental MLU is an indicator of the complexity of the input, and an index of input diversity, and might be expected to play a big role in determining how children acquire language. However, previous results have been mixed; while Hoff and Naigles (2002) reported a strong link between maternal MLU and the number of word types children produced, Hurtado, Marchman and Fernald (2008) did not replicate this result. This study tests whether there is a link between parental MLU and the number of word types that children have in their vocabulary. We also test the link between parental MLU and infants' lexical processing efficiency, also referred to as speed of processing (SoP). This efficiency has been linked to both infants' concurrent and later vocabulary development, but both the direction of the relationship, and the role of parental input in this relationship, is still unclear. This study assesses this relationship by testing whether infants' processing ability aids them in understanding complex utterances (with high MLU), and therefore influences their vocabulary development. We predict that 1) parental MLU will correlate with infant vocabulary development and that 2) the influence of parental input complexity on vocabulary development will be mediated through the infant's individual SoP. We hypothesize that fast processors will benefit from higher parental MLU as they can process more complex sentences, whereas slow processors may be hindered by regularly hearing such complex sentences in their input. In order to test these predictions, we tested 60 18-month-old infants learning Dutch. We assessed their lexical speed of processing in a looking-while-listening paradigm and used the the Dutch CDI to determine their concurrent vocabulary size and subsequent vocabulary knowledge at 24 months (we are currently collecting follow-up CDIs as they turn 30 months). The parental speech input the infants received was sampled during a lab-based play session at 18 months. We used CLAN to compute the parental mean length of utterance in morphemes. Using data from 37 infants for whom we had all three measures, we test our predictions using mediation analysis. Preliminary results (n=24) do not reveal a significant correlation between parental MLU and vocabulary development. However, they indicate that our prediction is borne out that faster processors benefit more when exposed to more complex language input.



P2-D-49: IDS properties that are rare in adult language can contribute significantly to language development: An fNIRS study on infant-directed vocabulary (IDV) in Japanese

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It has been assumed that infant-directed speech (IDS) can facilitate language acquisition by emphasizing and highlighting the properties of the target language. However, some properties of IDS are distinct from that of adult language and are difficult to be considered as "emphasizing" adult language properties. In Japanese, for example, a specialized form of vocabulary, infant-directed vocabulary (IDV), is known to occur frequently with a specific prosodic form, viz., a Heavy-Light bisyllabic form with a pitch-accent on the first syllable (H'L). Interestingly, this form is similar to a trochee in a stress-timed language such as English, even though it does not occur frequently in adult Japanese (Mazuka, Kondo, & Hayashi, 2008). Thus far, the behavioral studies have found that Japanese infants begin to show a preference to the H'L form over other word forms by 10 to 12 months of age (Hayashi & Mazuka, 2017). This form facilitates word segmentation (Hayashi & Mazuka, 2010) and word-object association (Oshima-Takane & Kobayashi, 2012), indicating that the IDV form has a facilitative effect on infants' language development. In this paper, we report the results of an fNIRS study in which the brain activation of 5 and 9-month-old Japanese infants' for the IDV form was examined. Infants listened to lists of HL words, such as /paN.ta/, and LH words, such as /pa.taN/, while they sat on their mother's lap. Their brain activation was measured by a multichannel NIRS system (ETG-4000, HitachiMedical Co., Jpn). The region of interest (ROI) for the analysis included the left and right inferior frontal gyrus and premotor cortex (IFG/PM), which roughly correspond to channels 15 and 5 in Figure 1), the anterior superior temporal gyrus (STG) (ch 18 and 7), the middle STG (ch 21 and 9), and the posterior STG (ch 19 and 6). Infants' Oxy-Hb levels revealed that in the IFG/PM ROI, responses to HL words were larger in 5-month-old infants than in 9-month-old infants, and responses to LH words were larger than that of HL words in 9-month-old infants. In the middle STG ROI, the responses for HL words were larger in 5-month-old infants than in 9-month-old infants in the left channel. The results indicate that 1) HL forms are processed differently from LH forms by Japanese infants in both age groups, but 2) the developmental changes indicate that the processing of HL forms requires less effort by 9 months, which corresponds to the age when the infants begin to show a behavioral preference to the HL form. The combined results from the behavioral and fNIRS studies show that the prosodic form of IDV is helpful for Japanese infants during their initial stage of word learning. This indicates that the ways in which IDS can facilitate infants' acquisition of adult language is not limited to "emphasizing" or "highlighting" the properties of adult language, and IDS research should look beyond the IDS properties that have been traditionally considered as facilitating.

P2-D-50: Quantity and quality of spoken input: A reanalysis of the Wells (UK English) and Demuth (Sesotho) corpora

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A majority of language acquisition corpus research is based on Western, Educated, Industrialized, Rich, Democratic (WEIRD) communities (Henrich, Heine, & Norenzayan, 2010), where the primary caregiver is usually the mother. Mother-child dyad speech has long been the main focus in early input studies, despite evidence suggesting that maternal input is not the only one that counts (Shneidman & Goldin-Meadow, 2012). This matter is particularly pressing because in many human communities (particularly non-WEIRD ones) care and interaction occurs with multiple speakers and the mother is not always the sole caregiver (Page et al., 2019). Yet, few studies describe child-directed and overheard speech produced by other family members, and even fewer studies investigate this in diverse cultures (see Shneidman & Goldin-Meadow, 2012). In this study, we analyze speech produced around children in two linguistically and culturally diverse corpora. We ask who produces this input, and how much of it is targeted as child-directed (CDS) versus adult-directed (ADS). We also describe CDS and ADS in terms of mean utterance length (MLU), type token ratio controlling for corpus size (MATTR), and function (questions versus other utterance types). To answer these questions, we annotated two CHILDES longitudinal corpora. The Demuth corpus (Demuth, 1992) is a non-WEIRD corpus in the Sesotho language, recorded in Lesotho. It contains ambient speech for three toddlers aged 2;1-3;3 years. The English Wells corpus (Wells, 1981) has recordings of 32 British children, 9 of which are now being annotated - those with siblings, and with the same age range as in the Demuth corpus. Sources of overall input (directed and overheard) show that 52% of Wells input comes from mothers, whereas in Demuth only 25% does. In Wells, siblings provide 35%, peers 3%, and other adults 7% of input, versus 15% for siblings, 30% for peers, and 17% for other adults (excluding the investigator) in Demuth. Figure 1 shows preliminary results based on 27,827 annotated sentences (57% of Wells, 52% of Demuth). 86% of Demuth input is CDS versus 4% ADS (the rest is NAs/overheard). For Wells, only 51% is CDS versus 24% ADS. In both corpora, children hear more CDS than ADS, but CDS is more prevalent in Demuth. Demuth CDS is produced mainly by peers and other adults, whereas Wells CDS by mothers and siblings. Moreover, qualitative features are shown in Table 1. Both Demuth and Wells CDS have shorter sentences, less lexical diversity and more questions than ADS, following the directions of previous findings. However, some CDS-ADS differences are quite small (e.g. MLU for Demuth). To sum up, these results highlight the prevalence of speech from the nuclear family in the WEIRD corpus, with a greater integration of others in the non-WEIRD corpus. Input from the mother is less prevalent in the non-WEIRD corpus than the WEIRD corpus, and in both corpora children contribute substantially to the overall input. This study invites for more corpus research in varied cultures, and further research into CDS produced by non-maternal speakers of different ages.

P2-D-51: Speaker race and language comprehension in monolingual and bilingual toddlers

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Past studies suggest that infants form linguistic predictions based on visually presented race information. For example, infants associate particular languages with same- and other-race



faces in the first year of life (May, Baron, & Werker, 2019). In language comprehension tasks, toddlers appear to maintain different linguistic expectations of same- and other-race speakers. In a word recognition study, Weatherhead and White (2018) presented 16-month-old infants with videos of same- and other-race speakers. After each video, infants were presented with two familiar objects, one of which was labelled, either correctly or by a mispronunciation. Weatherhead and White demonstrated that word recognition was accurate when words were preceded by a same-race video, but not when preceded by an other-race video. In particular, infants associated correct pronunciations but not mispronunciations with visual targets when presented with same-race models. In the presence of other-race models, infants did not respond differentially to correct and mispronounced labels. In the present study, we tested 24 monolingual and 24 race-matched bilingual toddlers (24 months) in Weatherhead and White's word recognition paradigm. Before each trial, participants were shown a video of a same- or different-race adult waving to them. In a series of trials, two objects appeared on-screen, one of which was labelled (e.g. "Look at the dog!"). As in Weatherhead and White's study, in half the trials, the labels were correctly pronounced and in the other half, the labels were mispronounced (e.g. "Look at the dag!"). The label always appeared at the mid-point of each trial. The dependent variables for analysis were fixation times to the labelled object prior to labelling (pre-naming phase) and after labelling (post-naming phase). As in past studies (Mani & Plunkett, 2010; Swingley & Aslin, 2000; 2002), a significant increase in fixation between phases suggests that the participant has associated the verbal label with the familiar object. No significant increase is consistent with rejection of the label as a possible name for the object. A 2 x 2 x 2 x 2 (pre-/post-naming x correct/mispronunciation x same/other race x monolingual/bilingual) ANOVA revealed a significant two-way interaction of phase and pronunciation type, $F(1,46)=8.67$, $p=.005$. Fixation times during the post-naming phase were significantly higher than the pre-naming phase for correct pronunciations ($t[47]=4.61$, $p<.0001$), but not for mispronunciations ($p=.56$). Pairwise comparisons within the monolingual and bilingual groups demonstrated that both groups successfully associated correctly pronounced words, but not mispronounced words with visual targets in trials prefaced by a video of a same-race adult (see Figure 1a). When words were prefaced by a video of a different-race adult, bilingual infants continued to recognize correctly produced words and reject mispronunciations. In contrast, in these trials, monolingual participants responded to correct pronunciations and mispronunciations in a similar fashion, rejecting both types of words as possible labels (see Figure 1b). Results suggest that bilingual infants' word recognition abilities did not vary based on race cues. Monolingual children demonstrated race-dependent responses and as in Weatherhead and White's study, they exhibited more limited abilities when words were associated with a different-race individual.

P2-D-52: Infants' preference for singers: Effect of singers' singing behavior and styles

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It is common for parents to sing songs to their infants during natural interactions (Trehub, Unyk, & Trainor, 1993). At this time, infants listen to songs, but often observe other concurrent activities. For example, parents often sing songs while tapping or bouncing to soothe infants, smile, or move their body while playing with their infant. Previous research has investigated



how infants' perceptions of songs develop (Hannon & Trainor, 2007); however, it still remains unclear how infants associate song with other movements or actions from the person singing to them. In the present paper, we investigated whether infants prefer to watch a singing person or a still face presented along with a song, and whether they respond differently when the singers' gaze is directed to them. We hypothesized that if infants simply associate visual information with songs, they would show no difference in any condition. If their attention was influenced by whether visual and auditory information match, their preference would differ between dynamic faces and still faces. Finally, if communicative cues provided by song are important, infants would show different patterns of preference in the direct versus averted gaze conditions. Three Japanese women were filmed while singing 3 traditional Japanese children's songs lasting approximately 15 seconds. They were recorded once, while they gazed directly into the camera, and a second time, when they looked 45 degrees away from the camera. Still movies were created by replacing the still photographs of the same women with the dynamic movie. During a familiarization phase, infants were presented with one of the four stimuli, followed by a test phase during which infants were presented with two side-by-side 15-second silent still photographs corresponding to the familiar face (seen during the familiarization) versus a novel face (see. Figure 1). Gaze and movie conditions were within subjects factors, and age group was a between subjects factor. The infants' looking times were measured by the Tobii T60XL eye tracker during both the familiarization and test phases. Forty-five 5-month-old infants and fifty-three twelve-month-old infants were tested. During the familiarization phase, both groups of infants looked significantly longer at the dynamic movies than the still photographs presented with song (5m: $F(1, 44) = 17.87, p < .01$, 12m: $F(1, 52) = 24.64, p < .01$). During the test phase, only 12-month-old infants looked significantly longer at the familiar face than the novel face, but only when they were presented in dynamic movies with direct gaze, as shown in Figure 2 ($F(1,52) = 4.29, p < .05$). Five-month-old infants did not show any preference in any conditions. The results suggest that by 12 months, infants' sensitivity to singing goes beyond the auditory signal alone and they associate singing with gaze behavior as well as accompanying lip movements. Prior to this stage, although 5-month-old infants looked longer at singing videos than still-face videos during familiarization, they showed reduced sensitivity to gaze cues provided by a singing adult. This suggests that sensitivity to the communicative functions of song develops between 5 and 12 months.

P2-D-53: The role of shape bias in 'online' and 'offline' categorisation

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From around 24 months, children begin to generalise names for solid objects to novel examples that are the same shape, placing less importance on colour or material. This shape bias may reflect a shift in attentional resources towards the perceptual feature that gives the most informative cue to category membership, thus aiding word learning. Shape bias research typically represents an in-person word learning situation, often with an exemplar visible throughout the task. However, in designs where the exemplar is removed, the additional requirement to hold a representation of the object in working memory could have implications for the shape bias. In this series of studies we compare 'online' (visible exemplar) and 'offline' (absent exemplar) versions of common shape bias tasks to investigate how labels are extended under different circumstances. We also consider how the shape bias presents in



cases where visual differences between objects are less obvious, and where salient visual features could distract attention from an object's global shape. This series of studies tests the prediction that children will choose objects that match the exemplar in shape most frequently across all tasks, and that the visual working memory demands of offline conditions may affect the strength of that bias. We also hypothesise that labelled items will elicit a stronger shape bias than non-labelled items, particularly when learning conditions are more challenging (e.g. highly similar distractors; no visible referent). Additionally, we predict that the presence of salient visual features will not disrupt the shape bias for typically developing children. This research is conducted with 60 typically developing children aged 30-months to 4-years. Critically, however, we also present data from 60 children with Autism, aged 4 to 9 years, and discuss what we can learn about shape bias in typical development from cases where language is delayed and attentional biases may be different. These studies are presented on a touch-screen computer. Children are first presented with an exemplar, half of which are labelled and half are unlabelled. For half of the tasks, the exemplar remains visible (online condition) and for half it disappears during test item presentation (offline condition). The studies include a forced choice task, in which children are presented with a shape-match, colour-match and material-match for the exemplar and must identify one as a member of the same category, and a yes/no task where test items can be accepted or rejected individually. Data collection is ongoing, however, provisional results indicate a consistent bias towards shape-match choices for both developmental groups. On tasks where the distractor items are markedly different from the standard, having the standard visible is a significant predictor of stronger shape bias in typical development. However, there is no such advantage when the visual differences are more subtle. For stimuli with salient visual features, both developmental groups show significantly higher acceptance of shape-match items over colour and feature-match distractors, although the presence of a label only predicts a stronger shape bias for the typically developing children.

P2-D-54: Early looking in play, word learning, and language development

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Early visual attention skills have been recognized as significant milestones in cognitive development. At the age of six months, infants start to learn to focus, follow, and influence other's gaze and develop sustained attention to the target of interest through daily interactions with social partners, most notably their parents. Specifically, the shared attention between infant and parent to the same target of interests, which also called joint attention, has been demonstrated as a significant predictor of language learning. In addition to parents' eye gaze, recent infant studies showed the importance of object naming and handling during the joint attention in maintaining an infant's attention to the target object. However, how these social referential cues work jointly or separately to navigate the infant's looking behaviors and promote language learning are not fully understood. The present study aims 1) to investigate how three primary referential cues (i.e., parental eye gaze, verbal labeling, and object holding) jointly and independently contribute to infant's gaze behaviors, such as fixation (>33ms) and sustained attention (>3000ms), to the target object of interest during a parent-child object play; 2) to examine the role of socially generated looking behaviors during the play in immediate learning about the object name, and 3) to examine the potential developmental significance of



the attentional behavior for language development over time. In the present study, forty-three parent-infant dyads with the infants aged from 5 to 19 months were recruited and completed a six-minute parent-child play session and a word learning test. In the play session, both infant's and parent's gaze behaviors were recorded by the head-mounted eye tracking systems along with the play scene and speech recording. We annotated individuals' behaviors in terms of infant's gaze, parent's gaze, speech, and object holding during the play (see Figure 1). After the play session, infants completed a word learning task in the preferential looking paradigm. Infants were presented with two images of the object items that were used in the play session. For Aim 3, we collected a follow-up vocabulary measure (MCDI) three months after their first lab visit. The generalized mixed effect model found that infants were significantly more likely to produce gaze fixations ($>33\text{ms}$) to the target object when the parent looked at the handling object while naming the object compared to other referential combinations. In contrast, infants were significantly more likely to produce sustained attention ($>3000\text{ms}$) to the target object when the parent also looked at the object while naming the object (See Table 1). Further, the linear regression model found that the time duration of infant's sustained attention, parent's object naming, and parent's attention to the handling object significantly predicted infant's performance on the following word learning task ($F(7,26) = 3.72, p = .01, \text{adjusted } R^2 = 0.37$) and indicated potential relevancy to their later vocabulary measure. The present study characterizes how parent scaffolding can organize the infant's attentional behaviors and further facilitate language development in early childhood.

P2-D-55: Visual exploration in novel noun generalization task: A window on the relationship between vocabulary and shape bias

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Shape bias refers to the tendency of children and adults to generalise novel names for novel solid objects by similarity in shape. Over 30 years of research on the shape bias has produced a clear theoretical framework linking the development of the bias to the statistical regularities of the early noun vocabulary. Studies show that attention to the shape of an object in naming tasks increases as the noun vocabulary grows and children learn many names for categories well organised by similarity in shape. Smith and colleagues propose that this trains the attentional system such that the syntactic context of a naming event cue children's attention to the shape of solid objects. This talk takes a new look at attentional cuing idea by examining children's moment-by-moment visual exploration as they complete a novel noun generalisation task (NNG). We used a looking-while listening procedure to track the length and sequences of 17- to 31-month old children's looks during a NNG task with 3-Dimensional, solid exemplars (rather than images on a screen as in some prior work). On each trial the child was allowed to first explore the exemplar and the shape- and material-matching test objects briefly. The experimenter then placed the two test objects on a stand, held up the exemplar and said "This is my dax. Get your dax". A small camera located between the two test objects recorded looking during exploration, and during the prompt and request phase of the task. In addition to gathering looking data, we also code how children touch and explore the stimuli during familiarisation. This method enables direct investigation of each child's visual attention to the exemplar and test objects at the point when the novel label was said and comparison it to



attention to the objects prior to the name presentation. This way, we can investigate 1) how children allocate attention prior to naming, 2) if children's attention is cued to the shape-matching test object when the name is given, and 3) if this timing varies with vocabulary size. Our sample consists of 57 children (27 boys, 30 girls), with a mean age of 22.46 months and a mean productive vocabulary of 203.26 (range 3 to 418). Data analysis is ongoing, but preliminary findings suggest that although many children demonstrate a strong shape bias, there are revealing differences in their patterns of visual exploration as the decision process unfolds. As in prior research, children who have more words in their productive vocabularies select the shape-matching test object more often, $R = .27$ $p = .043$, and shape choices increase with vocabulary for all four test sets (Figure 1). As can be seen in Figure 2, when children show the shape bias, it is cued by the naming event of the task. Children who made shape choices (right panel) looked equally at the two test objects until the naming event (red dashed line) but looked to the shape-matching test object when cued with the name. This supports Smith's attentional cueing proposal.

P2-D-56: The larger the consonant contrast, the bigger the looking time difference: A meta-analysis

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During their first year of life and even before they begin to speak, infants tune into the speech sound system of their native language. Looking time measures have been an indispensable tool to understand the process of developing infant speech sound perception. Although looking time measures are a quantitative outcome measure, thus measuring how many (milli)seconds an infant attends to a given stimulus, they have mostly been treated equivalent to binary outcome measures, serving to elucidate whether or not an infant shows evidence for discrimination of a given contrast at a given age. To what extent these measures can provide information beyond such a binary index of infants' discrimination abilities has received little attention, but is of high relevance given the pervasiveness of looking time measures in infant research. Using a new database of infants' discrimination of native language consonant contrasts, we take a meta-analytic approach to address this question. Cohen's d standardized mean effect sizes, the main unit of calculation in meta-analysis, quantify the difference between two conditions, for instance the looking times to a habituated versus novel speech sound stimulus, based on mean differences and their standard deviation, thus reflecting the potential quantitative characteristics of looking time differences. Relying on this measure, we assessed whether the magnitude of effect sizes based on infant looking times could be related to two quantitative external predictors, infant age and magnitude of consonant contrast. The subset of the database for which we had sufficient information to calculate effect sizes covered 120 datapoints of infant consonant discrimination experiments, including results from 2392 infants aged 4-488 days from 8 language backgrounds. We transformed individual experiments' reported results into Cohen's d effect sizes based on the means and standard deviations or t -values reported in the original articles. We then performed a meta-analytic regression to assess the relationship of these effect sizes to infant age and contrast magnitude. The former variable was based on reported mean infant age for each respective experiment. The latter predictor was calculated by summing up the difference in place, manner, and voicing characteristics of the respective contrast; for instance, Our linear meta-analytic regression



showed that both infant age ($d = 0.013$, $se = 0.006$, $z = 2.08$, $p = 0.038$) and contrast magnitude ($d = 1.164$, $se = 0.534$, $z = 2.179$, $p = 0.029$) significantly predicted effect sizes magnitude, such that effect sizes for native consonant discrimination became larger with infant age and with larger contrast size (Fig. 1 and Fig.2). These results suggest that results obtained from infant looking time measures carry more information than the presence or absence of an ability. Instead, effect size magnitude correlates with external measures can be linked to more subtle differences related to processing difficulty. These findings converge with meta-analytic evidence from vowel discrimination (Tsuji & Cristia, 2017), as well as infant studies that show a relationship between looking time measures and external indices of cognitive processing (e.g., Kidd, Piandatosi, & Aslin, 2012).

P2-D-57: Investigating the relationship between infant learning and measured effect size in preferential looking paradigms

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In looking time studies, individual infants show a wide range of preferential responses. How should we interpret individual differences in looking times? Does the size of a looking time difference index the individual's strength of discrimination or amount of learning? Most methodological and analytic approaches are based on the premise that the size of individual infants' looking time differences are meaningful (e.g., Hoareau et al., 2019). Some analytic approaches, however, treat direction of preference as a binary outcome and ignore variability in preference size (e.g., Newman et al., 2006). An underlying difficulty in interpreting the magnitude of looking time differences is that our understanding of the relationship between learning processes and looking behavior is limited (Bergmann et al., 2013). The aim of the project is to ask whether the magnitude of the effect size in looking time studies is a meaningful index of the degree to which infants have learned. To address this question, we test infants' recognition of novel auditory stimuli following a training phase - a fundamental task for infant learners (Jusczyk & Aslin, 1995) - while manipulating a factor that is expected to affect learning: frequency of exposure. During the training phase, infants hear a list of nonce words, in citation form. While all infants hear the same total number of nonce words during familiarization, the frequency of target words varies. After the training phase, we test infants' preference for two (familiarized) target words and two (novel) nonce words they did not hear during the exposure (counterbalanced across infants - see Figure 1). The central question is whether more frequent exposure to target nonce words - and hence, stronger learning of these items - results in larger effect sizes as measured through infants' looking behavior. In a preliminary experiment (pre-registration: https://osf.io/j49gr/?view_only=124728c565994d5fa27bfc10ab250078), we are investigating two between-subjects boundary conditions: a condition where the target words are heard relatively infrequently (4 occurrences each in 80 total words; 4x condition), and a condition where the target words are heard relatively frequently (16 occurrences each in 80 total words; 16x condition). These data will inform decisions for a planned large-scale test of the relationship between frequency of exposure and effect size. The full design (planned for subsequent data collection) will include a continuous manipulation of nonce-word frequency



across several additional conditions (Figure 1). Preliminary inspection of the data (data collection ongoing; $n=24$ of a pre-registered final sample of 64) suggests no clear evidence of learning in infants in the 16x condition (difference in looking to novel vs. familiar words: $M=-793$ ms, 95% CI=[-2692 ms, 1213 ms]) and infants in the 4x condition (difference in looking to novel vs. familiar words: $M=-1557$ ms, 95% CI=[-4302 ms, 1187 ms]), with infants' looking tending towards a familiarity preference in both conditions. In our talk, we will present the results with the final sample and our next steps towards studying how systematic changes to infants' exposure - and consequently, to infants' learning - modulate effect sizes in looking time tests.

P2-D-58: Early attentional control abilities in monolingual and bilingual infants

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Bilingualism is a powerful experiential factor, and its effects have been proposed to extend beyond the linguistic domain by boosting executive functioning development. Crucially, recent findings suggest that this effect can be detected in bilingual infants indicating that it emerges as a result of early bilingual exposure and the experience of negotiating two linguistic systems in infants' environment. However, these conclusions are based on only two research studies from the last decade (Comishen, Bialystok, & Adler, 2019 Dev Sci; Kovács & Mehler, 2009 PNAS), so to date, there is a lack of evidence regarding their replicability and generalizability. We will present two experiments that assessed the replicability of these findings and the domain-specificity of attentional control abilities in seven-month-old bilingual infants in comparison to same-age monolinguals. Experiment 1 assessed attentional control processes in 16 monolingual Spanish or Basque and 16 bilingual Spanish-Basque seven-month-old infants using the anticipatory looking paradigm developed by Kovács & Mehler (2009). In this paradigm, infants were presented with an auditory cue (triplets of syllables) while they watched two squares located on the left and right sides of a screen. One second after the cue offset (the anticipation period) a visual reward appeared in one of the squares. In the first 9 trials, the reward appeared on one side (pre-switch), and in the last 9 trials the reward's location was switched to the other side (post-switch). All infants were predicted to successfully learn the location of the reward in the pre-switch phase, indexed by a greater proportion of anticipatory looks to the correct than the incorrect location. In the post-switch phase, bilinguals were predicted to outperform monolinguals given that this phase engages infants' attentional control requiring them to abandon the previously learned reward rule to learn the new reward's location. As expected, all infants directed more anticipatory looks to the correct location in the pre- than the post-switch phase, $F=3.74$, $p=.05$, learning the initial rule but failing to switch to the new rule. Crucially, results yielded no significant bilingualism effects on performance across the experiment, $F<1$, $p=.51$. Experiment 2 was designed to test the possibility that the unexpected results of Experiment 1 were due to methodological factors (this is a pre-registered experiment; data collection will be completed in February 2020). First, it implemented an adaptation of the anticipatory looking paradigm involving 12 pre-switch and 12 post-switch trials allowing infants more opportunities to learn the pre- and post-switch reward patterns. Second, to further assess the validity of this task and the generalizability of the attentional control processes that it targets, two versions of the task were administered in



two experimental sessions: one using auditory cues as described above, and the other using visual cues (triplets of shapes). Third, to ensure that the previous findings were not due to a lack of statistical power, the sample size was extended to 35 monolingual and 35 bilingual infants. These findings will be discussed in relation to the extent to which bilingualism effects are manifested across domains in early cognitive development.

P2-D-59: The role of emotion in toddler word learning

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From early in development, substantial individual differences have been observed in how many words children learn and how quickly they do so. Therefore, it is important to better understand what factors may influence the development of word learning. Prior research indicates that the context in which a word is spoken (e.g., location or background) influences how well young children learn the word (Perry, Samuelson, Malloy, & Schiffer, 2010; Vlach & Sandhofer, 2011). Specifically, it has been shown that variability in the context presented during learning leads to improved word learning in 3- to 4-year-old children when compared to consistent learning contexts (Vlach & Sandhofer, 2011). However, it remains less clear how variability in social contexts (such as emotion) may impact word learning. Given the frequency with which words are presented to young children in social-emotional contexts, a better understanding for how these contexts may influence word learning is crucial. Thus, the present study aimed to investigate whether toddlers overhearing words in an emotionally variable context would learn those words better or worse than toddlers in an emotionally consistent context. We used a novel noun generalization task with 2-year-old children. Children observed three object exemplars labeled per trial across eight total trials. Children were randomly assigned to one of four emotional labeling conditions. Children either heard the object labeled in a tone of voice that was consistently angry, consistently happy, consistently sad, or variable (one exemplar labeled in each emotional tone per trial). All emotional labels were presented with the appropriate emotional facial expression by the emotional experimenter. The emotional experimenter labeled each object twice (e.g., "This is a wug. It's a wug") before handing the object to a neutral experimenter. The neutral experimenter then allowed the child to interact with the object. The neutral experimenter was included to avoid having the child feel as though the emotions were targeted at them. After three learning trials, the neutral experimenter presented the child with a test trial in which the child was asked to hand the experimenter the object that matched the previous label (e.g., "Can you hand me the wug?"), out of four possible options. Only one option matched all three of the previous objects on any dimension. In this study, the correct answer always matched the learning trial objects on the dimension of shape. We investigated whether the number of correct responses (out of eight possible) varied by emotional condition. Preliminary data from 52 participants (Mage=2.49 years, 29 female) suggests that the number of correct responses in the variable condition (M=5.46, SD=1.90) may be higher than in the consistently angry (M=4.75, SD=2.53), consistently happy (M=4.62, SD=2.10), and consistently sad (M=4.64, SD=2.62) conditions (see Figure 1). These results suggest that the advantage of young children learning words in a variety of contexts may extend to social contexts such as emotional tones of voice. Ultimately, these findings hold implications for our understanding of how variability in emotional contexts may influence children's ability to learn new words.



P2-D-60: Toddlers show adult-like sensitivity to consonants and vowels in early word representations

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In the second year of life, babies start rapidly learning words in their native language. Underlying this phenomenon are the phonological representations of these newly familiar words--because toddlers are in the earliest stages of word learning, they may not have developed detailed representations of their words. Previous work has suggested that toddlers, like adults, are sensitive to mispronunciations of consonants in familiar words (Swingley & Aslin, 2002; White & Morgan, 2008), but studies exploring vowel mispronunciations have yielded mixed results. However, Mani and colleagues (Mani & Plunkett, 2007; Mani, Coleman & Plunkett, 2008) found that toddlers are similarly sensitive to mispronunciations of vowels in early words. The current work uses eye-tracking methods to directly compare toddlers' sensitivity to vowel and coda consonant mispronunciations. Our study replicates and extends previous work by testing toddlers with a larger set of stimuli than Mani and colleagues using novel distractors as in White and Morgan. Forty-eight toddlers between 17.5 and 20.5 months of age were presented with displays containing one familiar and one novel object. Half of the participants were assigned to the coda experiment and half were assigned to the vowel experiment. In test conditions, toddlers first saw an images of the target item and an unfamiliar distractor item to get measures of the baseline salience of each image. Then, the participants heard the name of the familiar object either correctly pronounced or mispronounced by one, two, or three phonological dimensions (manner, voicing, and place of articulation for the coda experiment or height, backness, and roundedness for the vowel experiment) in positive-affect infant-directed speech. Toddlers heard a total of 12 test items: three correctly pronounced words, and a total of nine words for mispronunciations along one, two, and three phonological dimensions (three each). Additionally, toddlers heard four novel and two familiar filler words. Words and images were not presented to the same infant twice. Looking was recorded using a remote eye-tracker, and proportion of looking time to target (PLT) was computed as time fixating on the target image divided by the time fixating anywhere on the screen. PLT of the salience was then subtracted from PLT after presentation of the audio stimulus to correct for baseline salience. Our results of PLT aggregated across the entire trial show that toddlers demonstrate less sensitivity to mispronunciations of vowels than coda consonants: there was no indication of reduced looking time to target images for 1-feature vowel mispronunciations. However, time course analyses suggest that toddlers are indeed sensitive to vowel mispronunciations: looking to the target image was delayed, if not diminished. In contrast to the similar time-courses for vowel mispronunciations, time-courses for coda consonant mispronunciations were strikingly different. As with adults, vowel mispronunciations do not inhibit lexical access to the same extent as consonants. In both consonant and vowel experiments, toddlers show comparable patterns to adults tested in a similar paradigm. These results provide evidence that toddlers not only have adult-like phonological representations of familiar words, but they also demonstrate adult-like flexibility during word recognition.

P2-D-61: Adults' estimations of infants' age from infant-directed speech



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Speech varies considerably depending on the characteristics of the speaker as well as the recipient. Infant-directed speech (IDS) is a well-known example where individuals modify not only the semantic content but also the acoustic features of their speech when addressing infants and children. Studies show that these modifications vary depending on the age of the recipient child (e.g, Kitamura & Burnham, 2003). The present study investigated whether adults can make correct estimations regarding the recipient child's age by listening to IDS directed to children of different ages. Native speakers of Turkish (N = 186) with varying degrees of English knowledge listened to naturalistic recordings of North American English speaking mothers' speech directed to their children between the ages of 6 to 44 months. Participants were randomly assigned to listen, either to the original recordings or to the low pass filtered versions. After hearing two speech segments, participants were asked to guess which had addressed a younger or an older child. Overall, participants' guesses were correct above the chance level of 50% (M = 62.21%, SD = 9.16%, $t(185) = 18.19$, $p < .001$, $d = 1.33$). Percentages of participants' correct responses were submitted to an ANCOVA with Condition (filtered vs. non-filtered), Parenthood (having at least one child vs. having no children) and Gender (male vs. female), as between-subjects variables. Participants' age and self-reported English level were entered as covariates in the analysis. Condition and Parenthood had significant effects on participants' accuracy ($p < .001$ and $p < .05$, respectively): While accuracy was above chance in both conditions ($ps < .001$), it was higher in the non-filtered (M = 63.49 %, SE = .984) compared to the filtered condition (M = 59.88, %, SE = .862). Parents made more accurate estimations (M = 63.68, %, SE = .857) compared to adults without children (M = 60.71 %, SE = 1.02), yet both groups performed above chance ($ps < .001$). Finally, self-reported English proficiency also had a significant effect on participants' accuracy ($p < .01$). No other significant effects or interactions were observed. A trial-based analysis revealed that the probability of making accurate estimations was predicted by the age difference between the paired segments (Wald $\chi^2 = 132.65$, $df = 1$, $p < .001$): As the age difference increased, participants were more likely to make accurate guesses (See Figure 1). These results suggest that the age-related prosodic variations might provide meaningful cues that are available to adult listeners. Further, even though sensitivity to the age-related cues is influenced by experience and the content of speech, it does not solely depend on these factors. The implications of these findings in terms of what functions IDS might serve will be discussed.

P2-D-62: Developmental changes in infants' neural sensitivity to emotional prosody differences in spoken words

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Emotional prosody is a salient social signal of the spoken language. Although social interaction is believed to play an important role in language acquisition (Kuhl, 2004; Friedmann, 2015), there have been very few research reports on the early development of emotional prosody perception (Grossmann et al., 2005; Kostilainen et al., 2018). The current event-related potential (ERP) study aimed to investigate developmental changes in neural sensitivity to emotional prosody differences in 3- to 11-month-old infants. Specifically, we adopted a multi-



feature oddball paradigm to examine the mismatch responses (MMR) to angry, happy, and sad tones as against the neutral tone. Unlike previous studies that used one exemplar word to carry different emotional prosodies, our experimental design employed different spoken words for representing each emotion in order to test infants' pre-attentive processing of different categories of emotion on a higher level of abstraction. Forty-six typically developing infants from 2 months 26 days to 11 months 11 days (mean = 7.6 months, male = 25) were recruited. Two were excluded due to interruptions during the EEG recording. The multi-feature oddball task used neutral emotion as standard (presented at 50% of the time), and angry, happy, and sad emotions as deviants (each presented at 16.67% of the time). There were 600 trials over a span of 17 minutes. The stimuli were taken from Toronto Emotional Speech Set (TESS; Dupuis & Pichora-Fuller, 2010), which contains 200 phonetically balanced monosyllabic words spoken in different emotional prosodies. During the experiment, infants were seated in their parents' laps in a sound-treated booth, and an experimenter stayed with them and waved silent toys to keep infants entertained. Continuous EEG data were recorded with the Advanced Neuro Technology system with 64 Ag/AgCl electrodes. Infants were divided into younger and older groups (cut-off age = 7.5 months). Based on the grand mean ERP waveforms (see global field power data in Figures 1 and 2) and the infant ERP literature, the search window of 200 - 450 ms after the stimulus onset was used for quantifying the MMRs with the mean amplitude (40 ms around the peak response). Linear mixed-effect models were implemented to examine the effects of age, gender, and emotional category with participant as a random-effect variable. The statistical results showed a significant age group effect with the older infants exhibiting stronger MMRs than the younger group ($p < 0.01$). There was also a trend of stronger MMR to the happy emotion than sad emotion. But no interaction between age and emotion was observed. There was also no significant gender effect. The findings suggest that older infants have developed more mature ability to extract emotional prosody categories over a stream of changing spoken words. In addition, infants tend to show stronger neural sensitivity towards the happy emotional prosody than the sad one. Our results confirm the feasibility of the multi-feature oddball paradigm in testing emotional prosody perception in infants, which provides the foundational work for conducting future studies on infants at risk for developmental problems such as autism.

P2-D-63: The effects of language and social contexts on bilingual infant vocalization

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Caregiver-child interaction is an essential ingredient in the process of language development. Previous research has shown that the amount of one-on-one parentese that monolingual infants experience is predictive of concurrent infant vocalization (Ramírez-Esparza, García-Sierra, & Kuhl, 2014). But, how are these effects realized in infants who receive their input in two languages? Here, we examined how language and social contexts are related to infant vocalization rates in bilingual infants. Using the Language Environment Analysis (LENA) recording system, we collected three daylong recordings from ten-month-old infants ($N=21$) who are exposed to French and English on a regular basis. The LENA software provided estimations of infant vocalization and adult word counts in 30-second segments. In addition, we manually coded half of all segments for speaker context (i. e, who was speaking around



the child: mother, father, siblings, others, multiple), listener context (i.e., who the speech was directed towards: infant, other, multiple), and language context (i.e., what language(s) was being used: dominant, non-dominant, mixed). Consistent with prior research (e.g., Ramirez et al, 2014), we observed a significant correlation between the number of infant vocalizations and the total frequency of one-on-one interactions [$r(19)=0.52$, $p=.017$]. Interestingly, when examining this relationship by language context, our results showed that the number of infant vocalizations was only correlated with one-on-one interactions in the dominant language [$r(19)=0.68$, $p<.001$], but was unrelated to one-on-one interactions in the non-dominant language [$\rho=-0.06$, $p=.784$] or in mixed input [$\rho=-0.17$, $p=.467$]. A stronger correlation was observed between global input (total number of segments including all languages and talkers; infant- and other-directed) and total number of infant vocalizations [$r(19) = 0.86$, $p<.001$]. However, this relationship was weaker when the global input was restricted to only the dominant [$r(19)=0.43$, $p=.049$] or the non-dominant language [$r(19) = 0.42$, $p = .057$], and was absent when considering mixed language input [$r(19) = -0.12$, $p = .590$]. Nevertheless, when we look at each language context in isolation, we observed a strong correlation between the number of segments containing input and the number of infant vocalizations in that context [Dominant: $r(19) = 0.65$, $p=.002$; Non-dominant: $r(19) = 0.88$, $p<.001$; Mixed: $r(19) = 0.80$, $p<.001$]. Our results indicate that bilingually-exposed 10-month-olds (1) vocalization rates and input levels are positively related across language and social contexts, and that (2) overall vocalization rates are positively related to the amount of dominant language input provided in one-on-one contexts. These findings suggest that the infant's dominant language may play a leading role in shaping early speech production. Ongoing efforts are directed towards examining these relationships in bilingual infants at a later age, when lexical development in both languages are rapidly increasing. These findings have important implications for bilingual development and will provide new insights into the relationship between infant volubility and later language development.

P2-D-64: An exploration of early phonotactic repair by French-learning infants using ERPs

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Infants' learning of their native language involves developmental mechanisms that allow the acquisition of the native phonemic inventory and the rules whereby phonemes can be combined within words (phonotactic constraints). Previous studies established that infants become sensitive to some phonotactic rules by 9 months (Jusczyk et al., 1994; Nazzi et al., 2009; Gonzalez-Gomez & Nazzi, 2012) and suggest they start repairing phonotactically-illegal words by at least 14 months (Mazuka et al., 2011). The current study explores when and how infants' brains attune to the phonotactic constraints of their native language to achieve phonotactic repair. When presented with spoken utterances beginning with */dl/ or */tl/, which are illegal word-initial clusters in French, French-speaking adults repair these into legal /gl/ or /kl/ (Hallé et al., 1998, 2008; Hallé & Best, 2007). Here, we use a modified version of the oddball ERP paradigm (Dehaene-Lambertz & Baillet, 1998) to test whether the brains of French-learning 7-, 11 - and 14-month-olds repair the */tl/ sequence. Infants were exposed to trials of



four syllables. Each trial consisted of three precursor syllables followed by a target. The target was kept constant (*/tla/*) and there were three types of precursors: */tla/* (no-change baseline condition), */pla/* (control-change condition, see Hallé et al., 1998), or */kla/* (critical-change condition). ERPs were recorded using the 128-electrode EGI system. Epochs were extracted based on target syllable onset (-200 - 800 ms) and baseline corrected (-200 - 0 ms). Mean ERP amplitudes were computed over two time windows (100-300, 400-600 ms), and three areas at left (10 electrodes), middle (9 electrodes) and right (10 electrodes) frontal recording sites (Fig. 1). Seven-month-olds exhibited larger positive ERPs over the middle sites in response to the control-change ($p=.015$) and critical-change ($p=.010$) conditions compared to the no-change condition in the 400-600 ms window. Eleven-month-olds showed a similar pattern in the 100-300ms window in the middle (control- vs. no-change: $p=.030$; critical- vs. no-change: $p=.040$) and left (control- vs. no-change: $p=.007$; critical- vs. no-change: $p=.055$) sites, showing that at 11 months, responses are faster and start to lateralize to the left hemisphere (Fig. 2). Fourteen-month-olds also showed a positive response in the 100-300ms window showing a larger response for the critical- versus control- and no-change conditions, which would indicate a perceptual repair. However, this difference was too small to be statistically significant. Our results suggest that phonotactic repair found in French-speaking adults is not yet present by 11 months. The fact that we do not find differences between conditions at 14 months might indicate that this ability is in the process of being acquired at that age. Hence, although French-learning infants have started to learn some phonotactic rules by 10 months, they appear not to repair phonotactically-illegal sequences by 11 or even 14 months of age. Developmental changes were nevertheless found, showing faster and more left-lateralized responses to phonemic changes, suggesting that phoneme discrimination is improving between 7 and 14 months. These changes might constitute a prerequisite for the subsequent emergence of phonotactic repair. We are currently testing 18-month-olds to test this possibility.

P2-D-65: Perception of Korean affricate contrast by native infants

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Compared to other consonantal categories, affricates (e.g., */dʒ/*, */tʃ/*) have received relatively little attention in the infant speech perception field. A recent study reported that English-learning infants showed a perceptual narrowing pattern on their ability to discriminate non-native Urdu unaspirated-aspirated affricate sound contrast: where 7-month-olds distinguished them, but 11-month-olds were not able to do so unless they were habituated to the aspirated category first, thus displaying an asymmetry (Dar et al., 2018). Similarly, it was reported that Mandarin and English-learning 6- to 8-month-olds can discriminate Mandarin affricate from fricative sound, providing support for initial universal speech perception abilities (Tsao et al., 2006). However, perceptual narrowing may not be as prevalent as previously hypothesized, and data from diverse language samples seem to have begun painting a different picture. The present study aimed to examine the development of Korean affricate sound pair discrimination by native infants. Korean distinguishes affricates in three ways (i.e. */c*/-/c/-/ch/*, fortis-lenis-aspirated, respectively) with acoustic cues, such as, duration of frication and aspiration and fundamental frequency utilized for categorical distinction (Kim, 2004). We particularly focused



on the fortis-aspirated pair (Figure. 1) because 4- to 6-month-olds showed an ability to discriminate the same category pair among stop sounds (Choi et al., 2017). Using a habituation-dishabituation paradigm, 24 4-6-month-old and 21 7-9-month-old Korean-learning infants were tested on the fortis-aspirated affricate contrast (i.e., /c*a/-/cha/). The overall results showed that the older group was able to distinguish the affricate pair, but the younger group could not reliably distinguish them. However, the discrimination pattern was related to the order in the trial (same versus switch first, Figure 2) and the habituated sound category: 7- to 9-month-olds could discriminate the pair most reliably when they were habituated to the aspirated category and then tested with the switch trial, suggesting that their discrimination was affected by the type of habituation sound category and the test order. The findings here demonstrate that Korean affricate categories emerge relatively slowly with input exposure and develop later than stop categories; showing the enhancement pattern of development, unlike in recent findings. However, our results are similar to Dar et al. (2018) in that the discrimination pattern was influenced by the habituated sound category, although the affected age group was quite different: 7- to 9-month-olds in Korean-speaking infants and 11-month-olds in English-speaking infants in discerning Urdu contrast. More interestingly, both studies observed a similar asymmetry in infants' perception. When the infants were habituated with the aspirated category with a greater duration of frication and an additional durational cue, they were able to distinguish the affricate contrast. Similar to the coronal/labial case of asymmetry (Tsuji et al., 2015), these results may suggest that the sound category with more extreme acoustic cues may be more marked and thus present a better referential point for discrimination. The present study adds important data to the field by presenting a less attested consonantal category discrimination pattern, especially with infants developing unique three-way affricate contrasts in their native language.

P2-D-66: How bilingual language experience shapes the infant lexicon: A word learning study using bilingual CDI

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A core element of bilingualism is the acquisition of translational equivalents (TEs), i.e. cross-linguistic word pairs that share a referent. Even 13-month-old bilingual children understand words in both languages, including many TEs (De Houwer, Bornstein & De Coster, 2006). Bilingual children have also been found to know more TEs than would be expected if their languages were learnt independently (Bilson, Yoshida, Tran, Woods & Hills, 2015). Our project aims to provide further insight into the cross-linguistic and environmental factors influencing word acquisition by simultaneous bilinguals. This project comprises of two studies. For the first, we conducted exploratory analyses on existing cross-sectional bilingual CDI and language background data. The second study involves longitudinal data collection mapping bilingual vocabulary acquisition over the second year of life. Our cross-sectional sample (Floccia et al., 2018) consists of 202 bilingual 24-month-old toddlers growing up in the UK with English and one other language. Analyses were constrained to words shared across both CDIs for each language pair. For comparison, we calculated monolingual norms for the sampled words, operationalised as the percentage of 24-month-old monolinguals who understand the English word, using data from 632 English monolinguals. We hypothesise that shared concepts across bilinguals' two languages will boost the acquisition of TEs, and that strong phonological



similarity to an existing semantically equivalent lexical representation will further facilitate TE learning. Indeed, we found that even after accounting for monolingual norms, there is marked evidence of cross-linguistic influence on bilingual acquisition. Looking at single-language vocabulary, bilinguals are significantly more likely to know a word if they also know the TE in their other language, suggesting cross-linguistic facilitation for learning. Additionally, cognates (TE pairs with overlapping phonology) are more likely to be known in both languages than non-cognates (Figure 1). Notably, we found that the cognate boost for vocabulary acquisition only manifests when the TE is known in the other language, supporting the theory that cognate facilitation operates via scaffolding on an existing representation. In addition to linguistic factors, the pattern of bilinguals' vocabulary acquisition is influenced by their language environment. Bilingual toddlers typically know many TEs, but also comparatively more words in the language they hear more often. Moreover, bilinguals who are exposed to a balanced ratio of input in both languages were found to know the highest proportion of TEs (Figure 2). For the latter part of the project, our ongoing longitudinal data collection will allow us to explore how changes in language environment (e.g. starting nursery) may affect the developmental trajectories of bilinguals' two languages in different ways. In the UK, while there are many bilingual households, the home language(s) and their usage patterns can vary greatly. By collecting data for multiple language pairs, we can study the possible influences of language distance on vocabulary acquisition. Finally, by tracking bilinguals' vocabulary growth, we can also achieve a deeper understanding of the cognate facilitation effect for TE acquisition, to see how it develops over time and possibly interacts with changes in language exposure.

P2-D-67: Study of phonological overlap across languages in bilingual toddlers

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Bilinguals activate their both languages simultaneously on various degrees even in monolingual-like tasks (Spivey & Marian, 1999). Consistently, bilingual toddlers recognize words better if they overlap in their phonological representation across languages (Von Holzen, Fennell, & Mani, 2018; Von Holzen & Mani, 2012). However, previous research has used mainly cognate words as stimuli: cognate words overlap in their phonological form (and have the same meaning across languages; e.g., the cognate "door", in Catalan "porta" and Spanish "puerta"). Thus, phonological effects using cognates cannot be attributed only to the phonological overlap between labels because they also overlap at the conceptual level. Here, we analyse how phonological representations across languages influence word recognition of non-cognate words in Catalan-Spanish bilingual 36-month-old toddlers. We applied the visual word paradigm adapted to test toddlers (Chow, Aimola-Davies, & Plunkett, 2017). In the study, children saw four pictures on a screen while an eye-tracker recorded their eye-movements (see Figure 1). We included 16 test trials, where after 5000ms an absent target was named in Catalan. Among the pictures we presented: a) a Catalan-to-Spanish phonological competitor, b) a Spanish-to-Catalan phonological competitor and c) two phonologically unrelated competitors. For example, for the target "apple" (Catalan "poma", Spanish "manzana"), the Catalan-to-Spanish competitor was the picture of a "duck" (Catalan "ànec", Spanish "pato"). In this case, we expect the label "poma" to activate the label "pato" due their shared onset. The Spanish-to-Catalan competitor was the picture of a "sock" (Catalan "mitjó", Spanish "calcetín"), here we expect children to activate the target Spanish translation "manzana", and it to activate



the label "mitjó" due their shared onset. The unrelated competitors were "sandwich" (Catalan "entrepà", Spanish "bocadillo") and "brush" (Catalan "raspall", Spanish "cepillo"), because these words have different onsets to the target. We applied logistic growth curve analysis (Mirman, 2014) of fixations up to 2000ms after word onset. The time course of target fixations was captured with a second-order orthogonal polynomial with the fixed effects of type of competitor (Catalan-to Spanish, Spanish-to-Catalan and unrelated), and participant random effects on the slope. The preliminary model fits are in Fig. 2. There was a significant effect of competitor type, on the intercept of the Catalan-to-Spanish Competitor (Estimate=0.55, SE=0.07, p=0.00); the Spanish-to-Catalan Competitor (Estimate=-0.26, SE=0.08, p=0.00) and between them (Estimate=0.81, SE=0.07, p=0.00). These preliminary results support that bilingual toddlers activate phonological related competitors in their familiar languages on monolingual settings. Further analyses will explore the role of individual linguistic profiles on such phonological cross-linguistic effects. Currently, this is not possible due the limited sample size (n=10).

P2-D-68: A new software package for infant experimental testing procedures: Introducing BITTSy

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BITTSy (the Behavioral Infant & Toddler Testing System), was created to fill a need for a multi-paradigm experimental testing platform for infants that can be implemented consistently across multiple testing sites. BITTSy is capable of running key infant behavioral testing paradigms, including Headturn Preference Procedure [HPP], Preferential Looking, and Visual Fixation/Habituation, through the same interface. BITTSy is the first standardized system to support headturn preference procedures, and the first with the capability to combine this paradigm with other methods in a single testing session. BITTSy is a freely available, standardized system that is compatible with modern Windows operating systems. It uses only off-the-shelf hardware/wiring, making it easy to set up for researchers across a variety of settings (including those without technical support staff). As the first such system for HPP, BITTSy provides advantages to both current and new users of the paradigm, allowing for easier setup, improved functionality, and greater consistency in cross-site data collection. BITTSy is capable of presenting images, videos, and audio files through single or multiple monitors and loudspeakers, as well as controlling an array of lights (e.g. for HPP). Study procedures are specified through a structured but highly customizable protocol file, which implements built-in functions, such as randomly choosing a stimulus, displaying it, and waiting for an end condition such as an experimenter's keypress or a looking time requirement to be met. Through its protocol specification system, BITTSy allows for a greater degree of flexibility and control over the experiment structure and progression, for HPP as well as preferential looking and visual fixation procedures. Join us for a demonstration of BITTSy during the poster session, or visit go.umd.edu/BITTSy for more information!

P2-D-69: Development of cross-situational word learning in 12- and 17-month-old infants



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Cross-situational learning was proposed to explain how learners learn new words from co-occurrences between words and objects. It states that over exposures, the co-occurrence of words and their intended referents will increase while the co-occurrences of the words and other potential referents will decrease. Thus, adults learners were able to converge on the correct word-referent pairings; however, it is still an open issue whether young infants track cross-situational statistics to map words to referents. The current study recorded infants' pupil size with an eye tracker to examine if infants were able to learn from such statistics. Methods. Twenty-six 12-month-old and 19 17-month-old infants participated in the study. The word-learning task included a learning phase and a test phase. In each learning trial, two objects were presented simultaneously on the screen. Afterward, two words were played by the speakers. Since the position of objects and the temporal sequence of words were randomized, co-occurrences between objects and words across trials were the only information to disambiguate word-referent pairings. In test trials, only one object was presented and either a correct (congruent condition) or an incorrect (incongruent condition) word was played. Two novel pairs (novel condition) were also tested to check if infants were familiarized with the learning materials. Results. To evaluate the relation between language development and cross-situational learning, participants were further divided into two groups (low- and high-vocabulary groups) based on whether they scored less than 50th percentile on the Mandarin-Chinese Communicative Development Inventory (Taiwan) (MCDI-T; Liu & Tsao, 2010). Figure 1 shows the time courses of participants' pupil responses. Statistical testing using model comparisons of generalized additive mixed-effects models showed that 17-month-old infants in high-vocabulary group exhibited larger pupil dilation in incongruent condition compared to congruent condition ($\beta = 0.1$, $t = 2.65$, $p = .008$), indicating that they correctly mapped the novel words to its referents. In contrast, pupil size in incongruent condition of 17-month-olds in low-vocabulary group and 12-month-olds' was similar to that in congruent condition. Moreover, for 17-month-olds, the pupil size difference between incongruent and congruent conditions was positively related with expressive vocabulary size, especially item scores ($\rho(\text{item}) = .52$, $p = .02$; $\rho(\text{percentile}) = .46$, $p = .045$). Figure 2 shows the average changes of pupil size over conditions. Conclusion. The results revealed that 17-month-old infants with relatively larger vocabulary size were able to learn new words through tracking cross-situational statistics of words and referents. On the other hand, 17-month-old infants with relatively smaller vocabulary size and 12-month-old infants failed to use the same mechanism. Inferred from the results, the ability to learn from cross-situational statistics was related to language skills of 17-month-old infants. Cross-situational learning mechanism may facilitate infants to map novel words to referents, and advanced lexical ability may assist infants tune to the co-occurrences of words and referents across multiple encounters. Furthermore, the results demonstrated that pupillometry is a valid tool to explore word learning mechanisms in infancy.

P2-D-70: Facial directions representing the pointing reactions on forced-choice tasks in children

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Background: The introduction of new experimental methods exemplified by the intermodal preferential-looking paradigm (IPLP) and the forced-choice pointing paradigm (FCPP) has led to more sophisticated investigations of language development in children. Each method has its advantages and disadvantages (Ambridge & Rowland, 2013). The applicability of the IPLP for preverbal infants even under 2 years is one of its major advantages. However, preferential-looking data lack reliability compared to pointing reactions in general because of ambiguous responses. In contrast, the FCPP produces unambiguous reactions but is only possible when children can produce pointing according to their understanding of an experimenter's instructions. Especially in experiments involving toddlers aged between 18-30 months, when a significant change in language ability occurs, it is difficult to determine which of these two methods to use since this period spans the suitable ages in both paradigms. Therefore, a new methodological strategy that enables an integrated interpretation of both the IPLP and the FCPP is needed. Objective: This methodological study explores the correlation between preferential looking time and decisive pointing reaction of toddlers for whom the IPLP and the FCPP are applicable. We try to suggest valid criteria for estimating toddlers' intentional judgment on forced-choice tasks for those who cannot produce pointing reactions based on their preferential looking. Methods: Total of 16 Japanese monolingual toddlers aged 19-23 months were extracted for analysis (8 boys and 8 girls; Mean age = 21.5 months, SD = 1.7). Participants completed the forced-choice task that investigated their semantic categories of noun-like words (modified based on Hagihara & Sakagami, 2020). For example, after watching two juxtaposed video stimuli of "putting shoes on" and "rubbing two baskets," participants were prompted to choose one of them according to the instruction "Which is shoes?" Movements of toddlers' heads and gazes during each trial were recorded with a webcam set in the center top of a monitor. Temporal trajectories of facial and gaze directions were quantified using OpenFace 2.2.0, an open-source facial behavior analysis toolkit (Baltrušaitis et al., 2018), and later utilized to calculate preferential looking time. Pointing reactions were also recorded with a video camera and coded later. Among all trials, 252 trials were included in this methodological study's analysis (4 trials were excluded due to the lack of explicit pointing reaction). Results and Conclusion: Agreement rate analysis between pointing reaction and preferential looking time while changing the temporal window of looking time was conducted. The highest agreement rate was obtained when the time window was set within 0-1,500 msec after the completion of the experimenter's question (kappa coefficient = 0.74, 95%CI = 0.66-0.82, 87 % of agreement). Additionally, when using OpenFace, the calculation of preferential looking time based on the facial direction was likely to be slightly higher than on gaze direction (despite n. s.). These results indicate that preferential looking time would be a reliable alternative index of children's decisive pointing reaction by setting the apropos analysis plan (e.g., deciding the suitable time window), contributing to building a better research design for investigating toddlers' language development.

P2-D-71: Impact of an early auditory training on the electrophysiological functioning underlying language acquisition in infancy

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Developmental Language Disorder (DLD) is the most common childhood disorder. It is becoming increasingly clear that the key to its ultimately remediation lies in understanding the early mechanisms that come into play as the developing brain assembles functional networks. Basic auditory perception develops very early in life and is involved in language acquisition. Studies from our research group show that (a) early auditory processing is impaired in infants at familial risk for DLD and (b) it impacts later linguistic development. These pieces of evidence pave the way to the development of interventions that may be administered early in life within the period of known maximum cerebral plasticity. The overall study aims at developing an innovative and ecological early intervention based on environmental auditory enrichment to be tested on infants with/without risk for DLD (7-9 months of age), in an attempt to modify their developmental trajectories before the emergence and crystallization of any behavioural symptoms. Here, the efficacy of the intervention on typically developing infants (without risk for DLD) is tested on the electrophysiological markers of auditory processing and on early linguistic skills investigated before and after the intervention activities. 27 typically developing 6-month-olds participated to this study: 13 infants participated to the early auditory intervention (INT+) whereas 14 did not (INT-). The intervention 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 (N=4) for 1 hour/week for 6 weeks and indications were given to caregivers in order to continue the intervention at home. All infants underwent the same evaluations. Basic auditory skills at age 6 and 12 months were characterized via EEG/ERP using a non-speech double-deviant oddball paradigm. Pairs of tones were presented at a rapid rate (70ms inter-stimulus interval) and stimuli differing in either frequency or duration served as deviants. At age 6 and 12 months also expressive and receptive early language skills were assessed by means of standardized tests (Bayley Scales). The results show that INT+ infants presented at age 12 months a more mature ERP pattern, characterized by shorter latency of the P1 component (standard stimuli) and enhanced P2 component (Mismatch Response). Interestingly, such ERP pattern resembles that of INT-children at age 24 months (see Figure 1). In addition, comparisons between groups in the linguistic measures show significantly broader improvement in INT+ infants, both concerning expressive and receptive language skills ($F(1,25) = 4.74$ $p = .039$ and $F(1,25) = 11.40$ $p = .002$, respectively - see Figure 2). Taken together, these results provide some preliminary evidence on the efficacy of an early intervention based on active acoustic experience in modifying infants' neuronal and electrophysiological functioning underlying auditory processing skills, as well as early linguistic competences. The next steps of the present study will include the investigation of the efficacy that this intervention may have on infants with a family history for DLD, who have higher risk of atypical linguistic developmental trajectories.

P2-D-72: Efficiency of spatial-temporal attention can account for inter-individual differences in auditory scene analysis

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Proficient language users detect temporal cues embedded within the acoustic spectra of ongoing speech through efficient Spatio-temporal attentional mechanisms (Astheimer & Sanders, 2012; Benasich, et al., 2002; Dispaldro & Corradi, 2015; for a review see Stevens, &



Bavelier, 2012). We investigated the effect of stimulus saliency on the efficiency of spatial and temporal attention, using respectively an overlap task (Exp 1) and a discrimination task (Exp 2). Within a longitudinal design, we also examined the relationship between inter-individual differences on the attentional disengagement efficiency at 4 months (Exp 1) and the efficiency to discriminate tone changes at 7 months of age (Exp 2). Saccadic latency and looking times were recorded using an eye-tracker. Findings of the Exp 1 showed that the increase of the central stimulus complexity extended the latency of disengagement. Similarly, the results of the Exp 2 showed that 7-months-old infants were able to discriminate high salient, but not low salient syllabic-change, suggesting that strong syllables demand less resources allocation to be processed with respect to weak ones. Finally, a negative correlation between the efficiency in disengagement and syllabic-change discrimination was observed. These results suggest that infants who failed to disengage (Exp 1) were also those unsuccessfully detecting the syllabic-change (Exp.2). We discussed our data proposing that inter-individual differences in spatial-temporal attention might be the consequence of the inability to rapidly process visual and auditory information.

P2-D-73: Language exposure and noise levels during critical auditory development in the preterm population

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Preterm infants born with low-birth-weight (LBW; ≤ 1800 grams) are at significant risk for long-term disability secondary to deficits in hearing, memory, speech, and language development (Webb et al, 2015; Graven & Browne, 2008). Auditory system anatomical structures are well developed by 25 weeks gestation, therefore LBW preterm infants can hear sounds when admitted to the neonatal intensive care unit (NICU)(Yan, 2003). The auditory environment of the NICU is vastly different from the protective uterus. The high-tech environment of the NICU increases physiologic and neurodevelopmental risk from noxious noise levels commonly produced by lifesaving equipment positioned close to infants (Wachman & Lahav, 2011; Altuncu et al., 2009). To help mitigate these negative effects the American Academy of Pediatrics (AAP) established NICU noise limit guidelines of 45 decibels (A-weighted scale; dBA). Research findings suggest that although loud noises may be harmful, exposure to sound is vital for auditory functional maturation. For example, low frequency sounds like the human voice are necessary for healthy cognitive auditory pathways to develop in the preterm infant (McMahon et al, 2012). Efforts to reduce environmental noise, including NICU redesign to single-family rooms, have led to a reduction of speech input to these at-risk infants (Vohr et al., 2017; White et al, 2008). To our knowledge, consequences of reduced language input have not been studied in LBW infants-a subset of preterm infants who are at increased risk for poor language outcomes. To encourage positive language input to LBW preterm infants, it is necessary to understand the relationship between noise levels and speech in the NICU environment and how this relationship differs by time of day. This prospective, descriptive study examines the noise level recorded inside the incubator concurrently with the quantity of language (word count) heard by LBW preterm infants, born at 26-32 weeks gestation, as measured by Language ENvironmental Analysis (LENA). Measurement occurred during a 16-hour recording period (8 daytime hours and 8 nighttime hours). Preliminary results from 23



LBW preterm infants ($X=30.60$ weeks; $X=1424.33$ grams) from English-speaking families reveal relatively small variation in overall noise level in the NICU (daytime: $X=52.31$ dB, $SD=3.22$; nighttime: $X=51.72$ dB, $SD=3.75$). However, there is large within- and between-infant variability in language input (word count) that infants are exposed to during day/night observation periods. During the daytime, infants heard an average of 1736 words ($SD=2152$), with 22% of the sample hearing fewer than 150 words and 26% of the sample hearing over 2000 words. At nighttime, infants heard fewer words overall ($M=800$ $SD=1375$), and there was generally far less variability both within and between infants. Our results suggest the relatively constant noise levels in the NICU far exceed AAP recommendations, placing these fragile preterm infants at increased risk for auditory deficits. This data shows many LBW preterm infants are not exposed to crucial language input necessary for supporting auditory pathway development leading to healthy neurodevelopmental outcomes. Analyses with the full sample of 50 infants will confirm these patterns.

P2-D-74: Infants' segmentation of auditory-visual speech

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Visual prosody, like acoustic prosody, aids speech segmentation in adults (Mitchel & Weiss, 2010; 2014) but, despite the importance of speech segmentation in language acquisition, little is known about the influence visual speech might have on infants' speech segmentation. Given that infants perceive the mouth as an important conveyor of articulatory information (Tenenbaum, Shah, Malle & Morgan, 2013), it appears likely that visual information from a speaker's face may facilitate infants' speech segmentation. The overall aim of this study is to investigate whether the addition of visual speech information augments 7.5-month-olds' segmentation of fluent speech. A secondary aim is to examine the possible relation between infants' attention to the eye and mouth regions and their segmentation performance. Thirty-two 7.5-month-olds participated in a speech segmentation task. Infants were first familiarised with passages containing particular target words and then tested for recognition of words from those passages (targets) or words that did not occur in the passages (non-targets). Longer looking to the screen during target than non-target trials was taken to signify successful speech segmentation. Stimulus materials were adapted from previous segmentation studies (Jusczyk & Aslin, 1995) and presented in either auditory-only (AO, $n=13$ infants) or auditory-visual (AV, $n=19$) conditions. AO stimuli consisted of auditory recordings paired with a still photo of the speaker's face whereas AV stimuli consisted of auditory-visual recordings of the speaker talking. Eye movements were recorded using Tobii X120. Looking behaviour analyses revealed that infants in the AV condition looked significantly longer in target than non-target trials ($p=0.002$), whereas infants in the AO condition showed no significant difference in looking in target and non-target trials ($p=0.11$). Two areas of interest (AOIs) around the speaker's eyes and mouth were defined to investigate infants' looking preferences over time. Infants in the AV condition spent a significantly larger proportion of time attending to the mouth region than infants in the AO condition ($p=0.003$), whereas there was no group difference in attention to the eye region. The time-course of infants' gaze behaviour also revealed significant findings only for the mouth region: although infants in the AV condition initially attended significantly more to the mouth than did infants in the AO condition for both target and non-target trials



($p < 0.017$), this difference diminished over time; by 480ms after trial start infants in the AO condition attended to the mouth as much as did those in the AV condition. Regression analyses revealed that, across groups, infants who attended more during familiarisation also attended more during target and non-target trials ($p < 0.026$), but proportion of time spent attending to the mouth during familiarisation did not predict differences in attention to target versus non-target trials ($p > 0.60$). These findings suggest that (1) infants in the AV condition successfully segmented speech whereas infants in the AO condition did not, and (2) looking behaviour to the mouth region varied as a function of stimulus modality but was not related to segmentation performance. Future work is required to address the possible means via which visual speech information augments infants' speech segmentation.

P2-D-75: When dogs make meow: An electrophysiological exploration of onomatopoeia processing in toddlers

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The goal of this study was to investigate cross-modal lexical-semantic processing at different stages of language development. Adults often communicate with children by using a speech mode called infant-directed speech that typically involves speech prosody, lexical and syntactic modifications (Soderstrom, 2007). The lexical modifications frequently include Onomatopoeia, which phonetically imitates sounds or suggests the source of described sounds. Onomatopoeias are very common in infant's production repertoire at the age between 8 to 16 months and they usually decrease in terms of relative proportions between 16 and 20 months. At the same time, other productive categories, including common nouns, increase (Camaioni and Longobardi, 1995). In this work we investigated whether different types of lexical information carrying the same meaning (onomatopoeias, common nouns) engage similar or different semantic processing and whether they change across early childhood. In addition, we analyzed how different types of lexical information are tied to the object they refer to and whether cross-modal semantic processing is affected by the type of lexical information. To this aim, we recorded event-related potentials (ERPs) to onomatopoeic utterances and common nouns associated to pictures of familiar objects in children from two age groups: 16 to 20 months and 24 to 30 months ($n = 20$, respectively). In addition, we included an adult control group. Onomatopoeic utterances and common nouns were presented in a congruent and an incongruent, respectively: in the congruent common noun condition the auditory word was coherent with the content of the image; the incongruent common noun condition presented an auditory word that was incoherent with the image; the congruent onomatopoeia condition presented an onomatopoeia word that was coherent with the image and in incongruent onomatopoeia condition the onomatopoeia was incoherent with the image. The younger children revealed a greater posterior N400 effect to incongruent onomatopoeic words than to congruent ones, while no differences were observed in response to common nouns. This result suggested the onomatopoeic utterance was more strongly associated to the meaning of the object at an earlier stage of language development. The older children showed a greater N400 response to incongruent common nouns compared to congruent ones and no N400 effect to onomatopoeic words. This result was in line with previous studies that revealed that at this stage children should be able to associate pictures of known objects to their correct name (Friedrich and Friederici, 1998) and to replace the onomatopoeic utterance with the



common noun associated to the meaning of a given object. Furthermore, adults revealed an N400 effect to both incongruent onomatopoeic words and common nouns, showing that they were able to process both the two lexical forms associated to the representation of a visual object. Overall, our results revealed differential N400 effects to onomatopoeic utterances and common nouns across the different age groups, suggesting that these categories are differently organized in children's semantic memory and that the acquisition of linguistic abilities affects and modifies semantic processing of different lexical information.

P2-D-76: How preference and input shape early word learning

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In early development, the interaction between the child and the environment fosters learning. For example, it has been shown that children under age 1 prefer infant-directed speech (IDS), in contrast to adult-directed speech (ADS), and that this type of speaking seems to possess certain characteristics that benefit children's language acquisition. The preference for IDS seems to decrease over the second year of life. Nonetheless, parents use IDS also with their toddlers and it supports children's word learning at this age. Thus, it seems that IDS benefits their learning experience, independent of their own preference. This seems contradictory because preferences can guide our focus of attention, and thereby, our learning behaviour. To examine the relationship between preference, environment, and learning, the current study investigated how 18- to 24-months-olds' word learning relates to their preference for ADS or IDS, and how the mothers' manner of speaking is linked to the children's word learning. We tested 40 18- to 24-month-old children in a gaze-contingent preference task and a word learning task. In the gaze-contingent preference task, children were presented with two adults on the screen. Then, children could choose with their gaze which adult they would like to hear speaking: one would tell a story in IDS and the other in ADS. In the word learning task, children were presented with four different novel objects and their novel labels. Crucially, two objects were presented in IDS and two objects were presented in ADS. At test, they saw two objects and heard one of the labels while their gaze was recorded to examine target looking upon hearing the label. In addition, the mothers were recorded when speaking with their children and with an adult to evaluate their IDS and ADS. The results indicate that mothers' IDS and ADS differed in qualitative features even with their children between 18 and 24 months. However, children showed no systematic preference for either IDS or ADS in the gaze-contingent preference task. Children learned words for objects from both IDS and ADS, although target looking in the test phase followed different trajectories, indicating differences in processing at test. Further planned analyses include generalised linear mixed models using mothers' input and children's preferences as predictors for target looking in the word learning task to reveal any possible interactions between these factors. Together, these results will shed light on how the input a child perceives and the preferences a child forms can influence a child's word learning behaviour early in life.

P2-D-77: Changes in mothers' infant-directed vocalizations over time: A longitudinal free-play study



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Mothers' communication patterns with their infants are attuned to their infants' ages and abilities. Cross-sectional reports have suggested that older infants hear more directives and more references to ongoing actions than younger infants (e.g., Campos et al., 2000; Clearfield & Nelson, 2006; Karasik et al., 2008). Further, early patterns in infant-directed speech relate to children's vocabulary growth (Hart & Risley, 1992). However, it remains unclear whether mothers' vocalizations change longitudinally over time. Here, we aimed to track changes in mothers' infant-directed speech in a longitudinal study occurring over the first two years of life, as infants acquired locomotor skills (e.g., crawling and walking). We also followed-up with participants at age 4 to determine whether early patterns in infant-directed speech related to later language outcomes. Thirteen mother-infant dyads participated in biweekly free-play sessions in a laboratory space from the time infants were 6 to 17 months. Sessions were recorded and mothers' infant-directed vocalizations were transcribed using Datavyu. We counted the number of words mothers produced per session and categorized mothers' vocalizations as: declaratives (e.g., labeling object), questions (e.g., yes/no), repetitions, and imperatives. Examples of imperatives involved attentionals (supported or directed infants' attention), location regulators (managed the direction of the infants' movements), and action shapers (provided infants with information about how to complete or modify ongoing actions). We followed up with the children at age 4 to assess their expressive and receptive vocabulary using a 212-item checklist modeled after the MacArthur Communicative Development Inventories and the NIH Toolbox application, respectively. We used Friedman tests to determine whether mother's vocalizations changed over time and we correlated the mothers' vocalization patterns at 12 months with the children's 4-year language abilities. First, we aimed to determine whether mothers' infant-directed vocalizations changed over the first two years. Preliminary analyses on 11 mothers revealed fluctuations in the number of words mothers produced in each session over time ($p < .007$). Mothers used significantly more imperatives and fewer questions as their infants aged ($p < .034$ and $p < .001$). There were no other significant age-related changes. When we investigated whether these variables changed as infants acquired locomotor skills, we found that mothers' use of certain imperatives - location regulators and action shapers - seemed to fluctuate as infants acquired crawling and walking skills ($p < .026$ and $p < .036$). Next, we examined whether early patterns in mothers' infant-directed speech related to children's language outcomes at 4 years. Spearman correlations revealed that when mothers used more imperatives at 12 months, children showed higher receptive vocabulary at 4 years ($p < .024$). No other relationships were detected. These findings suggest that in our sample, mothers' input to their children was somewhat linked to infants' chronological age, locomotor status, and language outcomes in childhood. Further analyses will investigate how mothers' increased use of imperatives may relate to the infants' ongoing locomotor activities and language development over time.

P2-D-78: Speech envelope tracking in the infant brain

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When humans listen to speech, their neural activity tracks the slow amplitude fluctuations that the speech signal has over time, known as the speech envelope (Ahissar et al., 2001; Abrams et al., 2008). Studies have shown that a speech stream must contain a well-preserved envelope for humans to understand it (Drullman et al., 1994), and the quality with which the neural activity tracks this envelope is related to the quality of speech comprehension (Ahissar et al., 2001; Peelle et al., 2013). However, it has recently been called into question whether this neural mechanism is sufficient for comprehension to take place, as some studies have found envelope-tracking to be present even when speech is unintelligible (Howard & Poeppel, 2010; Pefkou et al., 2017). More generally, it remains controversial whether speech comprehension and envelope tracking are causally linked. To shed new light on this debate, here we investigated whether newborns and 6-month-olds are able to track the speech envelope of sentences in familiar and unfamiliar languages to assess: (i) whether envelope tracking is a neural mechanism involved in language comprehension, (ii) whether general experience with speech is necessary for it to emerge, and (iii) whether familiarity with the native language modulates it. We tested 47 newborns born to French monolingual mothers (within their first 5 days of life), and 25 French monolingual 6-month-old infants. We presented them with naturally spoken sentences in their native language (French), in an unfamiliar but rhythmically similar language (Spanish), and in an unfamiliar and rhythmically different language (English), while simultaneously recording their brain activity using electroencephalography (EEG). To assess speech envelope-tracking we investigated whether the participants' neural responses synchronised to the amplitude and the phase of the speech envelope. For amplitude-synchronisation we computed the cross-correlation between the EEG data (1-40 Hz) and the speech envelope (0-40 Hz); and for phase-synchronisation we computed the phase-coherence between these signals filtered at the syllabic rate (3-6 Hz). Our results show that prenatally French-exposed newborns are able to synchronise to both the amplitude and the phase of the speech envelope in the three languages equally well. However we found differences at 6 months, when infants continued to synchronise to the phase of the speech envelope in the three languages, but only synchronised to the amplitude of the English sentences. Our findings suggest that tracking the amplitude and phase of the speech envelope takes place in the absence of attention and comprehension (as it was found in newborns), and that amplitude-synchronisation seems to be modulated by language experience at 6 months.

P2-D-79: The phonemically rich get richer: Early classroom language experiences build language abilities

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Individual variation in the quantity and quality of infants' early language input and production, during play with caregivers at home and during laboratory tasks, predicts future language development and academic performance. Much less is known about infants' language experiences in early education programs and their association with infants' language abilities. Participation in high-quality inclusive education programs typically improves outcomes for infants at risk for language delays, including infants with hearing loss who have accrued less



exposure to acoustical information than typically hearing infants. Characterizing the quantity and quality of language experiences in inclusive education settings is of import because infants in these programs vary in their verbal production abilities. Moreover differences in language capabilities may elicit differential input from adults and have cascading consequences on language development. Here, we employed an automated measurement system in an inclusive early education classroom for infants with hearing loss to examine whether (1) the quantity and quality of infants' language experiences varied as a function of their hearing age, (2) infants' input predicted their language use, and (3) associations between infants' language experiences and language outcomes. Participants included 29 infants enrolled in three English dominant oral language inclusion classrooms. Twenty-one infants had hearing loss and wore cochlear implants or hearing aids and eight infants had typical hearing. Vocalization data were collected once every two weeks using LENA audio recorders over 34 total observations. Using LENA pattern recognition software, audio recordings were segmented into language input from adults and infants' own speech-related vocalizations. From the segmented speech stream, we calculated the mean duration and rate of adult and infants' vocalizations. Sphinx speech recognition software was used to calculate phonemic diversity, the number of unique phonemes per vocalization. Language abilities were measured at the end of the school year using the PLS-5. There was no effect of hearing age (time with proficient hearing [from birth or aided hearing]) on the quantity or quality of language input that children received. However, as hearing age increased, children produced more frequent ($\chi^2=9.25$, $p<.01$), longer ($\chi^2=8.38$, $p<.01$), and more phonemically diverse vocalizations ($\chi^2=7.98$, $p<.01$). The frequency and phonemic diversity of adult speech positively predicted the frequency and phonemic diversity of child speech. Even after controlling for differences in receptive and expressive language abilities related to hearing age, children who produced more phonemically diverse vocalizations exhibited higher end-of-year receptive, $\beta=26.10$, $SE=12.48$, $t=2.09$, $p=.048$, and expressive language abilities, $\beta=22.86$, $SE=10.44$, $t=2.19$, $p=.04$. Mediation analyses indicated that the effect of the phonemic diversity of children's language input on end-of-year language abilities was explained by the phonemic diversity of children's own vocalizations. These findings suggest that qualitatively richer language experiences strengthen children's verbal production, which is associated with language outcomes. Automated measurement yielded big behavioral data, which allowed for the identification of phonemic richness as a promising correlate of developing language capacities and target for individualized intervention.

P2-D-80: Effects of book-reading intervention on parent skills, infant attention and language

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Introduction: For young children, early language and literacy skills are critical to academic success (National Early Literacy Panel, 2008; National Institute of Child Health and Human Development (NICHD) Early Child Care Research Network, 2005) and shared book reading is a well-established vehicle for promoting these skills (Dunst, Simkus, & Hamby, 2012; Hutton et al., 2015; National Early Literacy Panel, 2008). Although book sharing interventions are well-established for children with/at-risk for language delays (Reese, Sparks, & Leyva, 2010), the majority of research has not included children younger than 2-years-old. Recent work has yielded strong evidence for the utility of book-sharing intervention for improving child language



and related outcomes (Murray et al., 2016; Vally, Murray, Tomlinson, & Cooper, 2015). We have developed Ready, Set, Share a Book! (Salley & Daniels, 2017), an intervention that uses a parent-directed coaching model, which can be implemented by a variety of early intervention (EI) specialists providing services to infants and toddlers. Participants: Parents and their children age 14-18 months (n=30; n=12 female) who were carried full-term (> 36 weeks) were recruited for the study and randomly assigned to intervention (n=15) or wait list control (n=15) groups. The sample was community referred, without identified medical, neurological or genetic conditions. Children were primarily Caucasian (89%), and median maternal level of education was a college degree. Methods: The intervention program was delivered in a weekly, small group format (4-5 parents and infants) over an 8-week period in a community setting. During each session, a facilitator introduced a new target skill (see Table 1) and led group discussion; parents then practiced the target skills and received 1:1 coaching with a facilitator. Assessments were completed pre- and post-intervention and at 2-month follow up during lab visits: language was obtained from parent report using the MacArthur Bates Communicative Development Inventory (MCDI; Fenson et al., 2003); sustained attention was measured using the Early Childhood Vigilance Task (Goldman, Shapiro & Nelson, 2004). Feasibility/acceptability of the intervention was measured from parent report post-intervention. Results: Compared to the control group (and controlling for baseline scores), infants in the intervention group demonstrated meaningful gains with moderate to large effects in gestures used and expressive vocabulary post-intervention (MCDI, partial $\eta^2=.12$ and partial $\eta^2=.05$, respectively). Increases in sustained attention were observed at post-intervention and also maintained at follow up (ECVT; partial $\eta^2=.12$ and partial $\eta^2=.12$ for post-intervention and 2 month follow up, respectively). Parents in the intervention group had significant increase in use of target book-sharing skills, which in turn was positively correlated with improvement in child attention ($r=.50$, $p=.03$). Parents rated the intervention as beneficial and helpful for their child (100%) and reported that they would recommend the experience to other families (100%). Conclusion: Overall, data support preliminary feasibility of the intervention and replicate the work of Cooper and colleagues (2013) for families in the US. Results highlight the promise of a book-sharing intervention for enhancing early language and attention/cognitive skills, which are important predictors of school readiness and long-term academic success.

P2-D-81: Conditional probability and token frequency as predictors of individual infants' word knowledge

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Laboratory experiments with infants have revealed many language-relevant cognitive abilities that might help them identify native-language words. For example, infants learn syllable sequences they hear frequently, that appear in one-word utterances, that tend to occur together and so forth. All of these heuristics, if deployed by infants in their daily lives, seem intuitively likely to improve access to linguistic structure relative to not using them or guessing. Typically, computational models of these heuristics evaluate their utility by comparing outputs of a model implementation against a dictionary gold-standard: if infants show these tendencies in the lab, and models of these tendencies extract structure from corpora, it suggests that infants use them to learn their language. Rather than asking how well models extract structure, we instead ask how well models resemble actual infants' learning. We used a large



infant-directed speech corpus (Brent & Siskind, 2001), converted the transcription to estimated syllables, applied three different models to each child's corpus, and compared the outputs (estimates of word learning) against the words children were reported to know or say, based on the CDI (Swingley & Humphrey, 2018).

The first model did not segment the corpus, but collated syllable sequences of every length and took the top n-percentile frequencies as units. Thus, for an utterance of syllables ABC, the frequencies of {A,B,C,AB,BC,ABC} were incremented by one.

The second model segmented utterances according to the mutual information (bidirectional conditional occurrence frequency) of adjacent units (Aslin et al., 1998). First, units were syllables; syllable pairs above threshold j in mutual information were grouped. Then, iteratively, mutual information of the resultant units was computed, continuing until asymptote. The collection of units thus formed was evaluated by frequency criteria.

The third, baseline model segmented utterances according to a random chunking process informed about the correct proportion of mono-, bi-, and trisyllabic words. As above, high-frequency chunks were taken to be words.

Results: Each model's output was examined for fit to a dictionary (did the model find words?) and to each child's actual reported vocabulary (did the model predict a given child's words?). First, the conditional-probability model consistently outperformed the random chunking model at all nondegenerate parameter values, both relative to the dictionary and in predicting individual children's stock of words. Second, for most children, a child's own corpus predicted his/her vocabulary better than other children's corpora, showing specificity, even if analysis was restricted to words spoken in the predicting corpus (see Figure). Third, the frequency-based model performed about as well as the conditional-probability model (not shown), but at the cost of maintaining a significantly larger stock of protolexical forms. The results provide evidence that even considering only word-form influences on early word learning outcomes, and even in a largely monosyllabic language, conditional-probability clustering may provide children with an efficient mechanism for word discovery.

P2-D-82: Child-directed prosody in the TalkBank LENA corpus

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Infant-directed speech (IDS), has distinctive prosody: it is uttered more slowly (Fernald et al., 1989), with higher and more variable pitch (Fernald & Simon, 1984) compared to adult-directed speech (ADS). IDS prosody is described mainly in laboratory settings, but our work specifically examines utterance-level prosody in naturalistic home environments in the IDSLabel Dataset (Casillas et al. 2017; Bergelson et al., 2019), available from <https://homebank.talkbank.org/>. Here we describe pitch height, pitch variability, and speech rate in this corpus, which is comprised of day-long LENA recordings that were machine-annotated for speaker category (adult/child; near/far), and estimated adult word count (AWC) and child vocalization count (CVC) in the day-long recording. Human coders tagged recordings for speaker gender (male/female) and register (IDS/ADS). The original corpus contained a total of 4.13 hours of adult speech (10,790 clips) spoken to or near 61 child participants, aged 0;3-1;8. For each clip, we extracted mean, range, and standard deviation of pitch (in Hz) over intervals of 50ms, and then normalized Hz to semitones above 120 Hz. We excluded pitch measurements that differed from the speaker's overall means by more than 1.5 standard deviations to reduce octave errors; clips for which there was substantial



disagreement between coders; the longest and shortest 5% of clips, ensuring only similar-sized utterances were analyzed (range: 0.77-3.45 s); and adult participants for whom we had fewer than 10 clips in either register. The final dataset contained 7801 clips associated with 44 children: 21 children had clips associated with adult male caregivers, and 42 children had clips associated with adult female caregivers. We fit mixed effects regression models with our above-mentioned dependent variables, with fixed effects of gender, speech register, and the interaction between the two, and with a random intercept for parent ID and a random slope for register. Significance was determined by comparing full models with models missing the critical fixed effect. With this large, naturalistic dataset, we replicated three classic findings (see Fig. 1). First, parents had a higher mean pitch when addressing children ($p < 0.001$). Second, speaking rate was also significantly slower in IDS than ADS, whether quantified as the number of syllables over phonation time, or as the number of syllables over total duration of speaking time (p 's < 0.001). Third, standard deviation in pitch was greater in IDS than ADS ($p < 0.001$)--pitch in IDS was more variable than in ADS. Our prosodic results in this naturalistic dataset concord with results from the laboratory-driven literature (but contradict VanDam et al.'s 2015 findings for fathers using LENA). Because current and prior research exploring the function of IDS suggests that fine acoustic elements of IDS, including prosodic and segmental variability, are important in child language acquisition (Werker & McLeod, 1989; Adriaans & Swingley, 2013), our field needs to better describe prosody in actual home environments. Ongoing analysis is examining potential links between these prosodic variables and LENA-recorded measures of child speech exposure (the AWC estimate) and child speech production (CVC estimate).

P2-E-83: Analyses semantic networks based on word co-occurrence: Analysis of Spanish

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Word co-occurrence in sentences may reflect language organization as a self-organized mental lexicon, which can be described by a network-structure of interacting lexical items. Previous studies have examined language from this perspective, Beckage, Smith and Hills (2011) provided a network representation of the lexicon. They reported that children's lexical networks show a small-world effect, this effect is observed in major proportion in networks conformed by children vocabularies in contrast with random networks. Same results were found in a previous study with Spanish-learning Mexican children (Rubí & Falcón 2019). They compared 30 month-old children's networks and random networks. Networks were constructed according the words in each child's vocabulary and also in accordance to the co-occurrence statistics. Child's network showed more connectivity and more local structure than the random networks. This confirmed the hypothesis that networks configured with children's vocabularies show a small-world effect. However, what type of relationships among words are represented in a network that is generated by syntactic co-occurrence? According to Richards (1991), word associations in co-occurrence analyses, give information about the structuring of vocabulary and the syntactic and semantic relationships among words. In classifying word associations, different classification systems which have some common characteristics were applied (Ferrand & New, 2003; Perea & Rosa, 2002). For example, Ferrand et. al (2003)



reported two types of relationships: associative (i.e., "bread-butter") and semantic (i.e., "bread-cake"). Their results demonstrate that automatic priming appears to be due to both association strength and semantic relationship. The aim of this work is to analyze the organization systems in word associations obtained through a co-occurrence analysis. First we selected 251 words, all nouns that were analyzed along a corpus, according to the co-occurrence statistics in a normative language-learning environment (462,326 words). We used the LEXNET-UAEM software (Rubí & Falcón 2018) to generate a database of semantic relatedness between words. We chose co-occurrence statistics as the index of relatedness because they are an objective measure that is supposed to indicate semantic and syntactic relatedness (Farkas I, MacWhinney B 2004). Each generated pair of word associations were classified as: a) taxonomic (members of the same category, i.e., lion-tiger), b) syntagmatic (words that co-occur in a same context, i.e., mouse-cheese), c) components (elements that forms part of the referent, i.e., face-mouth), d) descriptive (perceptual characteristics of the referent, i.e., sun-yellow). Results showed 1880 associations between words, divided in different classifications systems. The word associations obtained through a co-occurrence analysis between words of a corpus with child-directed speech targeted at Spanish speaking children (from one to nine years old), reported a major proportion of syntagmatic relationships, with 1337 associations (71%), in second place the taxonomic relationships with 458 associations (24%), followed by component relationships with 53 associations (3%) and finally descriptive associations (2%). These results are similar to those of other studies based on free associations (Barrón-Martínez & Arias-Trejo, N. 2014). Present work contributes to add more information about the nature of lexical networks in Infant-directed speech

E-Communication 2 (syntax, pragmatics, signed, nonverbal, disorders)

P2-E-84: Pupillometry provides nuanced information about the role of motionese in infants' processing of dynamic activity

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Over the first few years of life, infants acquire the ability to make sense of, predict, respond to, remember, and learn from a variety of everyday human actions. Finding segmental structure within unfolding activity - in particular, boundaries at which units of action begin and end - seems key to the acquisition of such action-processing fluency, and has important downstream implications for cognitive and linguistic development (e.g., Levine et al., 2018). However, action unfolds rapidly and is just as quickly gone. How do infants find structure in the complex, dynamic, fleeting action that they observe? Caregivers' infant-directed action demonstrations might serve to help with this challenging task. In interactions with infants, caregivers modify their motion in a variety of ways that engage infants' overall attention (i.e., "motionese;" Brand, Baldwin, & Ashburn, 2002). It seems likely that these modifications additionally highlight and promote infants' processing of the internal structure of action, supporting infants' learning. The current research investigates this important hypothesis. We first constructed a large corpus of infant- and adult-directed activity sequences. Caregivers and infants were invited into the lab, and caregivers were asked to demonstrate a set of ten novel objects to their own infant and to



another adult. In addition to using this corpus to investigate infants' processing of action it will be made openly available on Databrary, enabling researchers to ask many important questions about the nature of caregiver-infant interactions. We then used a subset of these videos to explore how motionese influences infants' processing of action as it unfolds. To investigate this question, we used a novel, infant-friendly, and open-source pupillometry methodology that we have been helping to develop in our lab. While typical infant research methods (such as looking time) do not afford information about infants' processing of activity as it unfolds, pupillometry does provide this sort of nuanced detail, making it an ideal method for our investigation. We selected six pairs of short clips (12 total) that featured one infant- and one adult-directed version of a single actor performing the same action on the same object, and in which one action boundary occurred at the same juncture across versions. Individual infants viewed either the infant- or adult-directed clip from each pair as their pupil size was monitored. We found that infants' pupil size increased in response to action boundaries, but only for motionese demonstrations. Thus, in addition to engaging overall attention, motionese likely serves to promote infants' processing of action's internal structure. These findings set the stage for future work targeting the source of this increased pupil dilation at boundary regions. In sum, this work makes several important contributions to developmental science. First, we created a large, first of its kind, open video corpus of caregiver-infant interactions. We also validated a new pupillometry methodology for addressing any number of novel questions about infants' processing of visual information as it unfolds over time. Finally, this work provides the first demonstration to date that motionese influences infants' on-line action processing, and in this way scaffolds their understanding of, and ability to learn from, dynamic, novel activity.

P2-E-85: The relative role of voice and gesture in early communication development

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This study aimed to determine the extent to which gesture in comparison to vocal communication could have played a role in the origin of language by determining amounts of gestural communication in comparison with vocal communication across the first year of life. Despite its importance in the development of children's language skills (Acredolo & Goodwyn, 1988; Iverson & Goldin-Meadow, 2005; Colonnese et al., 2010), very little is known about the emergence of gesture from the first months of life. We know of no direct or longitudinal research on gesture from the first half-year of life nor of any research comparing the amount and nature of vocal and gestural communication in the first year. Ten infants were observed at ages ~3, 6, and 11-months-old with their primary caregivers during interactive play sessions. The primary modalities of interest were gestures, protophones (speech precursor sounds), and gaze direction. Data and gaze direction of the protophones had been previously coded during another study (Oller et al., 2013). Our gesture coding was designed to focus on acts of the first year that can be deemed precursors to signs, that is, precursors to gestural symbols across the first year of life and/or precursors to non-symbolic gestures as they occur in mature persons, usually accompanying speech. The rate of occurrence between gestures and protophones was vastly different. As demonstrated in Figure 1., gestures occurred at an average of 2 per minute or less across the three ages, whereas protophones occurred at an average of approximately 6 per minute, almost 3 times the rate of gesture. For directivity,



Figure 2. Illustrates that the protophones were directed by gaze toward a person 74% more often than gestures. However, both protophones and gestures were directed by gaze toward a person far less than half the time. The results suggest vocalization is overwhelmingly predominant over gesture in communication of the first year. The vocal predominance applied whether the communication was directed or not directed by gaze toward another person. Thus, vocalization appears to be utilized explicitly for communication to a vastly greater extent than gesture in the first year. Since gesture is inherently visual, it requires the recipient to be looking--yet the gesturing babies relatively rarely looked to see if the potential recipient was looking at them. Our results dramatically contradict the assumption that gesture is predominant in early infant communication, and thus suggest that gesture is not the primary foundation of language. On the contrary, the results are consistent with the suggestion that vocalization is, and always has, formed a more important foundation for language than gesture.

P2-E-86: Dynamic interaction patterns of monolingual and bilingual infants with their parents: On the roles of language status and culture

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Bilingual children show a number of advantages in the domain of communication. Growing up with two or more languages leads to more events of challenging communication children are exposed to, which, in turn, is likely to have an effect on their communication style. In previous research, however, children were tested at an age when productive language skills already emerged. The aim of the current study was to investigate whether differences in interactions are present before the onset of productive language. In the present study, 64 parents and their 14-month-old infants explored a decorated room together for a duration of 5 minutes. The coordination of their behaviors in the modalities of action, language, and gesture was micro-coded and analyzed using cross recurrence quantification analysis. Two measures were extracted from the raw data as indicators for the synchrony of the interaction: 1) The recurrence rate as the percent of time points (frames) where a behavior of the infant matches the behavior of the parent (e.g., parent is gesturing and infant is gesturing). 2) The trapping time as the average length of frames that a parent and infant shared a behavior. The results showed no differences in interactions between the different language statuses, all $p > .131$. Parents of monolingual and bilingual infants were similarly coordinated in their interactions. In two additional analyses, we first compared monolinguals and bilinguals with caregivers that shared the same language and culture. Results showed the same pattern of non-difference, all $p > .351$. Second, we compared bilinguals with caregivers from different cultures. The rate and duration of coordination differed across infants with different cultural backgrounds, all $p < .019$. The results show that the Swiss culture group (bilingual infants interacted with their Swiss parent) was less coordinated than the non-Swiss group (bilingual infants interacted with their non-Swiss parent) and shared the same behavior for shorter times. Taken together, the findings show no universal difference in the dyadic communication of preverbal monolingual and bilingual children with their parents. It is thus unlikely the mere exposure to two languages that serves as the basis for potential differences in the communication of monolinguals and bilinguals.



P2-E-87: Auditory environment experienced by children with normal hearing and children with cochlear implants

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Much research has demonstrated that early auditory environment influences child language and cognitive development (Gilkerson et al., 2018; Hart & Risley, 1995; Hurtado et al., 2008). For example, the amount of caregiver speech directed to young children significantly predicted later vocabulary outcomes (Gilkerson et al., 2018), whereas the television exposure had a negative effect on language outcomes (Zimmerman et al., 2009). To compensate for early auditory deprivation and degraded auditory input, children with hearing loss (HL) may need a more optimal auditory environment to access the auditory-linguistic information necessary to achieve age-appropriate language skills. However, very little is known about the properties of the auditory environment experienced by children with HL. The primary objectives of this study were to determine whether measures of auditory environment differ between children with normal hearing (NH) and children with cochlear implants (CIs) and to examine how these measures may change throughout the development. We collected and analyzed 184 naturalistic recordings using the Language ENvironment Analysis (LENA) system from 38 children with NH and 17 children with CIs. Detailed information about the participants and the LENA recordings is available in Table 1. Automated measures generated by LENA were extracted from each recording. These measures included: adult word counts (AWC), conversational turns (CT), child vocalizations (CV), television and media (TVN), overlapping speech (OLN), and noise (NON). All the measures were normalized by the duration of the recording. For each measure, we fitted a mixed-effects model with Hearing status (NH, CI), Age, and their interaction term as the fixed factors, and Participant as a random intercept using the lmer function (Bates et al., 2015) in the R environment (R Core Team, 2014). For AWC and NON, no significant main effects or interactions were found, $F_s < 1.17$, $p_s > .28$. Significant main effect of Age was found for CV and OLN, $F = 4.62$, $p = .033$, and $F = 8.57$, $p = .004$, respectively, as both measures increased as a function of child age. For CT, the interaction of Age and Hearing status approached significance, $F = 3.80$, $p = .053$. Post hoc analyses showed that the CT increased as a function of age for children with NH, $F = 2.60$, $p = .011$; in contrast, CT did not change as a function of age for children with CIs. Finally, for TVN, the main effect of Hearing status approached significance, $F = 3.71$, $p = .056$, this was because children with CIs were exposed to a larger amount of electronic media in their daily lives than children with NH. These findings provide some preliminary evidence regarding the properties of early auditory environment for children with HL as compared with children with NH. Understanding the similarities and differences in the early auditory environment between children with NH and children with HL would help us understand the source of delays and variability of language outcomes in children with HL. In addition, it will also inform clinicians in providing appropriate services for families of children with HL.

P2-E-88: Infants generalize object labels between human and robot

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Before their first birthday, infants understand that labels are shared among speakers of the same language. For instance, in Henderson & Woodward (2012), 8- and 10-month-olds were habituated to an event in which an agent provided a novel label while looking at and grasping one of two novel objects. During the test trials, a new agent appeared and uttered the same label as in the habituation trials and then picked up either the same (same-object event) or different object (different-object event). Both 8- and 10-month-old infants looked reliably longer at the different-object event than at the same-object event. Such results were not found when the agents uttered emotional expressions instead of labels before and while acting on objects. The results suggest that infants appreciate the conventionality of words: labels, but not preferences, are shared across human speakers in a community. Built on such previous research, the current research examined the range of agents whom infants expect to share labels. Specifically, we asked whether infants would consider labels to be shared across human and robot speakers. Recently, there is emerging literature on how infants understand robots' actions. Infants attribute goals to humanoid-robots (Kamewari et al., 2005) and follow the gaze direction of non-human agents or robots (Johnson et al., 1998; Meltzoff et al., 2010, O'Connell et al., 2009). Moreover, the robot gaze accompanied by verbal signals facilitates infants' object learning (Okumura et al., 2013). Therefore, there is a possibility that infants will (1) reckon a robot as an agent of verbal actions and (2) consider a robot as sharing the same linguistic conventionality with a human speaker. We tested 14- to 19-month-old Korean infants in a violation-of-expectation paradigm involving human and robot agents. We used iRobiQ, a humanoid robot developed in Korea, as a robot agent. The infants first received three familiarization trials in which an agent (either a robot or a human speaker) uttered a novel label ("panu!") twice, one per second, while looking at one of the novel objects on an apparatus floor. Then, during the display trial, the locations of the two objects were switched. During the test trials, a different type of agent from the one shown in the familiarization trials (either a robot or a human speaker) appeared. The new agent uttered the same label ("panu!") while looking at the same object as in the familiarization trials (same-object event) or a different one (different-object event). The preliminary data showed that the infants looked reliably longer at the different-object event than at the same-object event. This result suggests that infants expect object labels to be shared between humans and robots. The present finding (1) adds to the evidence on the development of infants' ability to understand robots as intentional agents and (2) provides the initial evidence that infants consider humans and robots to share the same linguistic conventionality.

P2-E-89: Regional representation of toddler vocabulary in the UK ? Construction of the UK-CDI words and sentences

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The Communicative Development Inventories (CDIs) are a suite of parent-completed questionnaires that assess children's language development, typically covering early production, comprehension and gesture in children up to 18 months and production and grammar up to around 39-42 months. A US English version of the CDIs for all of these age groups has been in existence for nearly 30 years and a UK version of the Words and Gestures (suitable for 8-18 months) has recently been published, but the UK version of the Words and



Sentences (16-30 months) is still in development. Because of the potentially greater variation within the UK in dialect, and the need for UK-relevant vocabulary especially in this age group when language production takes off, we sought novel methods to capture vocabulary variation across the UK and across this age range. We examined vocabulary use in 10 language samples from a variety of UK locations from the CHILDES database as well as databases from 6 labs across the UK (capped at N=30 per lab) where previous CDI data had been collected with children aged 16-30 months. We selected 638 words from the lab data or that were already on the UK-CDI Words and Gestures. These met predetermined criteria for correlation with age, frequency, or both. In addition we obtained data from 85 parents in five regions across the UK who participated in focus groups online (primarily using Facebook Groups). Parents were originally recruited from babylab databases and from parenting groups on Facebook. Parents were given a list of potential words from the previous CDI versions was presented in categories (e.g. "here are a list of animal sounds and a list of animal names, how old is your child and which ones do they say? Can you tell us any more that we have forgotten but your child can say?). The focus group format enabled parents to reply to previous parents' suggestions where they then recognised a word their child said, and using an online interactive forum that parents are familiar with meant that parents could participate when convenient and add answers later if necessary. From the focus group data we selected 64 words that were new to the CDIs. Each word was mentioned by more than one parent in more than one focus group, with some word categories capped. CDIs are designed in recognition format because generally recognition memory is better than recall memory; the first part of each focus group question, pre-selected words, uses this format. However, the agreement across regional groups on new words that were added to the pilot CDIs suggests that there is room for prompted recall in construction of new questionnaires. The CDIs were then created in the same format as the Words and Gestures (where a word has regional or personal variation, such as "child/bairn" or "penis/vagina" all the alternatives are given and parents are asked to select the one used by their child). After merging a small number of lexical items the pilot CDI has 598 words.

P2-F-90: The social dynamics of joint attention in American Sign Language interactions between deaf children and their parents

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Parental input in the early years is a robust and reliable predictor of vocabulary and other academic abilities (Rowe, 2012). Input that occurs during moments of shared joint attention enables children to make immediate connections between linguistic input and the surrounding visual world (Tomasello and Farrar, 1986), particularly when parents use a "follow-in"? approach of labeling objects to which the child is attending (Akhtar et al., 1991). For hearing children, the association between language and its referents is made through simultaneous and multi-modal perception; language input is perceived through the auditory mode, and objects are perceived through the visual mode. In contrast, deaf children acquiring American Sign Language (ASL) perceive both linguistic and non-linguistic information through the visual mode. The social dynamics of gaze, attention-getting, and object labelling in these visually-complex interactions likely differ from those of spoken language, but have not yet been studied extensively (Lieberman et al., 2014). In the current study, we analyzed naturalistic ASL-based



interactions between deaf children ($n = 18$) ages 9-60 months ($M = 34$ months) and their deaf ($n=12$) or hearing ($n=6$) parents. We hypothesized that, if parents use a follow-in approach to joint attention, they would label objects to which children were previously attending. We further predicted that spontaneous gaze shifts to the parent would be positively correlated with the child's age. Twelve minutes from each video were coded off-line for child-directed ASL signs, parent attention-getting cues, and the location of child gaze and object touch surrounding each ASL sign produced by the parent. We analyzed all concrete nouns ($n = 791$) to determine how attention-getting, child gaze, and child object touch aligned with parent labelling. We first coded whether the noun was accessible, defined as whether or not the child was visually attending to the parent when the noun was produced. Next, for accessible nouns, we determined whether the child gazed at and/or touched the referent object within two seconds prior to the label, and whether the parent overtly elicited the child's attention prior to the label. Mutual gaze was established between the parent and child for 47% of concrete nouns, and proportion of accessible nouns was positively related to age ($r = .50$, $p = .034$). Parents used a follow-in approach (Figure 1) by labelling an object to which the child had previously been attending (looking at or touching) 65% of the time, and this was positively correlated with age ($r = .52$, $p = .028$; Figure 2). We also found that parental attention-getting cues were relatively rare, preceding 32% of object labels. This suggests that deaf children are adept at managing their own visual attention through spontaneous gaze shifts to the parent. Taken together, our results provide initial evidence that joint attention in ASL-based interactions is achieved when parents use a follow-in approach whereby they label objects to which the child had previously been attending. Deaf children learning ASL seek linguistic input related to their focus of attention through frequent and spontaneous gaze shifts to their interlocutors.

F-Attention, Memory and Learning

P2-F-91: No fixation required: Evidence of short-term memory for both fixated and non-fixated array items

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Previous work examining infant visual short-term memory revealed evidence of memory even in the context of a "one shot" change-detection task (e.g., Oakes et al., 2013, Ross-Sheehy & Eschman, 2019). In one such task, infants were briefly shown arrays of 1-4 colored circles, followed by a brief retention interval, and finally a test array of circles that was either exactly the same as the previous memory array (i.e., "no change"), or changed by one circle (i.e., "change"). Substantially longer looking to the changed item in the test array is typically taken as evidence of memory for the entire array. However, results revealed that for set sizes 2 and up, change preference scores were predominantly driven by trials in which the infant fortuitously fixated the to-be-changed circle during the memory array (Ross-Sheehy & Eschman, 2019). Thus, it is currently unclear if VSTM is formed for the entire array, or only items that were fixated in the array. To directly test this, we applied an n-back approach to our change detection task, and manipulated the location of the color change based on looking behavior during the memory array. Infants were tested at 5-, 7-, and 11-months ($n=64$) and shown up to 120 trials of change-detection arrays consisting of four colored circles. Each trial



began with a 1500ms memory array, followed by a 500ms blank retention interval, and finally a 3000ms test array. Infants viewed trials from four different conditions including a No Change condition in which none of the circles changed color, and three change conditions in which the color of one circle changed. For the change conditions, the location of the change was pseudorandomly chosen based fixation during the memory array, and occurred either in the last location fixated (0-Back), the second-to-the-last location fixated (1-Back), or in one of the non-fixated locations (Change Other). If infants encode all the items in the array, we should see similar patterns of change preference across the three change conditions. However, if infants only encode fixated items, we should see substantially stronger change preference for 0-Back, and to a lesser extent 1-Back conditions. Change preference for each trial was calculated as the proportion of time spent looking to the changed circle divided by total looking to all circles, and mean preference scores were compared to chance (.25). Somewhat surprisingly, results revealed significant change preference for all three change conditions at every age tested (Figure1). This suggests that to some extent, infants encode the entire memory array, not just the items that were specifically fixated. Fixation behavior at test was also examined, and results revealed that infants fixated more circles for 0-Back and 1-Back conditions than for the Change Other, and No Change conditions. This suggests that although some change detection was apparent for all change conditions, infants nonetheless showed stronger evidence of change detection when change occurred at a previously fixated location (Figure2). Taken together, results suggest a dual memory system, with strong memory for fixated objects, and moderate memory for non-fixated circles.

P2-F-92: The relationship between preferential attention to the mouth at 7 months and expressive language at 18 months

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Investigating infants' allocation of attention towards critical facial features (e.g., eyes, mouth) has been an important focus in the study of infant emotion processing and face recognition (Hunnius et al., 2011; Turati et al., 2006). Examining infants' differential attention towards these facial features may also reveal important information across other domains - such as language development. For example, Young et al. (2009) found that preferential attention towards the mouth at 6 months was related to greater language expression at 24 months, and Tsang et al. (2018) found that greater looking to the mouth compared to the eyes was positively correlated with expressive language across 6 to 12 months. Both of these studies measured "mouth-looking" in response to dynamic, talking faces. To our knowledge, this relationship has not been examined using dynamic, non-talking faces (i.e., dynamic emotional expressions), or static emotional faces - despite finding that infants also exhibit preferential attention towards the eyes or mouth in static faces (Segal & Moulson, under review). The aim of the current study is to examine whether increased attention to the mouth of static and dynamic emotional faces at 7 months is related to expressive language at 18 months. At 7 months, 56 infants completed two eye-tracking tasks. In the first, infants were presented with a happy and fearful face, and the eye tracker (Eyelink 1000 Plus, SR Research Ltd., Canada) recorded the overall time spent scanning each face and the critical facial features. In the second task, attention towards the critical facial features was measured in response to dynamic emotional



expressions. At 18 months, 10 infants to date have completed a language communication scale and 8 have completed the MacArthur-Bates Communicative Development Inventory (Fenson et al., 1993). Data collection at the 18-month assessment is ongoing. We calculated a difference score between looking to the eyes and mouth for each eye-tracking task as a measure of "mouth-looking," and expressive language scores were calculated separately for each language scale. Mouth-looking was positively correlated across the static and dynamic eye-tracking tasks, confirming that preferential scanning of eyes vs. mouths was consistent across tasks, $r(54) = .636$, $p < .001$ (Figure 1). Language expression at 18 months, as reported on the language communication scale, was negatively correlated with dynamic difference scores, $r(8) = -.683$, $p = .030$, (smaller difference scores indicate greater mouth scanning, Figure 2), but not static difference scores, $r(7) = -.449$, $p = .226$. Correlations between mouth-looking and MCDI scores were in the expected direction, but only 8 babies were included in the current analysis. Although preliminary, these findings suggest that greater attention to dynamic, but not static mouths, at 7 months is associated with greater expressive language at 18 months. Further work is required to elucidate whether increased mouth-looking in the first year of life is causally related to better language development, or whether 7-month-olds' preferential mouth-looking may indicate that these infants already have more developed language ability. Addressing these questions may support the development of early markers for language ability within the first year of life.

P2-F-93: Hyper-excitable brain: Enhanced pupil dilation following everyday sounds in infants with autism

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From birth, arousal mediates attention to sensory stimuli, enabling information processing and learning. Achieving optimal levels of arousal given the constraints of the situation is essential for any cognitive system, and the consequences of disruptions to this mechanism, particularly if they occur during early brain development, are far-reaching. Autism spectrum disorder (ASD) is a common neurodevelopmental condition defined by atypical responses to sensory stimuli and social-communication difficulties. In particular, hypersensitivity to sounds have been noted in many studies of individuals with the condition. By influencing what the infant attends, altered arousal to everyday sounds potentially draws attention from other sources of information continuously. Yet, no study has investigated whether the emergence of autistic symptoms during the first years of life could be linked to atypicalities in arousal responses during auditory stimulation. In this study, we examined whether the arousal levels induced by ordinary social- and non-social sounds predicts later ASD diagnosis. We also explored the relation between arousal and autistic symptoms, as well as short-term behavior effects. To do this, we used pupillometry to measure the infant's arousal response to social- and non-social sounds, with increased pupil dilation reflecting activation of arousal control systems in the brain. The sample of 10-month olds ($N=99$) was recruited within our prospective longitudinal study of high-risk infant siblings, and was grouped on high-risk with later ASD diagnosis ($N=18$), high-risk without later ASD diagnosis ($N=50$) and low-risk controls ($N=31$). We found that infants who are subsequently diagnosed with autism have stronger pupil dilation to non-social everyday sounds compared to controls, and that the magnitude of pupil dilation predicts socio-communication symptoms in the larger group of infants at risk (with and without



diagnosis). We also found that pupil dilation predicted saccade frequency on a trial-to-trial basis during the experiment, illustrating how arousal affects information intake at short time-scales in human infants. This study provides the first developmental evidence in support for the hypothesis that enhanced arousal response to ubiquitous auditory stimuli contributes to the atypical neurodevelopmental trajectory seen in individuals with autism. In addition to their mechanistic implications, the results provide important new leads on early intervention strategies.

P2-F-94: The temporal profile of infants' face bias: Visual attention from a large cohort followed longitudinally

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Orienting to others is crucial for learning about the world. Infants show a marked bias for attending to faces, however, we do not know much about the online changes of their attention to faces during the first 3 years. The definition of temporal profiles of attention might help understanding how infants orient to faces at different stages of development. The current study aimed to characterise the distribution of attention over time longitudinally, in a large cohort of infants from 5 to 36 months. We recorded the eye-movements of 163 infants (70 females), of which 100 had an older sibling with Autism Spectrum Disorder (ASD+), at 5, 10, 14, 24 and 36 months with a TX300 eye-tracker. The infants watched 8 5-seconds arrays of 1 photograph of a face plus 4 distractors. We excluded trials with missing data >25% (1 participant excluded). We aggregated the data in time bins of 500ms and calculated the proportional looking time (PLT) to the face. We applied Growth Curve Analysis with a multi-level modelling approach, including 3rd degree polynomials, random intercept per visual array and random intercept and slope per participant. The average PLT was above chance (Intercept = 46.10, CI 95% = 42.29 - 49.92), but tended to decrease over the course of the trial (Slope = -16.21, CI 95% = -20.22 - -12.20) and with age (Age = -0.51, CI 95% = -0.55 - -0.47). Age markedly influenced the change of PLT over time by means of the quadratic and cubic component (quadratic*age = 0.26, CI 95% = 0.11 - 0.42, cubic*age = -0.38, CI 95% = -0.54 - -0.23). Gender modulated the effect of age, with males showing a more pronounced average decrease with age (Age*Gender = -0.21, CI 95% = -0.29 - -0.13). Infants with a sibling with ASD had a more prominent average decrease with age (Age*ASD+ = -0.15, CI 95% = -0.26 - -0.03), but smaller gender differences (Age*Gender*ASD+ = 0.28, CI 95% = 0.12 - 0.43). PLT changed from a flat slope to a curvilinear, asymmetrical profile in increasingly mature infants (Figure 1). Younger infants were steadily captured, and slowly and linearly disengaged from the face. Older infants instead rapidly disengaged and bounced back by the end of the trial - possibly indicating enhanced social interest and oculomotor control. Furthermore, by 36 months, male infants had significantly dropped their attention level - possibly a sign of emerging gender-conforming looking preferences due to environmental social incentives. The general transition was also evident in the group with an older sibling with ASD, however, these infants showed less interest for the face and a smaller differentiation by gender (Figure 2). This distinction was marked by male infants showing relatively higher PLT compared to peers - supporting the idea that infants



on the autism spectrum may adjust less to the social environment, which in turn may lead to milder differentiation by gender. These results highlight a developmental transition modulated by gender and familiar likelihood of ASD, with the potential of obtaining individual trajectories of face-orienting tendencies.

P2-F-95: The role of auditory information in guiding infant scanning of male and female bodies

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Adults' expert processing of information from bodies is reflected in specialized scanning patterns (Hewig, Trippe, Hecht, Straube, & Miltner, 2008; Nummenmaa, Hietanen, Santtila, & Hyönä, 2012). Recently, White and colleagues (2018) found that, similarly to adults, 3.5- and 6.5-month-olds attend differently to the torsos of male and female stimuli. This finding demonstrates that not only are young infants sensitive to sex information, but that this sensitivity directs their attention in systematic ways. Furthermore, a subsequent study found that without redundant information across the faces and bodies neither 3.5- nor 6.5-month-olds exhibited such specialized attention (White et al., 2019). In the present study we examined whether information presented in another sensory modality, specifically vocalizations made by men or women, could facilitate infants processing of sex information in bodies. Such a finding would be consistent with the intersensory redundancy hypothesis which posits that social category processing is facilitated when congruent information is present in more than one source (Bahrick, Lickliter, & Flom, 2004). We examined the scanning of images by 3.5-, and 6.5-month-olds ($N = 61$). Half of infants were tested on images where relevant sex information was only present in the body and the face was non-informative/neutral, see Figure 1A, while the other half were tested on images where relevant sex information was only present in the face and the body was non-informative/neutral, see Figure 1B. In both conditions, a laughing voice congruent to the sex information present in the face or body played throughout each trial. Consistent with the previously cited studies of specialized scanning patterns in adulthood and infancy, it was hypothesized that, if infants reach the threshold of sensitivity to sex information necessary for specialized scanning patterns to emerge, they will display heightened attention to the torso region of the female stimulus compared to the torso region of the male stimulus. Performance did not significantly differ between the non-informative/neutral face or non-informative/neutral body conditions at either age. Collapsing across conditions, 6.5-month-olds exhibited a higher proportion of fixation to the female torso ($M = .16$, $SE = .03$) compared to the male torso ($M = .12$, $SE = .02$), $t(31) = 2.13$, $p = .04$, $d = 0.38$, but 3.5-month-olds' proportion of fixations to the female torso ($M = .26$, $SE = .03$) did not significantly differ from the male torso ($M = .23$, $SE = .04$), $t(27) = 0.93$, $p = .36$, $d = 0.17$. Thus, although sex-specific scanning of bodies emerges as early as 3.5 months of age (White et al., 2018), it is not until later in development that infants are able to utilize auditory information to overcome a lack of visual information. The present results constrain theories of body knowledge development by demonstrating the intricate and changing nature of the relationships between channels of social information (i.e., faces, bodies, and voices) early in life.



P2-F-96: Statistical learning of a sequence of emotional faces in 12-month-old infants: The influence of social context

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Previous research suggests that infants are capable of extracting statistical regularities from a continuous stream of elements, an ability that helps them making sense of the surrounding world. This capacity, referred to as statistical learning (SL), is thought to appear early on in development (Bulf et al., 2011; Teinonen et al., 2009), and to support infants' learning in many different domains. Indeed, infants have been shown to extract statistical regularities from sequences of words (Saffran et al., 1996; Teinonen et al., 2009), sounds (Hannon & Johnson, 2005; Saffran et al., 1999), events (Roseberry et al., 2011), actions (Monroy et al., 2017, 2019) and many other types of stimuli. However, so far, no research has examined infants' ability to extract statistical information from a sequence of emotional faces and whether the social context, which is known to largely influence infants' perception and understanding of others' behaviors (e.g., Woodward & Sommerville, 2000), modulates this ability. The current study aims to fill this gap by comparing 12-month-olds' ability to extract statistical information from a sequence of emotional faces containing salient social cues (i.e., social condition) vs. emotional faces deprived of salient social cues (i.e., non-social condition). We presented infants with videos of 2 actresses expressing the same facial emotion, and subsequently turning either towards (social condition) or away (non-social condition) from each other while maintaining the expression at its peak. Infants were first familiarized with a sequence of 8 videos, each video displaying a different emotion (i.e., anger, happiness, fear, sadness, surprise, amusement, disgust, exasperation). During the familiarization phase, four fixed pairs of videos were presented so that the transitional probabilities were of 1.0 within each pair (units) and 0.5 between pairs (part-units) (Figure 1). During the test phase, infants were shown units in alternation with part-units. We expected 12-month-olds to be able to extract the statistical information embedded in the sequence to which they were familiarized in the social, but not in the non-social condition, thus showing a preference (i.e., longer looking times) for the low predictable transitions (i.e., part-units). Preliminary non-parametric analyses in the social condition indicated that infants looked longer to part-units ($M = 87.42$ s; $SD = 37.11$ s) than units ($M = 65.13$ s; $SD = 32.21$ s); $p = .03$ (Figure 2). These results suggest that 12-month-old infants were able to extract the statistical information embedded in the sequence of emotional expressions within a salient social context. However, whether this ability is modulated by the degree of sociality of the stimuli remains to be determined. This question will be answered shortly, once data collection for both the social and non-social conditions will be completed.

P2-F-97: Habituation detection: Understanding infant attentional processing

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Despite the ubiquity of habituation to study infant cognition, some basic characteristics of the habituation process remain elusive. A better understanding of habituation will both advance



the methods we use to assess infant cognition and provide deeper understanding of habituation itself. We ask two questions: First, what is the functional form of the habituation curve? Second, how can we optimally decide whether an individual infant has habituated? The first question is surprisingly understudied. The literature offers many solutions to the second question, resulting in different habituation criteria used in different studies. One alternative to answer these questions is a model-based approach (e.g., Gilmore & Thomas, 2002). Our model proposes to divide the habituation curve into three sections: 1) the initial level of attention, 2) habituation, where the attention level decreases with repeated exposure, and 3) the asymptotic/residual attention level, the amount of attention that remains after habituation. The model represents each phase with a separate parameter (Figure 1) and can describe habituation curves. We can therefore explore different habituation criteria, eg identifying when evidence is found for decreasing attention, or identifying that habituation is complete when attention level asymptotes. Common criteria used to detect habituation (eg, 50% decrement in looking from the initial looking level, Oakes, 2010) have proven to be useful and have been verified in a simulation study. However, although simulations confirm that such criteria have a high detection rate (>90%), they can also have a high false positive rate (>90%), especially in cases of high variability. Figure 2 shows (simulated) habituation data and the results of a sequential analysis used in the model-based approach. Starting at trial 5, the habituation model is fitted to the data and then compared with a non-habituation model. The bottom half shows the posterior probability that the habituation model fits better than the non-habituation model. The dashed lines indicate decision bounds - once the posterior probability exceeds one of these bounds, the experiment may be concluded either as indicating enough evidence for habituation, or enough evidence for absence of a meaningful habituation pattern. These bounds may be adjusted to balance the trade-off between sensitivity and specificity. To better understand the performance of different criteria, we performed a simulation study. Data were generated using the model from Figure 1 for 20 trials using different parameter settings (based on fitting the model to a number of real data sets). Compared to the 50% decrement criterion, the model-based approach has a much lower false negative rate (30-60% in different parameter settings), but at the cost of remaining undecided more often and/or the requirement to gather more habituation trials. This approach can help habituation research by providing better tools for evaluating habituation data. Specifically, this model-based approach enables researchers to quantify the variability in the data. In addition, this approach provides more information than an all-or-none decision about whether infants habituated, but rather quantifies uncertainty about the eventual decision (habituated vs. not-habituated) as well as the extent to which an infant has habituated.

P2-F-98: Number of toys affect features of joint attentional interactions in mother-infant dyads

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Joint attention (JA), in other words, sharing experiences with a partner while having a mutual focus of attention, is thought to optimize infants' capacity to gain knowledge from social interactive environments (Bruner, 1981). The number and duration of JA episodes of mother-infant dyads predict the development of infants' language and various socio-cognitive abilities (Mundy & Sigman, 2006). The aim of the current study was to investigate the effects of the



number of toys in the environment on the features of JA episodes in mother-infant dyads. Previous studies showed that when children play alone with fewer toys, they sustain their attention longer and play in a greater variety of manners (Dauch et al., 2018). We expected the dyads with access to more toys to engage in more frequent but shorter JA episodes which are more frequently initiated by maternal directions, compared to dyads playing with a lower number of toys. We also expected mothers with more toys to make more attempts to direct the infants' focus of attention. At 12 months of age, 83 infants and their mothers participated in 5-minute free play in the laboratory as part of two different longitudinal studies. The Five Toy group (n=50) received 5 toys in a basket, while the Eleven Toy group (n=33) received 11 toys on the play rug. We coded the interaction videos for the following JA-related behaviors: (a) frequency, (b) duration, (c) manner of initiation (by maternal direction or follow-in), and (d) type (coordinated: child is aware of the maternal focus, passive: child does not show awareness). We also coded the number of mothers' attempts to establish JA. Confirming our hypotheses, results revealed that although the total time spent in JA did not differ across groups, the Five Toy group engaged in less frequent, longer, and more coordinated JA episodes compared to the Eleven Toy group (see Table 1). The manner of initiation did not differ across groups. As expected, mothers in the Eleven Toy group made more attempts to direct the focus of the child compared to the mothers in the Five Toy group. Since the toys were presented in a basket in the Five Toy group, mothers had control over the number of toys currently present on the play rug. Within the Five Toy group, we conducted correlations between JA-related behaviors and the average number of toys on the play rug (coded as the mean number of toys in front of the dyad per each 30 seconds). The number of toys was positively associated with the frequency ($r(49)=.41, p=.003$) and negatively with the duration ($r=-.44, p=.001$) and proportion of coordinated JA episodes ($r=.35, p=.014$). Mothers' attempts to establish JA increased with the number of toys ($r=.39, p=.005$). In sum, we showed that when the dyads had fewer toys, they engaged in less but longer and coordinated JA episodes. With fewer toys, mothers made fewer attempts to direct infants' attentional focus. To conclude, the number of toys present in the environment affects the characteristics of joint attention episodes in mother-infant interactions.

P2-F-99: Does the location of novel stimuli affect infant looking in serial paired-comparison tasks?

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Paired-comparison tasks are frequently used to test a variety of perceptual and cognitive skills during infancy with novelty preferences used as the primary dependent measure. Despite their popularity, researchers do not fully understand how infants attend to novel and familiar stimuli. Evidence suggesting that novelty preferences among 4- to 5-month-old infants are primarily dependent on adjustments in look duration (Fisher-Thompson, 2017). Although look duration is typically longer when gaze is directed at novel rather than familiar stimuli, infants do not look more often at novel stimuli. Given that gaze shifts are also unrelated to stimulus novelty, stimulus features along with location are suggested to have little effect on where infants look during serial paired-comparison tasks. To test this idea, infants were assigned to one of five experimental conditions varying where novel stimuli appeared (see Figure 1). If the infants are paying attention to where novel stimuli appear, possibly anticipating where to look to find novel



stimuli (Wentworth, Haith, & Hood, 2002), then gaze shift patterns and look number should differ between conditions along with look duration. To determine whether the location of novel stimuli affect looking behavior, 70 4-month-old infants were tested using a serial paired-comparison task. Stimuli were moving, colorful geometric shapes. Infants completed up to 40 trials (mean = 39.6 trials). Each trial presented a novel stimulus on the left or right display; the familiar stimulus reappeared on each trial on the opposite display. Presentation patterns differed across experimental conditions, varying the number of times novel stimuli shifted display location from one trial to the next (Figure 1). Looking data were scored off-line. Although percent novel differed from 50% across all groups, $M=57.4\%$, $p<.001$, 95% CI [4.6, 10.2], percentages did not differ across experimental groups (Table 1). ANOVA results, presented in Table 1, revealed only a stimulus effect for look duration: as previously found, looks aimed at novel stimuli were longer than were looks aimed at familiar stimuli. Condition effects and interactions between stimulus type and condition were small. Strong side biases (preferences for one side of the display) were found across conditions, $M=69.0\%$, $p<.001$, 95% CI [16.1, 21.9], but these biases did not correlate with percent novel, $r(68)=-.05$. Data suggest that stimulus location had little effect on the looking behavior reported in Table 1. The duration and number of looks to novel stimuli, and the frequency of gaze shifts, were unrelated to stimulus location. Looking measured with the serial task during early infancy appears to largely reflect exploratory behavior with infants adjusting look duration based on stimulus features, but stimulus novelty and location do not appear to affect look number or gaze direction. Infants did not adjust where they looked when novel stimuli shifted between right and left displays in predictable or random patterns. Nonetheless, 24 infants (34% of the sample) produced relatively strong novelty preferences, and another 3 infants produced strong familiarity preferences. Additional analyses will be presented focusing on these infants to determine whether their behavior differed from the majority of infants.

P2-F-100: Engagement of frontoparietal cortex in attention behavior from fMRI with awake infants

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One of the main ways young infants learn about the world is by overtly shifting their attention to perceptually salient events. Indeed, this tendency of infants to explore and understand with their eyes is the methodological foundation of a vast number of studies about infant cognition (Aslin, 2007). Assumptions about the mechanisms guiding attention are critical to interpreting looking behavior in these studies. For instance, drawing the conclusion that infants have conceptual knowledge about objects from increased looking at an event that violates solidity (Baillargeon et al., 1987) requires an assumption that the system controlling the allocation of attention is integrated with the perceptual and cognitive processes that make the event surprising. In adults, attention recruits several brain regions spanning the frontoparietal cortex (Corbetta & Shulman, 2002). These brain regions cluster together into networks that support different behavioral components of attention by modulating processing in sensory and motor systems. However, relatively little is known about these networks in infants and how they are recruited in the deployment of attention. We focused on the behavioral and neural mechanisms of attention to onsets of salient stimuli (i.e., stimulus-driven attention), as this is a particularly pervasive mode of attention in infancy. We used event-related fMRI with 24 awake, behaving



infants aged 3-12 months while they performed a child-friendly Posner cuing task (Johnson et al., 1994; Posner et al., 1978). Peripheral cues were presented briefly to infants before a peripheral target appeared in the same (valid) or opposite location (invalid), in addition to trials where cues appeared bilaterally (neutral). Eye-tracking in the scanner was used to measure response time, namely the time needed to saccade to the target after cue onset. In all 24 participants, response times were faster to valid versus invalid trials, with neutral trials intermediate. This indicates that the cues were effective at capturing stimulus-driven attention, facilitating the planning of an eye movement to that location. There was no relationship between this behavioral cuing effect and the age of the participant. We then compared the fMRI activity evoked by these trial types. When contrasting invalid versus valid trials, key regions of adult frontoparietal cortex including the right temporal parietal junction and anterior cingulate were activated, suggesting that these regions may function early in development as in adults to support the reorienting of attention. This is remarkable given the substantial anatomical growth that is yet to occur in these regions for infants under one year (Matsuzawa et al., 2001). More generally, this work starts to provide a mechanistic account for how the infant brain controls the allocation of attention. This has the potential to help explain looking behavior across a range of situations with the hope of refining interpretations and informing long-standing debates in infant cognition.

G-Cognitive Development

P2-F-101: Six-month-olds rapidly learn novel labels for objects, but labeling does not improve their working memory for objects

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Infants form representations of hidden objects, but are limited in their ability to remember the objects' features. For example, 6-month-old infants who viewed two featurally-distinct objects (a triangle and a disk) hidden sequentially behind two occluders consistently remembered the featural identity of only the last-hidden of the two objects and not the first-hidden (Káldy & Leslie, 2005). However, social context can influence what infants remember about objects (Applin & Kibbe, 2019). Pointing to objects prompts 9-month-old infants to encode object features (Yoon et al., 2008), and providing 9-month-olds with contrastive verbal labels for objects improves object individuation (Xu, 2002). Indeed, labels help infants as young as 6 months form categories based on object features (Fulkerson & Waxman, 2007), and categorical knowledge can improve 6-month-olds' ability to encode object identities (Kibbe & Leslie, 2019). We asked whether 6-month-olds (n=24) could learn contrastive novel labels for two objects, and whether this knowledge would help them encode the objects' features during a demanding working memory task (based on Káldy & Leslie, 2005) (Figure 1). Infants first viewed four Teaching trials in which an experimenter placed two featurally-distinct objects (a triangle and a disk) on a puppet stage in front of an agent. The agent then pointed to and labeled each object ("Wow! A blick!" "Wow! A dax!"). During four Test trials, no agent was present, and the objects were hidden sequentially behind two occluders. We tested infants' working memory for object features by removing one of the screens and revealing either the expected object (control) or the unexpected other object (swap) and measuring infants'



looking time to each outcome. Infants were tested on either the first-hidden object (which 6-month-olds typically forget, $n=18$) or the last-hidden object (which 6-month-olds typically remember, $n=6$, data collection ongoing). Finally, to assess whether infants learned the labels for the objects, we presented infants with both objects on a wide tray and asked infants, "Where is the blick? Can you get the blick?" Infants were given the opportunity to reach for one of the two objects. We found that giving the objects contrastive labels did not help infants remember the featural identity of the first-hidden object (mean swap=8.66s, mean control=9.47s; $F(1,17)=.376$, $p=.548$). While data collection for the last-hidden object is ongoing, infants' pattern of looking suggests they remembered the features of this object, consistent with previous work (mean swap=9.0s, mean control=6.65s), suggesting that labeling did not interfere with working memory for objects across the board (Figure 2). Interestingly, of the 15 out of the 24 infants who successfully reached for one of the two objects when given a choice, 12 selected the correct object for the given label (80%, binomial test $p = .04$, Figure 2), suggesting that 6-month-olds can learn novel labels for two different objects across 4 exposures, and can recall this information after 4 demanding working memory trials. Our results suggest that 6-month-olds may be able to rapidly learn new words for novel objects, but that their feature working memory limitations may nevertheless be somewhat rigid.

P2-F-102: The discrimination of numerosities by newborn infants: An fNIRS study

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Introduction. Young infants possess sophisticated abilities to perceive numbers. Six-month-olds can discriminate arrays of 8 vs. 16 dots (Xu & Spelke 2000). Even earlier, newborns are able to distinguish between different numerosities presented cross-modally (Izard et al. 2009) and map number and time onto space (de Hevia et al. 2014). The neural basis of these abilities, however, remains poorly understood (Edwards et al. 2015), especially in the youngest infants. In three near-infrared spectroscopy (NIRS) studies, we, therefore, investigated whether newborns are able to discriminate large numerosities and if so, what are the underlying neural mechanisms. **Methods.** In Exp 1, we used NIRS (NIRx NIRScout 8-10; wavelengths: 760 nm & 850 nm) to record newborn infants' ($N=31$, age: 0-5 days) brain activity in the frontal, temporal and parietal areas (Figure 1A) while they were listening to blocks containing only sequences made of a syllable repeated 6 times or 18 times (Non-Alternating blocks) or blocks containing alternating sequences of 6 and 18 syllables (Alternating blocks; Figure 1B). If newborns can discriminate between the two numerosities, differential activation between the Alternating and Non-alternating blocks should be observed, possibly in the (right) parietal areas (Edwards et al. 2015). Exp 2-3 served as controls to tease apart numerosity and temporal duration. In Exp 2 (Figure 1B), we tested another group of newborns ($N=27$; 0-5d) using the same paradigm and NIRS setup, with the only difference that the syllables in the sequences with 6 syllables were artificially elongated to match the duration of 18-syllable sequences. In Exp 3 (Figure 1B), we tested a third group of newborn infants ($N=28$; 0-5d) in the same paradigm and setup, but now number duration was controlled for by presenting one short and one long (unique) syllable (matching the overall durations of 6 and 18 syllable sequences of Exp. 1). The NIRS data was processed following Gervain et al. (2008, 2012). **Results.** Preliminary analyses show higher activation ($p=0.048$) to the Non-Alternating blocks in the left parietal area (channel 3, Figure



2A) in Experiment 1. When directly comparing the 6-syllable vs. the 18-syllable Non-Alt blocks (Figure 2B), we found greater activation ($p=0.026$) to the blocks with 6 syllables than to those with 18 syllables. In Experiment 2, we found no significant difference between the Alt vs. Non-Alt conditions. This may indicate that the basis for discrimination in Exp 1 was duration, but it could also be due to the phonological ill-formedness of the elongated syllables. In Experiment 3, by contrast, we found greater responses to the Alt condition than to the Non-Alt condition in the bilateral temporo-parietal areas (channels 9, 13, 21, Figure 2C). We interpret this finding to be the result of the greater acoustic variability of the Alt blocks. Conclusion. This study has provided some suggestive evidence about the brain mechanisms underlying newborns' ability to discriminate large numerosities. However, the relative contributions of number, duration and low-level acoustic characteristic of the stimuli require further analyses.

P2-G-103: Numerical representation over linguistic units in 9 to 10 months-old infants

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Introduction Increasing evidence indicates that infants are able, since their first hours of life, to discriminate the numerosity of sets (e.g. Izard et al., 2009). In the auditory domain, 6 month-old babies discriminate 2 from 4 tones, but fail to discriminate 2 from 3 tones (vanMarle & Wynn, 2009). At 9 months, infants discriminate 4 vs 6 tones and 8 vs 12 tones; but strikingly, like the smaller babies, they fail when presented with 2 vs 3 tones (Lipton & Spelke 2003; 2005). The aim of the present study was to further investigate this limitation in the auditory domain. Different from previous studies we tested discrimination of speech sequences instead of tone sequences. We hypothesized that the relative number of auditory items that infants hold and discriminate might increase with linguistic materials. **Study Population** Participants were 9 to 10 months-old infants (Exp 1. $N=18$, N males = 9; Exp 2. $N=20$, N males = 10; Exp 3. $N=16$, N males = 8). All participants were full term, with no birth complications, and no hearing or visual problems reported. **Methods** The experiment consisted of a familiarization phase of 20 trials and a test phase of 8 trials. In the familiarization trials, we taught infants to look to one side of the screen (right or left) when a given number of syllables was presented (e.g. 2 syllables), and to look to the other side when another set of syllables (e.g. 3 syllables) was presented. A looming puppet appeared after each syllable sequence, on the corresponding side. The test trials were similar to the familiarization trials, except that no puppet appeared after each syllable sequence. Infants' gaze was recorded with an eye-tracker (TOBII 1750), and the first fixation was coded as correct or incorrect based on the correspondence with the pairing sequence-side learned during the familiarization phase. We computed difference scores and separate t-test to compare the scores to chance level. **Results** The results indicate that infants distinguished and separately represented 2 and 3 syllable-sets both when the syllable sequences differed in the overall duration (Exp. 1; $p < 0.01$; $d' = 0.589$) and when edited to have identical duration (Exp. 2; $p < 0.05$; $d' = 0.52$). In Experiment 3 infants failed to distinguish 3 and 4 syllable-sets ($p = 0.45$; $d' = 0.19$). **Conclusions** The results of Experiments 1 and 2 suggest that numerical discrimination over speech items exceeds discrimination over tones. Moreover, the findings of Experiment 3 parallel previous studies in the visual domain showing a cross-boundary (i.e. small/large: 3/4) discrimination failure (e.g. vanMarle, 2013; Feigenson et al., 2002). This suggests that 9 to 10 months-old infants use a capacity limited,



"auditory event file system" (Hommel, 1998; Hauser et al., 2002) to enumerate small numbers, when instantiated over linguistic units.

P2-G-104: Irrational group behaviors: When and why infants think that inefficient behaviors are a cue of social influence

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Group specific practices are sometimes seemingly irrational or arbitrary, such as rituals or fashions. We suggest that one reason behind the cultural success of these strange behaviors is their social signaling value which comes from (i) their cost and (ii) the ease with which their reproduction is detected. Here, we test this hypothesis in infants, by assessing whether they expect the imitation of an action to carry more social significance when the action is inefficient. In Study 1, we tested whether infants treat the reproduction of inefficient behaviors as a cue of social influence. During the familiarization phase, fifteen-months-old infants saw an agent (follower) following another agent (rational leader) across a circuitous walls-delimited path (see Fig. 1). Infants also saw the same follower following a third agent (irrational leader) in a similar scenario but in which no walls were present. Despite the absence of constraints, the irrational leader (and the follower) always took an unnecessarily circuitous path to reach their final destination. Later in a test phase, the two leaders simultaneously took two different paths. We measured infants' looking time when the follower followed either the irrational leader or the rational leader. In line with our hypothesis, infants' average looking times suggest that they expected the follower to follow the irrational leader rather than the rational one (mean-rational = 21.439 sec.; mean-irrational = 14.008 sec.; $p < 0.01$, see Fig. 2). Thus, infants treat the reproduction of inefficient behaviors as a cue of social influence. In Study 2, we confirmed that inefficient behaviors are a cue of social influence for infants only when they are imitated. Fifteen-month-olds saw animations that were identical to those of Study 1, except that during the familiarization trials, the follower neither followed the rational nor the irrational agent (see Fig. 1). The test phase was the same as in Study 1. In Study 2, infants' average looking times suggest that they expected the follower to follow the rational agent rather than the irrational one (mean-rational = 10.149 sec.; mean-irrational = 17.475 sec.; $p = 0.02$, see Fig. 2). Thus, infants evaluate inefficient behaviors negatively when they are not imitated. In short, the social signaling role of strange behaviors has an early developmental onset. Infants evaluate negatively inefficient behaviors when they are not reproduced by others. However, they treat the reproduction of inefficient behaviors as a strong cue of social influence, which can be used to (i) identify leaders within groups, and (ii) to assign group membership.

P2-G-105: Using the MIT Lookit webcam platform for home-based studies

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Lookit is a web platform that lets families participate in infant and toddler research at home using their own computers and webcams. This talk gives a brief overview of the technology from the perspective of a third party researcher. The first part will outline the practical



considerations relevant to new researchers looking to use the platform, which has recently been made available to researchers outside an original group of beta testers. The second part will describe one recently completed study that looked at infant laughter. The Lookit platform consists of a website (lookit.mit.edu) where families can register to take part in a range of studies. It is being used by ten different research groups with central support from the team at ECCL. Studies can consist of onscreen instructions with picture, audio and video stimuli supported by questionnaire and video based data capture. Looking measures collected on Lookit can be coded with intercoder agreement comparable to lab-based studies, and participants are more representative of US families than typical lab samples (Scott & Schulz, 2017). Setting up new studies is straight-forward. Studies require ethical approval from researcher's local institutional review board and a data-sharing agreement must be in place between MIT who host the data and the researchers institution. Procedures are set up using a library of experimental components; researchers can use customizable components for common elements (e.g., video setup, consent, preferential looking or looking time trials, surveys, or storybook pages). A researcher-facing interface lets researchers design and test their studies, manage data collection, download data, and contact participants. Studies are deployed in separate containers that allow researchers complete control over any changes to functionality while testing. Lookit provides a number of built-in safeguards for handling of participant data, including an online interface for confirming informed consent; before confirming consent, researchers are not granted access to session data or to associated child or demographic. Granular permission structures allow researchers to edit, manage, contact participants from, and/or view data only from their own studies. All code running the platform is open-source and publicly available. The benefits of the Lookit platform are illustrated by considering our study of infant laughter. Spontaneous behaviours like laughter are difficult to study in the lab but well suited to being captured in the home environment. In this study, parents sat with their children and performed 5 different joking actions three times in a row, actions included tearing paper, playing peekaboo and other incongruous behaviours. For each joking action the interaction was captured on video and parents answered two questionnaire items rating their child's reaction (see Figure 1). The individual video segments for each condition made them easy to analyse and the online nature of the study made it easy to recruit a large number of participants (N = 97). This resulted in a large and diverse dataset of naturalistic laughter interaction videos that would have been impossible to very challenging to collect in the lab.

P2-G-106: Emerging executive function skills between 7 and 11 months

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Executive function (EF) skills encompass a wide range of cognitive skills that are key to learning, such as the ability to inhibit interference, working memory, and the ability to switch attention (Diamond, 2013). It is a heavily researched area, yet very little data is available during infancy, especially in relation to other important areas of learning, such as speech processing (Diamond, Werker & Lalonde, 1994, Conboy, Sommerville & Kuhl, 2008). In her seminal work, Diamond described the developmental trajectory within the first year of the ability to complete the delayed A-not-B task that requires reaching (Diamond, 1990). In more recent studies, Kovacs and Mehler examined the ability to learn rules and switch attention by measuring more



covert anticipatory looking behaviors. They measured 7-month old infants who are in monolingual vs. bilingual language environment and reported that bilingual infants exhibited the ability to switch attention and learn two rules simultaneously while their monolingual counterparts were not able to (Kovacs & Mehler, 2009, 2010). In our current study, we aim to provide more data on the developmental trajectory of these cognitive skills by measuring monolingual infants longitudinally at 7 and 11 months of age, using methods similar to Kovacs and Mehler. In a typical session, infants sit on a caregiver's lap while facing a large screen. Two blocks (16 trials/ block) of visual stimuli are presented on the screen with a break in between. In a trial, a cross is presented in the center of the screen to attract infants' attention, and then the stimulus is presented (i.e. a star). Reward pictures follow and the location of rewards was contingent on the shape of the stimulus (e.g. star is followed by rewards on the left of the screen, Fig 1A). In the second block, this rule is reversed (i.e. star is now followed by rewards on the right of the screen, Fig 1B). Infants' anticipatory looks for the rewards (i.e. looking in the direction of reward prior to the onset of reward) in the first block are taken as measures of the ability to learn rules, while their anticipatory looks in the second block are taken as measures of the ability to switch attention. We collected data from 55 7-month-old infants; 44 of them returned to repeat the measure at 11 months. Coding is ongoing, and preliminary results show that 7-month-old infants (N=27) do not learn two rules simultaneously (correlation between trial number and duration of correct look: $r = 0.21$, $p = 0.43$, Fig 2A), corroborating previous studies. However, 11-month-olds (N=23) show learning of both rules in the first block ($r = 0.53$, $p = 0.03$, Fig 2B). At neither age were infants able to switch attention and learn the reversed rule in the second block. Further analysis suggests that 7-month-olds' learning of one rule was surprisingly dominated by the right side (regardless of shape). The current results demonstrate the emergence of executive function skills in infancy. Future research will examine this behavioral measure in relation brain development in these infants.

P2-G-107: PyHab: Open-source tools for infant looking-time research across multiple paradigms

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The movement towards more open and rigorous science in psychology over the last several years has brought with it a new and unique set of challenges for infant research. Infant labs have very different physical setups, use different paradigms, and have radically different stimuli. This makes the prospect of replicating past infant work not only expensive and time-consuming but often impractical or impossible to do precisely. One way to facilitate open and replicable infant research is to use tools that are designed from the ground up with replicability in mind. PyHab (Kominsky, 2019), an add-on for PsychoPy (Peirce et al., 2019) was created to fill this exact niche, by providing a free, open-source, universally available system for conducting infant looking-time studies that is specifically designed to facilitate replication: When PyHab saves an experiment, it is saved as a self-contained folder, including all stimuli, timing and randomization settings, display options, and even the underlying Python script itself, "frozen" at the moment the experiment was created and thus able to replicate the experiment exactly as it was originally run. PyHab is flexible, readily supporting most habituation and violation-of-expectancy designs, with multi-screen head-turn preference designs currently in development and expected to be available by the end of 2019. PyHab can be used for real



time coding of infant gaze behavior with or without controlling stimulus presentation. It has a variety of blinding and randomization tools and many forms of gaze-dependent stimulus control (e.g., options for pausing when the infant looks away, replaying attention-getters, etc.). Because of this capability for high automation of study procedures and PyHab's simple experimenter interface, it makes it very easy to train research assistants to collect data, regardless of technical proficiency. Because it is open-source, its capabilities can be expanded by anyone who knows Python. This poster is intended to provide an introduction to a new tool for open and rigorous infant research to the ICIS community, as well as solicit feature requests and other feedback to inform PyHab's future design.

P2-G-108: Do environmental sounds disrupt mother and infant talk?

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Everyday home environments are noisy. Infants interact with their caregivers amidst a cacophony of sounds--television, music, home appliances, and the drone of outside cars and construction. When sound levels rise, infant learning may be compromised. Indeed, high levels of environmental noise, both acute and chronic, may disrupt children's cognitive and behavioral development. Yet little is known about infant sound exposure in the home--where infants spend the vast majority of time. Here, we tested whether sound levels and types of sounds relate to real-time infant and caregiver language interactions in the home. We characterized different types of sounds within and outside the home during four hours (split across two home visits). We video-recorded infant-mother interactions as they went about their everyday activities, and recorded decibel levels with an app placed in the center room of the home that recorded values for every 30-sec time window. For sound types, we coded each 10-second interval of the video for the presence of five common types of sound: screens (such as television), communication devices (such as phones), music/radio, appliances (such as vacuum cleaners), and out-of-home transportation/construction sounds. In addition, transcriptions of infant vocalizations and caregiver language input were time locked to videos to test associations between sound types and sound amplitudes and infant and caregiver language. Our first aim was to characterize the nature of infants' "sound environments." What levels and types of sounds are infants exposed to during everyday activities in the home? How variable are the sound environments of individual infants? Are sound levels and sound types stable across a 1-week period? Our second aim was to test associations between sound types and amplitude and infant and mother behaviors. Do sound levels and types of sound relate to infant vocalizations and/or mothers' speech to infants? Preliminary findings indicate that infants' homes vary tremendously in frequency of sounds; the noisiest home contained sounds in 96.5% of the 10-sec time intervals and the quietest home contained sounds in 8.3% of intervals (M=41.42% of intervals). The primary sources of sound were music (M=23.27% of intervals) and screens such as television and tablets (M=23.37%). Sounds from transportation/construction (M=4.06% of intervals), appliances, (M=3.68%), and communication devices (M=0.95%) were relatively infrequent. Notably, infants' homes were stable in total sound exposure on both visits, $r=.68$, $p<.001$, and overall amplitude of sound, $r=.65$, $p=.01$. Mothers varied greatly in language input; the most vocal mother directed 2,550 utterances to her infant and the quietest mother spoke only 471 times (M=1,462.85). Total



sound exposure was negatively associated with total mother and infant utterances, $r=-.41$, $p=.03$. Furthermore, during noisy bouts, mothers were less likely to vocalize to infants, signed-rank test, $p<.001$. Findings point to deleterious effects of extensive sound exposure on infants' real-time interactions with mothers. Furthermore, we advance a unique methodological approach to characterizing the sound environments of infants through real-time video-recordings and decibel readings. Findings have practical implications for caregivers' structuring of infants' everyday sound environments.

P2-G-109: You have seen one, you have seen them all: Infants generalize outgroup members' preference more than ingroup ones

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Social psychologists have for long noticed the ease, and robustness, with which adults develop discriminatory attitudes and behaviors that favor their "in-group" (those similar to them) and undermine their "out-group" (those different from them). One of the key processes fostering such inter-group biases is the tendency to conceive of all out-group members as being fundamentally alike, a tendency that has been termed "the out-group homogeneity effect". Developmental studies show that both, intergroup biases (Dunham, Baron, & Banaji, 2008), and the out-group homogeneity effect (Shilo, Weinsdorfer, Rakoczy, & Diesendruck, 2018), are manifest already in early childhood. In fact, there is also evidence that intergroup biases may be present in infants (Pun, Ferera, Diesendruck, Hamlin, & Baron, 2018). The question the present research addresses is whether the out-group homogeneity effect is also already present in infants. In a recent study, Powell & Spelke (2014) demonstrated that infants expect members of a given group to act in similar ways. The question we investigated is whether this expectation is subject to intergroup biases. Namely, we asked whether infants are more likely to expect consistency in the preferences of outgroup than ingroup members. Based on Powell & Spelke's (2014) finding showing that after seeing two group members displaying a behavior, infants generalized it to other group members, we exposed infants to three outgroup or ingroup members showing the same preference. We then assessed their expectations about the preference of a fourth group member. In our study, 22 18-month-olds were first familiarized to 4 agents (adult females) who either shared or not the infants' preferences for food and color -- thus establishing in- or out-group membership respectively (between-subjects). Then, infants saw 3 of these agents, one at a time, selecting the same one of two novel objects. At test, infants saw the 4th agent making the same or different choice to the one displayed by the previous agents (i.e. behaving either consistently or inconsistently to her group members; between-subjects). The main dependent measure was a "violation of expectation" looking time at the 4th agent at test. At this point we have the result of the main "inconsistent" in- and out-group conditions, and are currently running the complementary "consistent" conditions. Results show that infants looked longer when an outgroup agent chose the inconsistent object than when an ingroup agent did so (see Fig. 1). This suggests that infants at this age are sensitive to group membership information when forming expectations about individuals' preferences, and that distinct expectations are formed for out- compared to ingroup members. Specifically, infants expect more consistency in the behavior of outgroup than of ingroup members. This is consistent with them having an outgroup homogeneity bias, indicating that



the distinct ways in which adults and young children construe in- and out-group members may have its origins already in infancy.

P2-G-110: The role of motion information in infants' and adults' object individuation process

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The ability to establish how many objects are present in a scene is a crucial aspect of humans' cognitive system. This ability is present very early in humans, indicating its pre-verbal nature. It was proposed that two distinct pre-verbal systems underlie infants' numerical skills: the Approximate Number System and the Object Tracking System (e.g., Carey, 2009; Piazza, 2010). The first system allows individuals to estimate numerosities without counting and it is imprecise, whereas the second one allows exact and precise quantification. In the present study, we investigated 10-month-old infants' (N = 40 for Experiment 1, N = 40 for Experiment 2) and adults' (N = 83) numerical expectations in scenarios in which information on self-motion and static object features may give rise to numerically incongruent representations. In Experiment 1, infants saw a red circle (or a blue box with yellow stripes) that appeared on the left side of a screen, moved autonomously sideways and then moved back behind the screen. Next, on the opposite side, an identical object was first brought in view by a hand and then pushed back behind the screen. The screen was finally removed revealing either one or two objects. The main findings of this experiment were that infants looked reliably longer at one-object test events, suggesting that they expected to find two objects. These findings were replicated and clarified in Experiment 2, in which we also controlled for the effect of object trajectory and the presence of the hand. In Experiment 3, adults were shown the same animations used in Experiments 1 and they were asked for their numerical expectations. Contrary to infants, their responses showed that most of them expected one single object. While infants' numerical expectations appeared to be dominated by information on object self-vs. induced motion, adults' expectations were mainly guided by information about object shape, size and color. These findings are discussed in relation to current models on the development of object individuation processes (Baillargeon et al., 2012; Kibbe & Leslie, 2013; Stavans, Lin, Wu, & Baillargeon, 2018; Wilcox, 1999; Wilcox & Baillargeon, 1998).

P2-G-111: Infants' false belief attribution: A test of the mentalistic hypothesis

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Theory of mind is the ability to understand the mental state of others, including beliefs, desires and intentions. In a landmark study, Onishi and Baillargeon (2005) argued that infants possess a mature theory of mind that can be reliably measured using implicit tasks. In their violation-of-expectation task (VOE), an agent plays with an object, repeatedly places it in one of two boxes (green) and then leaves the scene. During her absence, the toy moves to the other box (yellow) to induce a false belief. Infants look longer (i.e. showing surprise) when the agent searches in the box where the toy is located (yellow) as this behaviour is inconsistent with her



belief (that the toy in the original green box). In contrast to the mentalistic view, others have argued that infants are not inferring about the actor's false belief but are rather submentalizing (Heyes, 2014; Ruffman, 2014). That is, infants' looking patterns are influenced by the low-level perceptual features of the scene. According to this lean view, the infants' surprise resulted from the violation of the association that they developed between the agent and the green box during the familiarization trials when the actor puts her hand into the yellow at test. The present study aims to test the mentalistic hypothesis by replicating Onishi & Baillargeon's (2005) VOE task with one important methodological change : instead of the actor disappearing from the scene during the change of location of the toy, the actor puts on a veil to cover her view of the scene prior to the toy switching box. Infants aged 15-19 months ($M = 16.86$, $SD = 0.94$, $N = 50$) were equally divided into two groups. That is, half of the infants were randomly assigned to the incongruent condition (i.e. actor searches for the toy in the yellow box during the test trial; $n = 25$), whereas the other half was randomly assigned to the congruent condition (i.e. actor searches for the toy in the green box, $n = 25$). All infants had self-experience with the veil prior to the experiment. If the mentalistic view is correct, then one would expect that the agent disappearing behind a veil during the location switch (as opposed to behind a screen) should not change the false belief attribution. Thus, if infants have a mature understanding of the beliefs of others, infants in the incongruent group (i.e. those who see the actor reach for the yellow box at test) should look longer than those in the congruent group. However, our results show no difference in looking time across the two conditions ($M_{incongruent} = 11.31$, $M_{congruent} = 9.77$, $p = .42$). Therefore, the rich mentalistic theory is not supported by these findings. Interpretations based on lean views of infants' behaviors in the VOE false belief task will be discussed.

P2-G-112: Early emergence of responding to joint attention skills

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The ability to follow another person's gaze or pointing gesture is an important skill for young infants to acquire as it has been found to predict their language development (e.g., Bottema-Beutel, 2016; Carpenter et al., 1998). Our current understanding of this ability (usually referred to as 'responding to joint attention; R-JA') is largely based on studies conducted in controlled laboratory settings where an adult is typically instructed to try to direct an infant's attention to an object by giving a strict predetermined sequence of cues (e.g., Morissette et al., 1995; Mundy et al., 2007). This very controlled behaviour does, however, not necessarily reflect the way that adults normally direct the attention of young infants in their everyday life. The present study therefore aimed to examine children's R-JA abilities in a more naturalistic setting in which mothers were asked to direct their infants' attention to an object using any strategies they would normally use. Fifty British mother-infant dyads participated in an R-JA task in their homes when the infants were 6m, 10m and 12m old. The task consisted of four trials: two during which a toy was placed close (~50cm) to the infant's left or right (proximal trials) and two during which a toy was placed further away (~1.5-2m) to the infant's left or right (distal trials). Mothers sat opposite their infants on the floor and did not receive any instructions on how to direct their attention, except for being asked not to touch the toys and to remain where



they were sitting. Infants needed to first look at their mother and then at the relevant toy in both proximal or in both distal trials to successfully pass that type of trial. Infants were excluded from the analysis at certain time points in cases where they saw the toy before the trial had started or where they never looked at their mothers. At 6 months, 28% of infants included in the analysis of proximal trials had passed. By 10 months, 91% had passed, and by 12 months 100% had passed both their proximal trials. With regards to distal trials, 9% of infants passed at 6 months, 80 % at 10 months, and by 12 months 100% had passed both their distal trials. We also coded how mothers directed their infants' attention at 6m - an age at which R-JA skills were less developed and mother were therefore more likely to try out different strategies. We found that they used a variety of strategies (M = 6.81, range: 3-10), but all mothers used pointing gestures. Our results show that when in a familiar home environment, infants can follow the rich attention directing signals of their mothers to find their locus of attention at an early age. Infants in this study passed this R-JA task at an earlier age than infants in previous studies (e.g., Carpenter et al., 1998; Morissette et al., 1995), indicating that we might have previously underestimated the age at which infants start to develop R-JA skills in their everyday lives.

P2-G-113: Latina mothers' spontaneous math language with infants during home routines

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Children start learning math long before they enter the classroom. Parents use number and spatial language during everyday home routines, introducing infants to foundational math concepts while counting cookies, stacking cups, or playing with shape sorters. Parents' math language relates to children's later math skills. In an economy where children's STEM skills are increasingly important to economic mobility, parent math language to infants may be foundational to later school performance and ultimately STEM success and entry (Levine et al., 2010; Pruden, Levine, & Huttenlocher, 2011). We advance an understanding of infants' exposure to math language in a sample of Latino infants and their mothers, the fastest growing U.S. immigrant population. How much math language do Latino mothers and toddlers use in the home during their everyday routines? Which categories of math language (i.e., number, spatial) do they use? Do Latina mothers use English, Spanish, or both when directing math language to their infants? Participants were 80 mothers and their 12-to-25-month-old toddlers. Dyads were video-recorded for 1-2 hours at home as they went about their everyday activities. Transcriptions of videos were coded for total number of utterances, utterances that contained math language, and specific math concepts at word level: number, shape, magnitude/comparison, location/direction, orientation, spatial features/properties, ordinal patterns and deictics. All measures were prorated by hour to adjust for varied visit lengths. Mothers varied in utterances and math language to infants. Transcripts on 44 dyads thus far show that mothers ranged from 37.5-1732.9 total utterances per hour, averaging 512.6 utterances per hour (SD=464.87); 56.0-3782.0 tokens per hour (SD=975.57); and 28.5 - 422 unique types per hour (SD=125.2). Regarding math language specifically, coding of 22 transcripts thus far shows that mothers ranged from 8.60 to 282.60 math utterances per hour, or 5%-23% of all utterances. For math categories, mothers averaged per hour ~13.4 number



words, 2.2 shape words, 14.1 magnitude/comparison words, 8.8 location/direction words, 0.2 orientation words, 0.4 spatial features/properties and 0.5 ordinal pattern; deictics were most frequent at 39.2 words. Figure 1 highlights the striking variation among mothers in math language. Notably, 32% of toddlers used math language, and toddlers who used math terms had mothers who used twice as many math terms per hour ($M=126.57$) than mothers of toddlers who did not yet use math terms ($M=56.80$; Wilcoxon's $W=20$, $p=0.02$). The majority (82%) of mothers only used math words in Spanish. To examine the likelihood of using a specific language for different categories of math words, we focused on mothers who used both languages. Figure 2 shows that these "bilingual" mothers were more likely to use English for numbers, shapes, magnitudes/comparisons, and locations/directions, but used Spanish for deictics (here, there). Ongoing work will extend these analyses to the full sample. In summary, Latina mothers use substantial math language with their infants, even in naturalistic contexts without tasks that intentionally extract math talk. Although mothers privilege deictics, they vary in informative forms of math language, and their math talk relates to toddler math talk even at this initial period of language emergence.

P2-G-114: Do maternal sensitivity and cognitive stimulation during infancy predict executive functions and motor skills in early childhood?

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During infancy and early childhood, children show a rapid development of cognitive and motor skills. Studies show that cognitive and motor development are interrelated (Diamond, 2000). Parenting behaviors such as sensitivity, autonomy support and stimulation of development are positively associated with the development of child executive functions (EF; Fay-Stammach, Hawes, & Meredith, 2014; Valcan, Davis, & Pino-Pasternak, 2018). Given the interrelation between EF and motor development, it is plausible that these parenting behaviors not only enhance cognitive development, but also stimulate motor development. However, this has not been investigated before. Our aim was to investigate whether maternal sensitivity and cognitive stimulation in interaction with her infant at age 2, predict children's EF and motor skills at age 6-7. The sample consisted of 77 mother-infant dyads who participated in a Dutch longitudinal study on parenting and child development. At infant age 2, mother-infant interactions during the Three Boxes task were recorded at home and coded on parental sensitivity and stimulation of cognitive development (NICHD Early Child Care Research Network, 1999). When children were 6-7 years old, dyads visited the university sports center. EF was assessed in children without the mothers present using the Head-Toes-Knees-Shoulders task (HTKS, total correct responses, measuring a composite of cognitive flexibility, working memory, and inhibitory control; McClelland et al., 2014), and Dimensional Change Card Sort (DCCS, total correct responses and reaction time, measuring mainly cognitive flexibility; Zelazo, 2006). Motor skills were assessed with the Körperkoordination-Test für Kinder (KTK, Motor Quotient; Kiphard & Schilling, 1974; 2007). First, correlations among all study variables were computed to explore associations between EF, motor skills and parenting behavior variables. Next, multiple regression analyses adjusting for child age were conducted to test the prediction of EF and motor skills by sensitivity and stimulation. Preliminary results showed a significant correlation between KTK and reaction time on DCCS ($r = -.24$; $p = .04$).



KTK was not significantly correlated with the other EF variables. Both sensitivity and stimulation were significantly correlated with KTK scores ($r = .26$; $p = .02$, and $r = .25$; $p = .03$ respectively), but not with EF variables. Multiple regression analyses (Table 1) showed that, after adjusting for age, higher sensitivity significantly predicted higher KTK scores, explaining 6.5% of the variance. Adjusted for age, stimulation was not a significant predictor of KTK, nor did sensitivity or stimulation significantly predict EF variables. Findings show that motor skills are linked to reaction time in a cognitive flexibility task but not to performance in EF tasks. Further, results suggest that parenting behavior in infancy is related to motor skills in later childhood. However, we could not confirm the previously established link between sensitivity and stimulation of cognitive development with EF. Hence, the mechanism by which parenting behavior is linked to motor skill development, and the possible role of EF therein, remains to be elucidated. The results of this study will be updated with data from more participants in the next months.

P2-G-116: The development of hierarchical action planning in toddlers

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From 6 months, infants are able to plan one step actions (McCormack & Atance, 2011). However, actions that we use in daily life are more complicated. They consist of multiple levels of goals, with higher-level goals, such as making a cup of coffee being made up of more basic goals, such as adding the milk, which in turn consist of multiple subgoals or action steps at an even lower level, such as picking up the package of milk. Three-year-olds display good abilities to access and follow goals at the lowest level, but not at the superordinate level in a colouring task (Freier, Cooper & Mareschal, 2017). However, it could be that Freier and colleagues' (2017) colouring task is too complicated for children younger than 3. Therefore, more research is necessary to draw firm conclusions about young children's ability to follow multiple goals in their actions. This study investigates 27-month-olds' ability to follow multiple hierarchically organized goals in their action planning. We have currently tested 15 toddlers ($M = 27.07$ months, $SD = 2.82$, range = 24 - 31 months). We will continue to collect more data in the same group until $N = 20$ and add a comparison group of 36-month-olds. The toddlers completed a construction planning task using Duplo® blocks involving multiple goals in a goal hierarchy. The lowest level of goal was to build a tower that had a height indicated on the wall. The superordinate level was to make the tower striped, alternating between the two colours of Duplo blocks provided. In addition to the planning task, inhibition, switching, working memory, alternating abilities, and motor competence were assessed in small fun games to investigate whether performance on the planning task might be related to improvement in specific executive functions. Eight out of 15 toddlers were able to follow the lowest level goal, of building a tower of the correct height (Figure 1). However, only one toddler was able to follow both levels of the goal hierarchy (i.e. building the tower to the correct height, and alternating between the two colours). Interestingly, most of the toddlers who succeeded in the basic tower building but without stripes were able to identify what striped meant, and what a correct tower should look like. In contrast with Freier and colleagues (2017), the current results show that many toddlers around 27 months old struggle to incorporate the lowest goal in their planning of action sequences. However, like Freier and colleagues (2017) providing evidence that 3-year-olds fail to follow the superordinate goal, we also find that toddlers are unable to follow the higher goal of the goal hierarchy. Initial investigations suggest that switching abilities could



potentially be one of the mechanisms that could explain why following multiple goals in planning is so difficult in toddlers (Figure 2). Interestingly, although children are able to identify alternating patterns, they show great difficulty in doing it themselves in a coin alternating task. Potentially it could be that planning alternating actions is too complicated in this age group.

P2-G-117: Developmental divergence in infancy: Profiles across genetic conditions and typically developing infants

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Down syndrome (DS) and fragile X syndrome (FXS) are two of the most common genetic conditions associated with intellectual disability (Parker et al., 2010; Hagerman, 2013). As such, early developmental delays are common across each of these disorders. With distinct genetic etiologies, it is also likely that infants with DS or FXS demonstrate distinct developmental profiles across motor, language, and cognition during infancy, however this has not been examined. Further, existing research on early developmental profiles for both DS and FXS is incredibly limited, particularly during infancy. Characterizing the nature, extent, and specificity of delayed development across DS and FXS can inform targeted early intervention. Thus, the present study aims to 1) characterize the nature of divergence from typical development in DS and FXS developmental profiles; and 2) determine areas of overlap and distinction between infants with DS and FXS at approximately 12-months-old. Participants included 42 typically developing infants (M chronological age=12.38), 31 infants with DS (M CA=12.33), and 30 infants with FXS (M CA=12.81). The Mullen Scales of Early Learning (MSEL; Mullen, 1995) is a comprehensive developmental assessment measuring fine motor, gross motor, visual reception, receptive language, and expressive language from 0 - 68 months. Regression models were estimated to compare infants with DS and FXS to TD infants on raw scores across each domain of the MSEL. Phenotypic specificity was evaluated by then estimating comparisons between DS and FXS. Discrepancies between average chronological age and age equivalence were examined for each MSEL domain to ascertain the degree of developmental delay for infants with DS and FXS. As expected, results demonstrated that infants with DS and FXS were significantly lower than TD infants across all domains (see Table 1). Results also indicated that infants with DS were significantly lower than FXS in gross motor ($b=-2.82$; $p<.001$), fine motor ($b=-2.65$; $p<.001$), and receptive language ($b=2.28$; $p<.001$), but equivalent on visual reception ($b=-0.85$; $p=.219$) and expressive language ($b=-0.50$; $p=.477$). Additional results revealed that infants with FXS were most delayed in expressive language (five-month delay), and least delayed in fine motor (one-month delay). Receptive language was the area of greatest delay (six-month delay) for infants with DS, whereas visual reception was the least delayed area (three-month delay). Figure 1 presents discrepancies between chronological age and age equivalent scores for each developmental domain across groups. Findings from the present study demonstrate areas of early developmental impairments for infants with DS or FXS. While this is expected given their underlying genetic etiology and the phenotypic characterization of each disorder, findings uniquely indicate a variable profile of impairments for infants with DS or FXS. Further, our findings also identify certain areas of significant delay, such as receptive language, that have not been emphasized in the limited extant research on infant development in DS or FXS. Importantly, these results highlight the extent of developmental delay and characterize shared and unique aspects of developmental



profiles for infants with DS versus FXS which collectively provides support for targeted intervention.

P2-G-118: Tool innovation in 3- to 5-year-old children

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Previous research suggests that pre-schoolers' capacity to innovate tools is limited. Beck, Apperly, Chappell, Guthrie & Cutting (2011) showed that less than 10% of three- to five-year-old children solved the 'hooks task' within one minute. In this task, the child needs to build a tool in order get a reward out of a vertical tube. The solution is to bend a pipe cleaner to form a hook. In another task version, the child needs to unbend a pipe cleaner and push a reward out of a horizontal tube. Although the horizontal task was solved more often than the vertical task (33% success rate; see Cutting, Apperly & Beck, 2011), the majority of children had difficulties to find the solution. Recently, Voigt, Pauen & Bechtel-Kuehne (2019) suggested that successful tool innovation in children could require more time on the task and more than one possible solution. Therefore, Voigt and colleagues gave five-year-old children up to 10 minutes for solving the horizontal or vertical innovation task. They offered material for constructing six different tools (three functional tools per task). Success rates increased with time: whereas only 21% of the children solved the task after one minute, 76% did so after 10 minutes. The authors concluded that, when given more time and different tool manufacturing options, five-year-olds are skilled innovators. This raises the question whether even younger children can innovate tools in this experimental set-up. In the present study, we compared performance in three- four-, and five-year-old children. The preliminary results show that even four-year-olds are very well able to solve the innovation problems (70% success rate). However, the five-year-olds solved the tasks more often (90.6%, $\chi^2(1) = 4.22$, $p = .04$) and faster than the four-year-olds ($M_4 \text{ years} = 327.9\text{s}$, $M_5 \text{ years} = 225\text{s}$, Log Rank $\chi^2(1) = 3.95$, $p = .047$). Data-collection for three-year-olds is still under way. The data of all three subsamples will be presented on the conference poster and implications for the onset of tool innovation in toddlerhood will be discussed. Furthermore, we are interested in the innovation process itself. Why do some children succeed while others fail? To shed new light onto this question, we analyse children's private speech during the innovation task. Private speech is referred to as a form of verbal self-regulation children use in problem-solving contexts and could be a way to better understand cognitive and motivational processes during tool innovation, as well as age-related differences in performance.

P2-G-119: Understanding a third-party communicative situation: A comparison between American and Korean infants

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We regularly talk to one another in social interactions. When a speaker we interact with has different perspectives than us, we also take it into consideration to correctly identify the speaker's referent. A recent study (Choi, Song, & Luo, 2018) demonstrated infants' success in



this regard: they can use their perspective-taking and language comprehension skills to make sense of a third-party communicative situation. In this situation, a speaker, but not a listener or the infant, could only see one of two tennis balls because a screen hid one ball from her. When the speaker said to the listener "give me the ball," 19-month-old, but not 14-month-old English-learning infants correctly expected the listener to reach for the ball visible to the speaker, but not the one hidden from her. What factors might contribute to the developmental differences? Given that young infants are found to be aware of others' incomplete perceptions in a variety of experimental situations (Baillargeon et al., 2015), which speaks to their perspective-taking capacities, it seems plausible that the 14-month-olds' failure in identifying the speaker's referent may largely lie in their language skills, specifically, their limited understanding of the definite article "the" in English. The present study addresses this question. In Experiment 1, we first sought to eliminate the article "the" from the speaker's speech. However, "give me ball" is ungrammatical in English, which may pose further problems to English-learning 14-month-olds. We therefore tested 14-month-old Korean-learning infants because Korean, unlike English, lacks the article system, rendering "give me ball" grammatical. As in Choi et al. (2018), however, the Korean infants, like their English-learning peers, failed to identify the referent of the speaker's speech (i.e., "give me ball") as the ball visible to her. In Experiment 2, we replaced the definite article "the" with a demonstrative "that." These two linguistic units serve similar grammatical functions (Suppes, 1974), while demonstratives are more informative than the article and hence make it easier for listeners to identify speech referents (Van Hout, Harrigan, & de Villiers, 2010). In addition, 14-month-olds can understand the demonstratives, before articles (Frank et al., 2016), and even use it to identify a speaker's referent hidden from view (Saylor et al., 2011). In our experiment, both English and Korean-learning 14-month-old infants hear the speaker say to the listener "give me that ball" in their language. If this linguistic unit helps infants to identify the speaker's referent, they should expect the listener to reach for the ball that the speaker can see, considering the speaker's incomplete perceptions, similar to the 19-month-olds in Choi et al. (2018). Preliminary results are consistent with this hypothesis. In sum, these results, if held, will provide evidence that when watching two individuals interact in a communicative situation, 14-month-old English- and Korean-learning infants could both identify the referent of speech to make appropriate predictions, even when the two individuals have different perceptions of the situation.

P2-G-120: Toddlers can anticipate the informativeness of their actions

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Humans have the ability to discover new behaviors to collect valuable data, for instance, by assessing the quality of evidence resulting from possible interventions in the world. This research project focuses on the developmental origins of this capacity in toddlers (N = 104, 14-month-olds and 2-years-old), by testing their ability to anticipate an action's informativity. The participants had to find a character hidden in a box or among three distractors. By manipulating the experimental context (i.e., the characteristics of the box or distractors), we modified the potential informativity of the toddlers' actions. In Study 1, we manipulated whether the exact same action (opening a window) allowed to gain visual access to a target in order to locate it. In Studies 2 and 3, we manipulated whether flipping objects to gain visual access to symbols was relevant to identify a target. The results revealed that toddlers can adjust their



behaviors to select the relevant source of data depending on the context. These studies suggest that toddlers anticipate the informativeness of their actions, a capacity that is crucial to support creative active learning and hypothesis testing.

P2-G-121: The early emergence of belief justification in young children

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The aim of our study was to explore the early emergence of reason-giving ability. In our study, we planned to test whether children adjust their communicative actions in a false belief situation in order to justify their behaviour, when the task at hand allows them to take into account the desires of another person. Our goal was to explore this process at an age when verbal communication is very limited (18 months), and compare their pattern of behaviour with a group of children who are already competent users of language (42-48 months). During the procedure, the child and an experimenter (E) sat behind two containers with snacks (apples and carrots), which were occluded from the protagonist (P). P stated which food she preferred, E shared a piece with her and P left the room. In P's absence, E ate some snacks, which resulted in only one piece remaining: either from P's preferred (control condition) or non-preferred kind (experimental condition). Upon returning, P requested a snack, and in case the child gave one, she prompted them to justify their behaviour. We recorded whether the participant shared any food with P, as well as participant's communicative behaviour. Our predictions were that older children would provide the snack in the control condition, but in the experimental condition they would be more likely to decline, and to justify their behavior by referring to the absence of the favoured snack kind. We expected toddlers to give the remaining snack in both conditions. However, we hypothesized that in the experimental condition specifically, they will be prone to justify their action nonverbally by revealing the preferred food's empty container more frequently, than that of the non-preferred food. In line with our predictions, preliminary analyses indicate that older children interpreted the two conditions differently: they declined giving any food to the protagonist in the experimental condition more often, than in the control condition (N=39; Fisher's exact test: $p=.013$). Moreover, they showed sensitivity to the different epistemic states of the protagonist generated in the two conditions and tended to justify their behaviour spontaneously more often in the experimental condition compared to the control condition (Fisher's exact test: $p=.001$). In conclusion, our results indicate that children at this age are able to identify situations during which justifying their behaviour is necessary, and spontaneously share relevant information if needed. The testings are still in progress for the 18-month-old participants, results will be reported only after the closure of the data collection.

P2-G-122: The Developmental Object Familiarity Inventory (DOFI)

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Numerous studies have used object familiarity as an independent variable without ever actually defining the construct. Instead, it has been used as a measure of exposure - more exposure of a stimulus making it more familiar. Yet, we argue, that being familiar with an object is more than simple exposure: different levels of experience with and knowledge about an object should be integrated into the construct. Thus, we created the Developmental Object Familiarity Inventory (DOFI) as a new parent report measure to evaluate object familiarity on a six-point scale. The scale points are: (1)"My child has never seen this object before", (2)"My child has paid attention to this object before", (3)"My child has shown interest to explore the object at least once", (4)"My child has some knowledge about the object's use", (5)"My child can indicate where the object is when asked for it", and (6)"My child has and uses a consistent word for the object". This way, real-life familiarity about real-life objects can be measured, as well as, other research questions related to object familiarity (e.g., van Renswoude et al., under review). Items were 76 objects covering six object categories following the CDI's organization (Fenson et al., 1993): 'vehicles' (9 items), 'toys' (9 items), 'food' (11 items), 'clothing' (14 items), 'household' (18 items), and 'furniture' (15 items) based on the Dutch CDI (N-CDI; Zink & Lejaeger, 2002). In three studies the new measure's reliability and validity was investigated by collecting data about infants between the age of 6 and 24 months. A first study (N = 10 infant reports, M = 15,37; SD = 3,98) shows that the six scale points indeed follow a strict order for all parents for all items. A second study (N = 28 complete infant reports, M = 13,5; SD = 5,5) was aimed at testing the internal structure of the questionnaire (Messick, 1995; Downing, 2003). The survey had great internal consistency (Cronbach's alpha is .991) and a good inter-item correlation ($d = .63$). The scale's ordinality was to be analyzed with a graded response model (GRM, Samejima, 2011; Figure 1). When including age and gender as covariates in the model, age has a significant, positive effect on the latent trait ($\beta = 1.17$, $t = 2.67$, $p < .05$). Twelve participants responded to the test-retest survey. On average, the interval between measurements was 23 days (min = 9; max = 57; SD = 12,64). With a correlation of $r = .86$ ($p < .001$) the test-retest reliability was good. In the third, pilot study, an eye-tracking validation (N = 6 infants between the ages of 7,3 and 22 months, M = 14,4; SD = 4,52), the familiarity scores obtained in the DOFI were attempted to be related to preferential looking. We gathered important information to consider when designing future studies implementing the DOFI (in progress). In conclusion, the DOFI shows great potential to be used in object familiarity related research and might revolutionize the field towards a more natural and generalizable manner of research.

P2-G-123: Cardiac autonomic activity and cognitive development in 6- to 12-month-old infants

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The autonomic nervous system (ANS) plays a crucial role in regulating basic bodily functions. Cardiac autonomic measures, including heart rate (HR) and respiratory sinus arrhythmia (RSA; the variability in interbeat intervals in the frequency of respiration) have been found to change across early development (e.g., Richards & Cameron, 1989), and studies examining behavioral correlates of infant cardiac ANS have found associations with social functioning (e.g., Patriquin et al., 2014). Work with adults suggests that RSA is a marker of cognitive ability (see Elias & Torres, 2017), but results are mixed in infancy in this domain (e.g., Ask et al., 2019; Richards



& Cameron, 1989) and many studies focus on premature infants (e.g., Doussard-Roosevelt et al., 1997; Feldman, 2009). The present study extends past work to examine relations between baseline cardiac ANS activity and cognitive skills in 6- to 12-month-old full term infants. The current sample consisted of 14 infants ($M = 8.93$ months, $SD = 2.35$ months, Range = 6.13 - 12.97 months). As part of a larger testing session, HR and respiration were recorded using a Biopac MP150WSW system during a 5-minute baseline period as infants sat on their parent's lap. During this period, quiet toys and bubbles, as well as an aquarium movie, were used to keep the infant calm and engaged. At the end of the session, the Mullen Scales of Early Learning (MSEL; Mullen, 1995), a standardized assessment of developmental functioning, was conducted. Using MindWare HRV software, HR data was divided into five 60-second segments, and errors in peak detection were manually edited. Baseline HR was calculated as the average across all segments. A respiration frequency range of .24 to 1.04 was used for RSA (see Bar-Haim et al., 2000), and RSA segments with peak respiration rates inside of this range were averaged to calculate Baseline RSA. MSEL Early Learning Composite (ELC) percentile score, Verbal Developmental Quotient (VDQ), and Non-Verbal Developmental Quotient (NVDQ) were used as measures of cognitive ability. Analyses revealed a significant positive correlation between RSA and ELC, $r(12) = .666$, $p = .009$, with higher RSA associated with better cognitive skill (see Figure 1). When examining RSA alongside verbal and non-verbal abilities, this association held for NVDQ, $r(12) = .662$, $p = .010$, but not VDQ ($p = .420$). Additionally, Baseline HR was negatively associated with NVDQ, $r(12) = -.592$, $p = .026$, with lower resting HR associated with higher non-verbal cognitive ability (see Figure 2), but HR was not related to VDQ ($p = .585$). RSA correlations remained significant after partialling out age, but the association between HR and NVDQ became marginal ($p = .063$). The current analyses suggest that during the second half of the first year of life, baseline cardiac ANS functioning is a marker of concurrent cognitive ability. This was specific to the non-verbal domain, suggesting that ANS in infancy might be more tightly linked to lower-level cognitive skills. Longitudinal work with the current sample will explore predictive associations between cardiac ANS in infancy and later developmental outcome.

P2-G-125: The temporal structure of spontaneous language to infants at home: Regularities in semantic and functional word connections

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Humans categorize the world around them. Notably, the process of categorization is rooted in infancy. Infants learn to distinguish animals from food, from body parts, from vehicles, etc., based on perceptual features and object functions. Language input further solidifies category formation by grounding perceptual and functional similarities among objects with linguistic labels (see Sloutsky & Fisher, 2004; Smith & Colunga, 2012). Yet, little is known about the natural language inputs available to infants, including whether the timing of language inputs may highlight semantic connections among words from the same category (e.g., shoe, sock, pants) and/or functional connections among words from different categories (e.g., shoe, foot). We examined 110 hours of maternal speech to infants in the home environment to examine (1) the time distance between word categories and (2) the time distance between words from functionally related categories (e.g., food nouns and utensils) and between words from unrelated categories (e.g., food nouns and vehicles). We video recorded 91 mothers and their



infants (13 to 23 months of age) for 1 or 2 hours as they went about their day. Maternal language was transcribed in utterances. We focused on 547 concrete nouns and action verbs (e.g., ball and feed) and classified them into fifteen mutually exclusive word categories shown in Table 1 (Tamis-LeMonda, Custode, Kuchirko, Escobar & Lo, 2018). We structured the language input based on the "temporal similarity" between word categories--the median time distance (in minutes) between words from one category and words from another category. We calculated "temporal similarity" between each pair of categories. Finally, we used a hierarchical clustering algorithm to group word categories based on the similarity between them. Mothers produced on average 1,160 (Range 123.71 to 2304.31) utterances and 332 concrete nouns and action verbs per hour. Table 1 shows, for each word category, the total number of word types forming the word category, the mean number of instances produced by moms per hour and the top 5 words. We found interesting patterns in the time distance between word categories. Figure 1 shows the grouping of word categories based on their "temporal similarity" to other word categories. The most distinct clusters include (1) food nouns, kitchen utensils and eating/cooking verbs; and (2) body parts, bath nouns, clothing nouns and washing/dressing verbs. Words within these clusters occur within less than 7 minutes of each other. We are currently examining the temporal similarity of words from functionally related categories and comparing it to the temporal similarity of words from unrelated categories. Preliminary results suggest that the time distance between categories that are functionally-related, such as body parts and bath nouns ($M=3.17$), was shorter than the time distance between unrelated categories such as body parts and utensils ($M=17.15$). The current study is the first investigation of spontaneous language input to infants and the degree to which certain word categories tend to occur close in time. Our findings thus far suggest that the natural language inputs to infants have temporal structure that may support category formation and language learning.

P2-G-126: Family socioeconomic risk and infant nighttime sleep in the second year: The moderating role of attachment security

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Sleep regulation develops rapidly during infancy (Scher et al., 2004) and has been associated with later child adjustment (Pisch et al. 2019). Although socioeconomic risk has been linked with infant sleep problems (Barazzetta, & Ghislandi, 2016), not all infants living in socioeconomically stressed environments have poor sleep, and research identifying protective factors for infant sleep development in adverse socioeconomic circumstances is warranted. Drawing from attachment theory (Bowlby, 1969), the present study examined attachment security as a context for understanding how linkages between family socioeconomic risk and infant sleep regulation are exacerbated or buffered. It was hypothesized that less secure attachment may potentiate the adverse influence of socioeconomic risk on infant sleep, with more secure attachment playing a protective role. Families with infants ($N = 167$, 47% male) were recruited to participate in an NICHD-funded study of parenting, sleep, and infant development. At 1 month, parents reported information on parent race, age, education, and yearly family income. A family socioeconomic risk score was calculated by compositing the standardized scores of educational level and family income, and the standardized reversed scores of maternal and paternal age, such that higher scores indicating higher levels of risk.



At 12, 18 and 24 months, infant nocturnal sleep across 7 consecutive days was assessed using AW-64 actiwatchers (Philips-Respironics, Inc.) yielding actigraphic measures of average sleep fragmentation (sum of percentage of active bouts and inactive bouts less than 1 min), average infant total sleep time (TST) (the elapsed time from fall asleep time to wake time subtracted by infant awake minutes), and variability in TST (the standard deviation of TST across 7 days). At each time point, infant attachment security to mothers was scored by trained observers in the home using the Attachment Q-Set (AQS; Waters et al., 1995). AQS observers were "blind" to other data and trained to high reliability (pairwise absolute agreement intraclass correlation on 145 observations = 0.95). Multilevel modeling was conducted for each sleep variable separately to test whether socioeconomic risk (level-2 variable) and attachment security (level-1 variable) interacted to affect infant sleep at 12, 18 and 24 months. Child age was centered at 12 months. Sleeping arrangements across the first year, maternal depression, race and family size were statistically controlled, as they were correlated with study variables. Results revealed significant interactions between socioeconomic risk and attachment security in predicting infant TST (Table 1). Specifically, higher family socioeconomic risk was only significantly associated with shorter TST for infants with less secure attachment, but not for more secure infants (Figure 1). No significant interaction was found in predicting sleep fragmentation and variability in TST. However, higher socioeconomic risk was significantly associated with greater infant variability in TST after controlling for attachment (Table 1). These findings lent partial support to the hypothesis that less secure attachment potentiates the negative influence of socioeconomic risk on infant sleep development. Results will be discussed in terms of individual and family-level factors that may protect against the deleterious effects of socioeconomic risk on infant sleep development.

P2-G-127: Infants prefer to listen to familiar songs, regardless of singer identity

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Early mother-infant vocal interactions tend to be highly musical - for instance, mothers use different singing styles to soothe or play with their infants, and infant-directed speech shares many features with song. While many studies have documented infant preference for own-mother versus unfamiliar female speech, whether infants prefer their mother's singing voice is unknown. Mothers tend to sing a small handful of songs in a stereotyped way, and infants have lasting memories for familiar songs. In the present study, we investigated infant preference for relatively familiar and unfamiliar songs sung by either their own mother or an unfamiliar mother. Twenty-eight mothers were audio-recorded singing infant-directed renditions of up to 10 well-known children's songs from a pre-selected list, and indicated how frequently they sang each song to their child. The four most and four least frequent songs were matched with another mother's rendition of those songs. On a second visit, infants (8-10 months old) were exposed to these familiar and unfamiliar songs sung by either their own mother or another mother (stranger) in a head-turn preference procedure while their skin conductance was measured. Trials ended after 30 seconds or if the infant looked away for 2 consecutive seconds. Infants listened longer to familiar songs, regardless of singer identity ($p = .01$). Preliminary results from a subset of infants indicate that smiling occurred more frequently during own-mother singing than stranger singing, regardless of song familiarity ($p = .045$). Additional analyses will



investigate whether physiological arousal differentiates singer identity. Current results suggest that infants' attention to songs is mainly driven by familiarity rather than singer identity, but that singer identity influences their affect. Results raise questions about the function of mother's song versus mother's speech, and suggests distinct roles for song vs. singer familiarity in infants' musical experiences.

H-Social Development

P2-H-128: Cultural invariance in infant responses to world music

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Music is a human universal (Mehr, 2019) which, like nonhuman vocalizations (Filippi, 2017; Morton, 1977), is characterized by acoustical forms that are predictive of its behavioral functions (Mehr, 2018). Adult listeners use this fact to accurately distinguish between unfamiliar lullabies and love songs, dance songs, healing songs, and so on (Mehr, 2018). This could be attributable to their extensive musical experience, however, as opposed to the basic design of the human mind. Here we show that infants (N = 144) relax in response to foreign lullabies, relative to other foreign songs, as measured by heart rate and electrodermal activity. They do so consistently throughout the first year of life, suggesting the relaxation response is not merely a function of infants' musical experiences (Mehr, 2016; Mehr, 2017b). Parents also choose foreign lullabies over non-lullabies as the songs that they would use to calm their fussy infant. These findings raise the possibility that the link between form and function in infant-directed song is innately specified, in contrast to other features of music perception that are determined by culture, musical experience, or both (Jacoby, 2019; McDermott, 2016).

P2-H-129: What you really want: Toddlers weigh common ground and goal information when helping

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Early in life, infants and children are motivated to help others (Warneken & Tomasello, 2006). However, deciding how to help effectively often requires a consideration of multiple factors. For instance, we might use information about the recipient's knowledge to determine what they might want, and we might also use what we know about the recipient's usual goals or preferences. Sometimes we may face conflicting information about how best to help, requiring us to prioritize relevant information to determine the most useful or satisfying action. If your friend asks, "Could you hand me that key so I can unlock my car?", but the only key you can both see is the key to your own car, you would likely prioritize that person's goal and get them their own key. By age 3, children prioritize information about ultimate goals over immediate requests (Martin & Olson, 2013). We know less about whether, and how, younger toddlers



weigh conflicting socio-pragmatic cues when deciding how to help. We investigated how toddlers help when information about common ground and recipient goals conflict. In Study 1, 40 2-year-olds were shown an opaque container of blocks (hidden blocks) and a transparent container of blocks (visible blocks). Participants were shown that they could make music by putting blocks inside a colourful tube. For half of the participants (common ground condition), all blocks worked, but for the other half (conflict condition), only the hidden blocks worked. Then, a naïve confederate entered the room and said, 'I see a block! Can you give me the block so I can play a song please?'. We found that block selections differed between conditions ($p < .001$). Participants in the common ground condition chose the blocks which were in common ground with the confederate ($n=19$) more often than the hidden blocks ($p < .001$). However, toddlers in the conflict condition prioritised the confederate's goal and gave the functional but hidden block ($n=15$) more often than the visible but non-functional block ($p < .05$). In Study 2, we asked whether toddlers prioritised the functional blocks because they are motivated to help fulfil the confederate's goal, or because they simply prefer the music-making blocks themselves. Twenty 2-year-olds were shown that only hidden blocks could play music, but the confederate entered the room with the goal of building a block tower, for which both blocks should work. Toddlers selected the visible blocks ($n=11$) and the hidden blocks equally ($p = .82$), indicating that they did not prioritise playing music with the hidden blocks when it was unrelated to the confederate's goal; yet toddlers also did not prioritise common ground. By age 2, toddlers can weigh different sources of information when deciding how to help, and prioritize relevant information about the recipient's ultimate goal over information about the likely referent of her request (based on common ground). In ongoing research, we are further examining how toddlers use common ground to guide their helping, and how they might alter their prioritisation of socio-pragmatic cues in situations with multiple possible goals.

P2-H-130: Infant facial recognition: Variability, stability, and relationship with parents' facial recognition

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Most studies suggest that during infancy, experience and development influence facial recognition (e.g., Crookes & McKone, 2009; Pascalis et al., 2017), but in adults, the ability to recognise faces changes little with experience (White et al., 2014) or training (Towler et al., 2019), and the skill varies widely (Noyes et al., 2018). There is also a genetic influence and indications that it is a unique skill that differs to object recognition (Shakeshaft & Plomin, 2015). The aim here was to see whether there is also wide variability and stability early in life and whether parental facial recognition is related to their infants'. Using faces from the Glasgow Face Matching Test (GFMT, Burton et al., 2010), facial recognition was measured in infants and their parents. A mixed design was used with infants tested at 7 and 11 months ($n=34$). The 11-month-old infants also joined a cross-sectional sample of the same age (total $n=60$). A familiarisation/novelty preference method was used to test the infants. Unlike previous studies, infants were presented with a larger number of faces to get a broader representation of infants' capacity to recognise faces (16 sets split over two sessions at each age; 32 sets at 7 and 11 months). After familiarising infants to an identity using cumulative looking (8 seconds), infants



saw a new photograph of the same identity paired with a novel identity. Novelty preferences to the new identities were measured. Eye tracking was used to determine if there was also stability in infants' use of facial features to recognise faces across age. Infants' recognition of abstract shapes was also tested to determine whether facial recognition differs to general object recognition, and infants' development was measured to attempt to account for developmental changes. Infants were better at shape than facial recognition, and there was wide variability in infants' facial recognition, but little change between 7 and 11 months. There was substantial focus on eyes, but the more infants focussed on the mouth of the novel identity and less on the familiar identity the better their performance. This pattern also differed little with age. Mothers' performance did not predict 11-month-old infants' facial recognition, but fathers' did, albeit with a familiarity preference rather than a novelty preference. The findings suggest that like adults, infants' ability to recognise faces varies widely and it might not change dramatically between 7 and 11 months of age. The eye tracking data indicated that moving beyond a focus on eyes to also scanning the mouths predicted infants' facial recognition, and this pattern was relatively stable across age. The results also suggest that there might be a paternal genetic influence. A larger sample is needed to further test this and to examine whether these findings occur during other stages of infancy, and other aspects of facial recognition such as gender, race, and emotion. Despite previous findings that experience is important to infants' facial recognition, there appears to be relative stability and possibly a genetic influence.

P2-H-131: Exploring the interrelatedness of adverse childhood experiences in infancy using a latent class approach

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Children living in poverty face a range of parenting and environmental risks (Adverse Childhood Experiences; ACEs) that, in the absence of a nurturing caregiver, can result in toxic stress. Often times, many risks co-occur. This study examines ACEs infants in conjunction with additional measures of parenting. Participants for the current study were from the U.S. Early Head Start Research and Evaluation Project (EHSRE), who has data at the 14-month assessment (N = 2,361). The sample was racially/ethnically diverse with 34.5% African-American, 22.9% Hispanic, 37.9% White, and 4.7% other. At enrollment into the EHSRE, primary caregivers were 22.7 years of age (SD = 6) and about half (45.7%) had not completed high school. Latent class analysis (LCA) was used to identify the number of groups with distinct patterns of ACE indicators variables and interpret the meaning of groups. A BCH (Bolck, Croon & Hagenars, 2004) approach was used to test how group membership was associated with additional parenting variables. The LCA resulted in a 3-class solution: ACEs-Low (N=1,431, 60.6%), ACEs-Parenting (N=636, 26.9%), and ACEs-Family (N=294, 12.5%). The ACE-Low group shows relatively low levels of ACE exposure with some elevation on Physical Neglect and Parent Separation. The ACE-Parenting group has the highest levels of exposure to Emotional Abuse, Physical Abuse, and Physical Neglect. The ACE-Family group has the highest levels of exposure for Physical Separation, Domestic Violence, Substance Abuse, Parent Mental Illness, and Jailed Family (see Figure 1). ACEs class membership was significantly associated with each of the parenting variables examined (see Table 1). Analysis of Parenting Stress resulted in significant differences in Parental Distress ($\chi^2(2) = 100.39, p <$

.001) and Parent-Child Dysfunctional Interaction ($\chi^2(2) = 56.20, p < .001$). For both measures, the ACEs-Family group had the highest levels of parenting stress, the ACEs-Parenting group had the next highest, and the ACEs-Low group had the lowest level of distress and dysfunction. For the Knowledge of Infant Development Index ($\chi^2(2) = 16.35, p < .001$), the ACEs-Parenting group scored significantly lower than the ACEs-Low group while the ACEs-Family group was not significantly different from either of the other groups. For the Pearlin Mastery Scale ($\chi^2(2) = 144.31, p < .001$), the ACEs-Low group scored the highest, the ACEs-Parenting group scored the next highest, and the ACEs-Family group scored the lowest. For observed Parent Supportiveness ($\chi^2(2) = 141.64, p < .001$) in semi-structured play, the ACEs-Low group was most supportive, the ACEs-Family group was moderately supportive, and those in the ACEs-Parenting group were rated least supportive. Our study identified important distinctions between the at-risk ACEs groups and parenting resources. They also highlight the need to consider the interrelatedness of ACEs to individualize services and interventions that support parenting and child development. Results lend credibility to ACEs screening in infancy and could be used to inform intervention efforts and the development of more efficient, sensitive screening methods.

P2-H-132: Maternal childhood maltreatment predicts pervasive disruptions in mother's interactions with their infants at four months

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Introduction: Maternal childhood maltreatment (MCM) has intergenerational effects on a range of child outcomes (Plant et al., 2018). However, a recent meta-analysis of the effect of MCM on early parenting found only a weak relation (Savage et al., 2019). Notably, this effect was moderated by type of parenting assessment, with measures of positive parenting less strongly related to MCM ($r = -.10$) than measures of negative parenting ($r = .15$). In addition, negative parenting was overwhelmingly assessed by measures of hostile/intrusive behavior. Studies of maternal predictors of infant disorganized attachment have identified additional dimensions of maternal behavior that are associated with infant disorganization (Madigan et al., 2007), as well as with other maladaptive child and adult outcomes (e.g., Bureau et al., 2009; Lyons-Ruth et al., 2013). Thus, it is important to evaluate whether mothers with MCM show these additional forms of disrupted parenting. Finally, more than two-thirds of the studies included in the meta-analysis did not assess specific forms of MCM in relation to parenting. To address these gaps in the literature, the current study used a well-validated coding system to assess five aspects of maternal disrupted interaction in relation to presence, severity, and type of MCM. Method: 147 mothers (48.6% with MCM) and their 4-month-old infants participated in the study. MCM was assessed by the Adverse Childhood Experiences (ACE) questionnaire, which assesses six types of maltreatment (physical, sexual, emotional abuse; emotional, physical neglect; witnessing violence). Mothers' interactions with their infants were videotaped during the Still-Face Paradigm (SFP; Tronick et al., 1978) and coded with the Atypical Maternal Behavior Instrument for Assessment and Classification (AMBIANCE; Bronfman, Parsons, & Lyons-Ruth, 1999). The AMBIANCE codes five dimensions of disrupted interaction: Affective Errors; Role Confusion; Disorientation; Negative-Intrusion; and Withdrawal. Relevant sociodemographic variables (income, race, ethnicity) were included as covariates. Results: Using multivariate



ANOVA, and controlling for relevant covariates, the presence of MCM was related to four of the five aspects of disrupted interaction, indicating a pervasive effect of childhood maltreatment on the mother-infant relationship (Table 1). In follow-up analyses, mothers exposed to more types of maltreatment showed elevated levels of disorientation and role confusion (β 's = .30 .18 , p 's < .05), while specificity of effects were found for two aspects of MCM. With all other types of maltreatment controlled, physical abuse was uniquely related to negative-intrusion (β = .25, p = .03), whereas physical neglect was uniquely related to role confusion (β = .32, p = .001). Discussion: The effects of MCM on maternal behavior are evident as early as four months of age and are pervasive, predicting increased negative intrusive behavior, affective errors, withdrawal, and disorientation in interaction with the infant. Specific effects of both physical abuse on negative-intrusive behaviors and physical neglect on role confusion also emerged. Thus, using more fine-grained inventories of maternal disrupted behavior may offer a more sensitive assessment of how different types and severity of MCM affect the emerging relationship with the infant and how the effects of MCM are carried forward intergenerationally through the relationship over time.

P2-H-133: Characteristics of infants' eye movements when viewing interactions and implications for social understanding

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From the first few hours of life, infants are interested in social information and throughout the first year of life infants develop the first skills to operate in our social world. A crucial part of social development is the comprehension of social interactions including the understanding that a conversation takes place between two or more people, as opposed to between objects. Several studies demonstrate that in the first few months of life, infants already respond differently to people compared to objects (e.g. Legerstee, 1992). Furthermore, research shows that infants aged 6 months start to become sensitive to the distinct qualities of animate and inanimate agents (Johnson, 2000), which is related to their social understanding (Molina et al., 2004). Biro et al. (2014) suggest that infants aged 12 months understand vocal emotional cues in interactions between animated shapes and Fawcett & Liszkowski (2012) conclude that infants at this age can make predictions about social preferences in an animated shape task. In addition to studies that presented infants with animated shapes, a 2010 study by Augusti et al. reveals that infants can detect the difference between a face-to-face and a back-to-back conversation between real people. Building on this previous research, we were interested in investigating what characterises infants' viewing patterns when viewing social interactions, and to what extent their eye-movement patterns provide information about their understanding of these social interactions. To this end, we compared infants' eye movements when they were viewing cartoons depicting human-like characters in conversation and during cartoons in which the human characters had been replaced by objects whilst the conversation audio remained intact. We collected eye-tracking data from 246 infants consisting of 6-month-olds ($N = 80$), 9-month-olds ($N = 81$) and 12-month-olds ($N = 85$) recorded with an Eyelink 1000+ at a sampling rate of 500 Hz. We created two sets of cartoons (see Figure 1); each cartoon had three different versions, resulting in six different videos. Version 1 depicted a social interaction between two human-like characters. Version 2 showed the same interaction, but without mouth movements. Version 3 presented the interaction with the human-like characters



replaced by objects that moved as if they were engaged in a conversation, but the audio remained the same. Infants only saw one version of each cartoon, and presentation was counterbalanced. Preliminary analysis of the results revealed that during a conversation between human-like characters, all age groups present a deliberate pattern of eye movements with two distinct clusters of fixations on the two faces of the characters and frequent eye movements between the two faces. Conversely, when infants watch two objects with the audio of the human conversation their eye movements do not follow a specific pattern and infants show less engagement (See Figure 2). Additionally, older infants show anticipation of turn taking when mouth movements are included in the conversation between human-like characters. We discuss the implications of these results for the understanding of social interactions in the first year of life.

P2-H-134: Evaluating the impact of regular creative sessions for families with 0-4-year-olds from disadvantaged areas in the UK

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Research has shown that growing up in disadvantaged areas has a negative impact on children's cognitive and behavioural development (McCulloh, 2006). In order to prevent long-term adverse consequences, it is essential to address this issue early. Arts activities have been shown to help alleviate the negative influence of disadvantaged children's home environments, enhance children's emotional well-being (Creedon, 2011) and to reduce stress (Brown, Garnett, Anderson, & Laurenceau, 2017). Yet, arts for preschool children is often overlooked, because of an increased emphasis on school readiness and skills for higher school marks. The present project offered weekly professionally led music and arts activities for children from zero up to four years from disadvantaged areas in England. The aim of the project was to increase children's confidence, reduce stress, and to nurture the relationship with their parents and other children. Eight artists conducted weekly sessions in four libraries in disadvantaged areas. In total, 92 creative sessions took place over a time-span of six months. The sessions were visited by 30 preschool children, who were brought to the libraries by their parents. Throughout the project, three measures were collected from all the participants involved: the children, the parents, the artists, and the library staff. To assess the impact of the sessions, semi-structured interviews with parents (N = 10), library staff (N = 4), and artists (N = 6) were conducted. Each week, feedback was obtained from the library staff and the artists. Finally, for the evaluation of the experience and development of children during this project, the authors developed a questionnaire for parents. The questionnaire inquired parents about the day-to-day activities with their children, children's behaviour during the session, parents' responses to children's behaviour, and parents' feedback on the creative sessions. The questionnaire was administered at three different time-points: at the beginning, the middle and at the end of the project. Preliminary analysis suggests that the artistic sessions had an impact on all participants involved. Both parents and staff reported about being more comfortable and confident engaging in artistic activities with children. The sessions allowed parents to form connections with other parents from the area, and their children were more confident engaging with other children and adults. Moreover, the project inspired parents to engage in creative activity with their children at home, using affordable and accessible materials. The creative and artistic aspects also encouraged parents to be fully involved in the activity with their



children, fostering important parent-child connections. Furthermore, the artists reported about increased skills for their creative practice with infants and they developed essential skills for participatory art as opposed to just performing art. Finally, the library staff recognised the benefits of arts and creativity for young children and their parents, as well as for their own practice with young children. We will discuss the long-term implications of our results for families in disadvantaged areas in the UK and argue for a stronger emphasis on arts education in the preschool curriculum.

P2-H-135: Heart rate increase mediates contextual modulation of gaze following

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It has been demonstrated that infant gaze following is modulated by an adult's ostensive signals (Csibra & Gergely, 2009; Senju & Csibra, 2008). A recent study showed that the modulation of gaze following behaviour by a preceding eye contact, a form of ostensive signal, is mediated by an elevated heart rate induced by an ostensive signal (Ishikawa & Itakura, 2019). In this study, we aimed to extend our previous finding to another contextual factor which could mediate efficient social learning, the reliability of an informant (Poulin-Dubois, Brooker, & Polonia, 2011; Chow, Poulin-Dubois, & Lewis, 2008). It was hypothesized that contextual information, ostensive signal and reliability of an adult model, would (1) facilitate gaze following, and (2) whether the facilitation is mediated by the elevated heart rate during gaze following events. Forty-one 6- to 9-month-old infants participated in this study. In the training phase (Fig1a), infants observed either a reliable model, which always gazed toward the location of a peripheral object, or an unreliable model, which always gazed away from the location of a peripheral object. Then, the infants watched a video of the same model making eye contact or not showing any ostensive cues, before shifting her gaze toward one of two objects in the scene (Fig1b). During the task, a Tobii Spectrum Eye Tracker (Tobii pro Lab 1.118, Tobii Technology, Stockholm, Sweden) was used to present the stimuli to the infants and to record eye movements at a 120 Hz sampling rate. Also, a BIOPAC MP160 (Biopac System, CA, USA) and a BioNomadix (BIOPAC Systems, CA, USA) were used for the heart rate recording. The results showed that reliability and ostensive signal independently enhanced the frequency of gaze following, and led to an elevation in heart rate. Increases in heart rate, in turn, predicted gaze following regardless of reliability or eye contact. To examine whether increase of heart rate mediates between contextual information (ostensive cues, reliability) and gaze following (Fig2), we then conducted generalized linear modelling (GLM) mediation analysis. The result showed that heart rate increases mediated between communicative cue condition or reliability and gaze following. The results suggest that the contextual modulation such as ostensive signal or reliability elevated infant heart rate, which then facilitated gaze following. It is consistent with the claim that contextual information such as eye contact and other's reliability could affect infant reward expectation in gaze following situations, which infants might learn through early social experience (Moore, Angelopoulos & Bennett, 1997; Triesch, Teuscher, Deák & Carlson, 2006). It is mainly because recent studies have reported that physiological arousal is increased during reward expectation both in adults (Watanabe, Bhanji, Ohira, &



Delgado, 2018) and infants (Tummeltshammer, Feldman, & Amso, 2019). Further studies will be required to ascertain the mechanism underlying increase of heart rates before gaze following reflect, to better understand how contextual information affected infant physiological arousal and modulated gaze following.

P2-H-136: A multi-lab study of gaze-following development in monolingual and bilingual infants

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The ability to follow another's eye gaze is an important skill for social interaction and learning. For example, in word learning, gaze-following allows infants to map a word onto the object a speaker is referring to (e.g., Paulus & Fikkert, 2014). Several studies have shown that by 6 months, infants follow a speaker's eye gaze at above-chance levels, but their performance is not always reliable (Gredebäck, 2018; Senju & Csibra, 2008; Szufnarowska et al., 2014). Different approaches to measuring eye gaze may vary in sensitivity: Senju and Csibra (2008) found above-chance gaze-following when measuring infants' first look and frequency of looks to the gazed-at object, but not when measuring the total duration of infants' looks. The current study investigated how a variety of metrics might inform our understanding of the development of early gaze-following. Moreover, we tested two potential developmental contributors to infants' gaze-following abilities. First, we investigated age-related changes and expected older infants to show more reliable gaze-following than younger infants. Second, we investigated whether language experience could affect the development of gaze-following. Research with preschoolers suggests that bilinguals show more use of eye gaze cues in word learning than monolinguals, presumably because bilingual environments engender more referential complexity (e.g., Brodje et al., 2012; Yow et al., 2017). We thus hypothesized that bilingual infants might show a gaze-following advantage relative to monolinguals. To collect the large-scale data needed to address these questions, we used a multi-lab collaborative approach. 322 infants (131 bilinguals and 191 monolinguals) from 11 labs in 8 countries were tested using automatic eye-tracking or offline manual coding. Monolingual and bilingual infants of 6-9 and 12-15 months were compared on their latency and accuracy of gaze patterns using the eye gaze stimuli from Experiment 1 in Senju and Csibra (2008). On six test trials, infants saw videos of a female actor looking towards the camera and then directing her head and eyes towards one of the two objects located on her left and right. We conducted mixed-effects regressions and meta-analytic models to assess effects of age and bilingualism on (1) proportion of first look towards the congruent (i.e., gazed-at) object over the incongruent object, (2) frequency of looks to the congruent and incongruent objects, and (3) duration of fixations. We also investigated whether (4) latency of first look to the congruent object might change across development. Overall, first look and frequency of congruent looks appeared to be more sensitive measures than duration of fixations or latency. First look and frequency of looks revealed that infants of both ages successfully followed the actor's gaze, and this ability improved with age (Figures 1 and 2). However, contrary to predictions, monolingual and



bilingual infants performed nearly identically. Together these findings revealed that, independent of monolingual or bilingual status, early gaze-following development is significantly modulated by age-related changes. Our results also brought new insights to gaze-following research by highlighting that two measures--location of first look and frequency of looks--were more robust in evaluating early gaze-following patterns.

P2-H-137: Neural differential processing of gaze cueing from a congruent and incongruent informant

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Infants are known to be sensitive to, and be capable of processing social information from birth. However, less is known about abilities related to actively choosing the information source on which to rely, over passively processing all available information. A recent study showed that 8-month-olds' gaze following behaviour was influenced by the reliability of the informant (Tummeltshammer et al., 2014), suggesting that infants as young as 8 months of age might recognize whether the person in front of them is trustworthy. To better understand this discriminative ability of infants, the current study utilizes event-related potentials (ERPs), to investigate whether infants' neural activity indicates the differentiation of a congruent informant (who always gives the correct gaze cue to the object location) from an incongruent informant (who only gives the correct gaze cue on 25% of trials). 9-month-old infants (N = 22) were presented with 32 static images in total which showed two female experimenters (16 images for each), one of whom looked at the object appearing on one of the corners 100% of the time (i.e. congruent informant) and the other only looked at the object 25 % of the time and looked away from the object 75% of the time (i.e. incongruent informant). A paired-sample t-test comparing between congruent and incongruent informants showed that the amplitude of the negative deflection occurring at approximately 275ms post-stimuli over frontocentral regions was enhanced while infants were processing information given by a congruent informant (M= -15.05[μ V], SD= 4.56), compared to when the information was given by an incongruent informant (M= -12.35[μ V], SD= 3.79) (t = -2.49, p = .002). Previous studies have shown that a negative amplitude component occurring at around 400ms post-stimuli in 9-month-old infants (the negative component, or the Nc), has been associated with infants' attentional allocation (e.g. Striano et al., 2006; Parise et al., 2008). While the negative peak observed in the present study is at an earlier latency than the Nc, this indicates a difference in neural processing of congruent and incongruent informants in 9-month-old infants. Furthermore, an enhanced positive slow wave (PSW) over frontotemporal regions was observed for an incongruent informant (M= 9.27[μ V], SD= 5.32) compared to a congruent informant (M= 6.12[μ V], SD= 5.63) (t = -2.309, p =.003). As the PSW has been thought to reflect memory updating (Snyder, Webb & Nelson, 2002; Reid et al. 2004), this might reflect how infants alter their perception about the congruency of gaze cues during the short exposure to the information (16 per condition). In sum, the result demonstrates how quickly young infants can recognize the congruency of other people's gaze cues. This study extends our understanding forward on how infants collect and process social information, as the current study offers evidence that infants as young as 9 months of age selectively process sources of information differentially in



the social domain, which might enable them to learn efficiently at a social situation despite ample and complex information present.

P2-H-138: Self- and co-regulation in caregiver-child interactions: Reliability and validity of a new coding schema (SCORE)

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How primary caregivers interact with young children plays a key role for early self-regulation development. But schemes for video-microanalyses that focus on self- and co-regulation of both partners are still missing. The SCORE coding scheme has been developed to fill this gap. It differentiates between (a) the verbal- and the nonverbal level, as well as between (b) cognitive, motivational and emotional states. We report results of a pilot-study with $N = 32$ healthy children and their primary caregivers (Group 1: $N = 16$ 2-year-olds, Group 2: $N = 16$ 4-year-olds, mostly higher SES). All dyads were invited to play a puzzle game for 10 minutes, and videos were later coded with the SCORE-scheme which proved to be reliable (split-half reliability: $r = .80$; inter-coder reliability $r = .79$). To explore children's behavior, we conducted a 2 (Group1, Group2) \times 2 (verbal, nonverbal self-regulation) MANOVA, revealing a significant effect for Group, $F(2,29) = 12.501$, $p < .001$, Wilk's $\Lambda = .537$, $\eta^2 = .46$, mainly resulting from group-differences in verbal self-regulation. This is consistent with the view that toddlers make important progress in self-regulation between two and four years of age, especially at the verbal level. In both groups, children showed far more non-verbal than verbal self-regulation, however (non-verbal: Group1 - 87%; Group2 - 76%), thus confirming findings that verbal self-regulation is still comparably rare among toddlers. Caregivers provided more verbal- than non-verbal co-regulation in both groups (verbal: 60%), indicating that verbal communication plays a key role when supporting toddlers in solving cognitive tasks. A 2 (Group1, Group2) \times 2 (verbal-, non-verbal co-regulation) MANOVA revealed a substantial effect for Group, $F(2, 29) = 27.672$, $p < .001$; Wilk's $\Lambda = .344$, $\eta^2 = .66$. This effect was somewhat stronger for the verbal level, but also significant for the non-verbal level of co-regulation. Caregivers of older children showed comparably less co-regulative behaviors. Caregivers who showed frequent verbal co-regulation also showed more non-verbal co-regulation ($r = .65$, $p > .001$), suggesting that the behavioral codes of SCORE reflect a general response tendency of caregivers. The more co-regulation a given caregiver provided, the less self-regulation the child showed. This was true of the nonverbal ($r = -.52$, $p > .01$) and of the verbal level ($r = -.55$, $p > .01$), indicating that caregiver and child behavior are systematically related in individual dyads. Due to the nature of the given task, most co-regulative behavior referred to cognitive states in both age groups. When differentiating between the verbal- and the non-verbal level, results were different, however: Non-verbal co-regulation mainly addressed cognitive states, but verbal interventions targeted cognitive and motivational states equally often. Caregivers often helped toddlers to accomplish the given puzzle task without communicating verbally but used words as often as non-verbal activities to support the child in regulating his/her motivational states. Overall, these findings fit well with the current developmental literature. We thus conclude that SCORE offers a promising new tool to analyse caregiver-child interactions. Implications and potential future directions for research will be discussed.



P2-H-139: Experimental manipulation of parent pointing and responsiveness in parent-infant interactions

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Past experimental research has focused on the cognitive processes underlying infants' referential communication by pointing around 12 months of age, but there is less experimental evidence on the social dynamics within which infants use and acquire the pointing gesture. Imitation views suggest that infants imitate parents' pointing gestures. Increases in parent pointing should thus increase infant pointing. Consistent with this idea are findings of positive correlations between infant and parent pointing (Liskowski & Tomasello, 2011). Other views suggest that parents' following into infants' focus of attention enhances infants' referential interactions (Tomasello & Farrar, 1983). Increases in parents' following into infant attention should thus increase infant pointing. Consistent with this idea are findings of positive correlations between parents' referential responding to infant pointing and a longitudinal increase of infant pointing (Ger et al., 2018). The current study employed an experimental method to go beyond correlational findings. In a 2x2 design, we manipulated parent pointing and parents' referential responses to infant pointing. We used a previously established method that reliably elicits spontaneous pointing in parents and infants. Parents walked with their infants on hips for 5 minutes through a room decorated with various standard items (the decorated room paradigm; Liskowski et al., 2012). N= 68 parent-infant dyads at 12 months of age were randomly assigned to one of four conditions. In one pointing condition (P+F0), parents were told that pointing for their infants is beneficial and they were asked to point as much as possible for their infants. In a second pointing group (P+F+), parents were in addition told that it was beneficial to follow into infants' focus of attention by pointing, and they were asked whenever their infant pointed to point to the same thing. In a no-pointing condition (P-F0), parents were told that we were interested in what would naturally capture infants' interest in the decorated room. Parents were asked not to point for their infants to anything. In a second no-pointing condition (P-F+), parents were told that it was important that infants point out of their own, and that it was important to then follow into infants' interests. Parents were asked not to point but always to respond to what the infant pointed. A 2x2 Anova on the number of infants' index-finger points revealed no main effect for pointing; a significant main effect for following into infants' pointing ($F(1,64)=5,17; p=.026$); and no interaction, see Figure 1. Follow-up analyses with independent t-tests confirmed that parents followed the instructions. Parents pointed significantly more in both P+ conditions compared to both P- conditions; parents responded by pointing to the same referent significantly more often in the P+F+ than the P+F0 condition; and parents responded without pointing significantly more often to the same referent in the P-F+ than P-F0 condition. Findings reveal that parent referential responsiveness, but not pointing per se, is causal in increasing infant pointing. Findings are relevant to interpreting existing findings and design intervention studies. We will be able to report on the latter along with the current findings.

P2-H-140: Infants interpret tolerated taking as a cue of communal sharing relations

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Recent evidence suggests that infants represent interactions based on voluntary giving and tolerated taking as instantiations of different relational models: equality matching (EM) and communal sharing (CS), respectively based on the principle of even balance and social equivalence. Supporting this proposal, in a previous study we found that 12-month-olds, despite registering the identity of the participants of giving and taking interactions alike, encoded the direction of resource transfer, an information crucial to the tracking of welfare imbalances, only in the representation of giving (Tatone & Csibra, 2014). Here we build on this previous work to examine whether the observation of giving and taking influences the assumptions that guide infants' representation of social structures. Specifically, we tested whether 12-month-olds represented an open triadic structure (two agents related to a common patient) as a pure clique (three agents related to each other). Infants (N = 16 per study) were first familiarized to two agents, each giving (Study 1) or taking (Study 2) a resource to/from a common patient, and later shown one of the previous agents giving to/taking from the common patient (old interaction) or the other agent (new interaction). Based on adults' tendency to posit unobserved ties in network recall tasks selectively for CS-like structures (kin relations: Brashears, 2013), we predicted that if infants selectively interpret taking (but not giving) as a cue to CS relations, they should find the new interaction as compatible with the represented structure as the old one. As predicted, infants looked significantly longer to the new interaction compared to the old one in the giving case ($M_{\text{new}} = 19.41$, $SD_{\text{new}} = 4.39$; $M_{\text{old}} = 11.04$, $SD_{\text{old}} = 2.76$; $p = .017$, $\log(10)BF = 2.834$), but not in the taking case ($M_{\text{new}} = 18.43$, $SD_{\text{new}} = 4.85$; $M_{\text{old}} = 17.56$, $SD_{\text{old}} = 4.60$; $p = .879$, $\log(10)BF = -0.620$). The evidence that infants successfully detect a new interaction when presented with two partly overlapping interactions based on giving and taking (Tatone & Csibra, 2014) suggests that the lack of reaction to the new interaction in Study 2 was not due to a failure to encode the identity of the previous interactants. Rather, it was likely due to the structural assumptions that the infants drew from the particular relational model (CS) cued by the taking action. Taken together, these findings suggest that one-year-olds represent different sharing behaviors as indicative of distinct relational models, as evinced by the type of information encoded from single interactions (e.g., direction of transfer) and the types of structural assumptions that their combination supports (e.g., transitivity, triadic closure).

P2-H-141: Infant social networks and children's rapidly changing social worlds

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The term social network brings several different concepts to mind and is saturated in modern day society. The past several decades have seen an explosion of social network research studying diverse populations from adults, adolescents, primates, and other mammal networks. Social network research has grown so rapidly because networks are an excellent tool for studying social phenomena (Borgatti & Ofem, 2011). Psychologists have made small steps to understand how a person's individual social network impacts cognition and behavior. Research with both adults and primates show that social network size is related to brain structure and brain function; adults and primates with larger social networks have larger brain areas that deal with social cognitive capacities (Sallet et al., 2011; Bickart et al., 2011). Further, research with adults show that adults with larger social networks are better at perspective taking (Stiller



& Dunbar, 2007). Limited work has studied infants' social networks; one study showed that infant network size was related to more social speech and fewer incomplete utterances (Salzinger & Hampson, 1988). Given that social networks are such a rich tool for studying social experience, it is shocking so few studies have explored infant social networks - either the composition of these networks or how aspects of networks relate to social cognition. The present study is exploring the social networks of 9- to 14-month-old infants to better understand infants' early social experience and how it changes over time. This study is part of ongoing work in our group that contributes to a larger dataset of young children's social networks (9-months to 4-year-olds). The social network data was collected using a measure developed by our group, the Social Network Survey. Through parent interview, parents describe their child's "typical week" of activities to generate a list of people the child sees on a regular basis. Then, parents provide basic demographic information for each person. For each child, we can calculate the number of people the child sees on a regular basis and other characteristics of the child's social networks, such as network racial diversity and network linguistic diversity. Data collection for 9- to 14-month-old infants is ongoing ($n = 11$; Mage = 11.4 months), but initial, descriptive results provide compelling information about infants' early social experience. Consistent with our prior results, younger infants have descriptively smaller networks than older children (Figure 1; $r = 0.66$, $p < 0.001$). This result provides further evidence that children's social worlds are initially very small, but they grow rapidly in the first few years of life. We also looked at racial diversity of young infants' networks. The present study shows a similar trend to prior work; the distribution of racial diversity of children's social network is skewed around 0 (Figure 2); however, in prior work only 23% of children have no network racial diversity. In the present sample, 54% of infants have no racial diversity. This project will contribute to our understanding of children's rapidly changing social worlds. Future work will explore how aspects of networks relate to social cognition

P2-H-142: Interpersonal causality during the observation of interactions at 10 months of age

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From very early in life, infants acquire social and instrumental skills by observing people engaged in motor and interactive tasks. The understanding of cause-effect relationships that give origins to interactive scripts (e.g., give-and-take interactions) is essential for successfully navigating the social world. The literature on the perception of causality has shown that 10-month-olds are able to encode the systematic association between actions performed on an object and auditory outcomes (Perone et al., 2011; Perone & Oakes, 2006). No study addressed whether causality encoding is also present in interactive social situations, an issue that we addressed here. Twenty-one 10-month-old infants observed 2 s videos of interactive exchanges, and we investigated whether they were able to link specific human gestures directed toward another person to a specific outcome in the receiver. We used a double-habituation paradigm in which infants were first habituated to one specific association between a neutral action and a vocal reaction of a second person (e.g., touching the nose of the partner with the finger + "eehh" reaction), and then at a second one (e.g., touching the cheek of the partner with the palm + "aahh" reaction). In the test phase, infants watched three events: one of the two habituated videos (familiar), a video with a reversed action-reaction association



(violation), and a novel video, the latter two in counter-balanced order between infants. Results showed a main effect of condition ($F(2,3) = 20.44, p < .001$), indicating that infants looked longer to both the novel ($p_{corr} < .001$) and the violation ($p_{corr} = .041$) than the familiar test trial. These results were independent of which video infants watched in the familiar test trial (i.e., the first vs. second video shown in the habituation phase), and they show that 10-month-old infants can link specific social gestures to specific reactions in the receiver during the observation of others' interactions. This suggests that the coding of causal relationships plays a significant role not only in the understanding of object functioning (Perone & Oakes, 2006; Hauf et al., 2004) but also in interactive contexts.

P2-H-143: Developmental changes in auditory social perception between 5 and 24 months in a Gambian cohort

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Early adversity affects infants who grow in low- and middle- income countries (LMICs)(McCoy et al.,2016). The first two years of life are fundamental for the development of cognitive and social skills, and neuroimaging studies investigating brain development in LMICs can help defining early markers of atypical development(Perdue et al., 2019). Previous research has shown that the infant brain responds to social cues from between 4 and 8 months, and that early adversity might have an impact on development of the brain regions underpinning responses to social stimuli(Nelson et al.,2013). The Brain Imaging for Global Health (BRIGHT) project is delivering longitudinal measures of brain and cognitive development from birth to 24 months in Gambian and UK infant. In this study, we used functional near-infrared spectroscopy to define developmental changes in social perception over the first two years of life in the Gambia. 108 5-month-olds, 93 12-month-olds, and 91 24-month-olds were presented with social and non-social videos and sounds in a block design task extensively used and validated in previous infant studies(Lloyd-Fox et al.,2009,2013). Changes in oxygenated and deoxygenated blood were recorded from the temporal and inferior frontal(IFG) brain regions. We pruned channels with insufficient correlation between wavelengths and without a clear heart-rate peak(Pollonini, et al.,2016) and we corrected motion artefacts using spline interpolation and wavelet(Di Lorenzo et al.,2019). Infants were excluded from further analyses if they had poor headgear placement, less than 3 valid trials per condition (based on off-line behavioural coding for compliance) or more than 40% of the channels excluded. 52.77% of the 5-month-olds, 59.13% of the 12-month-olds and 70.32% of the 24-month-olds contributed to the group analysis. Here we report on channels with significantly stronger activation to the auditory social (social video and social sound) than the auditory non-social condition (non-social video and non-social sound)(AS>ANS). Consistent with previous research, 5-month-olds showed bilateral activation to AS>ANS in channels located over IFG and temporal brain regions. Interestingly, the distribution of the AS>ANS response was far more widespread at 12 months of age (double the number of significantly active channels) including a strong activation observed in the prefrontal-IFG region. At 24 months, the localisation of the response becomes more defined with a cluster of active channels(AS>ANS) in the right posterior temporal lobe, left posterior and central temporal lobe and bilateral IFG(Fig 1). These preliminary results showed developmental changes occurring over the first 2 years of life in



response to social stimuli in a Gambian cohort. The activation pattern at 5 and 24 months is consistent with previous studies that used the same paradigm in UK and Gambian cohorts (Lloyd-Fox et al., 2009, 2017), suggesting a very similar developmental trajectory of the social response in the Gambia and in the UK. Future investigations will assess the auditory social response at 8 and 18 months, to better describe its developmental trajectory during the first two years of life. To better understand the wider response to AS>ANS at 12 months than at other ages, we will further relate these findings with measures of cognitive and language development, such as the Mullen Scale of Early Learning, and early maternal social responsiveness acquired in the BRIGHT project.

P2-H-144: Meta-analysis of twin studies investigating the heritability of psychological and developmental milestones in infancy

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Background. Infancy is characterised by a cascade of psychological and developmental milestones and it represents the most rapid period of postnatal growth and development. Classical twin studies have been used for over a century to estimate relative contributions of genes and the environment to psychological and developmental traits. Polderman et al., (2015) meta-analysed virtually every twin study of complex traits published in the last 50 years, finding heritability of 49% across all traits, throughout the lifespan. However, no one has synthesised findings on genetic and environmental influences on infant traits specifically. We know that heritability changes across the lifespan (Bergen et al., 2007) but the causes of variation in infant traits remain unknown. **Objective.** To meta-analyse empirical estimates from twin studies of the relative contributions of genes and environment for all psychological traits and developmental milestones in infancy (0-2 years). **Methods.** We searched PubMed and PsycINFO for studies published before 30 November 2018: 1) on psychological and developmental traits between 0-2 years; 2) that provided twin correlations, concordance rates, or estimates of heritability (h^2), shared environmental influences (c^2) and non-shared environmental influences (e^2); 3) using the classical twin method, which compares monozygotic and dizygotic twins. **Preliminary results.** Full analyses are underway. We have searched over 4000 records and systematically retrieved over 180 published classical twin studies conducted in 16 different countries between 1972-2018, in which observed variation in infant traits was partitioned into genetic and environmental influences (see Figure 1). We have extracted h^2 , c^2 , e^2 estimates of over 300 phenotypes analysed in infants across the domains shown in Figure 2. **Discussion and next steps.** Preliminary findings reveal that classical twin analyses have been conducted on hundreds of psychological and developmental traits in infancy. These results represent the first systematic retrieval of findings on genetic and environmental influences on psychological and developmental milestones in infancy. Our next step will be to meta-analyse the extracted h^2 , c^2 , e^2 estimates in the first meta-analysis of twin studies on complex traits in infancy. Correlation coefficients from individual studies will be treated as effect sizes and combined in n -weighted analyses using the DerSimonian-Laird random-effects meta-analytical approach. Quality assessment of the included studies will be focussed on identifying the possibility of publication bias, which can occur in twin studies when those with higher heritability estimates or twin correlations are more



likely to be published, leading to an overestimation of the true correlations or estimates of genetic and environmental influence.

P2-H-145: Peer interactions as opportunities for language development in an early intervention preschool classroom

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Children's early language environments support their social and academic achievements. Children born into poverty often have lower levels of caregiver language input than those from high-SES backgrounds (Hoff, 2013). Previous literature has established the importance of caregiver language input and children's subsequent language development as well as the risks associated with living in underprivileged communities (Weisleder & Fernald, 2013). Preschoolers with delays in expressive language also engage in fewer productive social interactions when compared to typically developing peers (Gertner et al., 1994). Given the substantial amount of time young children are spending in the classroom context, peers are also a potentially important source of language input. One longitudinal study found that the number of vocalizations children heard from their peers in an early intervention classroom were positively associated with vocabulary development over the course of the school year (Perry et al., 2018). One reason why peers might support language development is that interacting with a more advanced peer can provide opportunities to hear new language and have a positive social interaction. Despite these opportunities for children to engage in and promote language development and social interactions in the classroom setting, relatively little is known about the role of peer language use and language development in positive social interactions, particularly in at-risk populations. To address this gap, the purpose of the present study was to examine how infant's social interactions and vocalizations with their peers influences their language development in a classroom for children from low-SES backgrounds. Participants in the study were 9 two- and three-year old infants enrolled in an early intervention classroom for high-risk, low SES families. Infants participated in five consecutive, weekly daylong observations in which they each wore a Language ENvironment Analysis (LENA) device for each observation. Trained research assistants observed the class during LENA collection and coded infant's proximity to specific peers and the valence of their interactions (positive or negative), sampling each infant twice per minute for ten minutes total each week. Infant's language skills (expressive communication & auditory comprehension) were measured via standardized assessment on the Preschool Language Scales 5th Edition (PLS; Zimmerman, Steiner, Pond, & Evatt, 2011) one month after data collection. Correlations were used to examine whether infant's positive interactions with peers was related to children's talking in the classroom and their PLS scores. Bivariate correlations are presented in Table 1. Multilevel mediation models were run to examine the role infant's talking played in the relationship between children's prosocial behaviors and language outcomes (see Figure 1). Results showed a strong positive relationship between infant's talking in the classroom and their language outcomes. Furthermore, the rate of talking fully mediated the relationship between both the amount infants are near each other and the number of positive interactions and their subsequent language scores. Results suggest an important relationship between



children's language use and prosocial behaviors. The classroom is an important context to scaffold peer interactions in order to provide more opportunities for infants to use language.

P2-H-146: Mother-child interaction video-coaching program to improve behavior at early childhood: A feasibility study

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The positive parenting is essential to promote child development, to attend a child's demands, to take care, to protect, to guide, and to invest in the child development trajectory (Brooks, 2013). Technology-based parenting using self-administered approaches (e.g., mobile phone or tablet-based apps) allow parents more flexibility, greatly increase the potential reach of parenting interventions, and reduce delivery costs, and logistical barriers to program access (Sanders, Turner, Metzler, 2019). The Strengthening Bonds Program (SBP) is a remote video-coaching universal parenting-centered program that aims to strengthen positive mother-child interactions and to enhance the mothers' awareness about the power of positive interactions (Linhares, Altafim, Gaspardo, & Oliveira, 2018). In addition to providing information to mothers about positive interactions with children, this innovative technology tool provides an opportunity for self-observation and self-assessment to become more aware and to strengthen the early relationships and caregivers' responsiveness to children's needs. This program was developed in the context of the IDEAS-Impact framework, proposed by the Frontiers of Innovation Initiative of the Center on the Developing Child at Harvard University (Shonkoff & Fisher, 2013), which offers a new methodology for prototype and test innovation programs in fast-cycle iteration learnings. Then, to reach sustainable scalability, the first step should focus on a feasible and valid pilot study. The present feasibility study aimed to examine the efficiency of the SBP to reduce behavior symptoms and to promote social behaviors in children. The sample included 33 mothers and their 2-to-3-year children, recruited in the Family Health Program (Ribeirao Preto Medical School, University of Sao Paulo, Brazil) and public schools. The families are social vulnerable living in a stressful and violent neighborhood. The intervention program comprises two steps: (i) one video record session of mother and child interactions in a play situation (12 min); (ii) one face-to-face session in group of mothers to orient and discuss about the positive dimensions of mother-child interactions (reciprocity, responsiveness, and adaptive directivity); (iii) video-coaching remote strategy, by sending short videoclips of the mother-child interactions. The innovative video clips were edited, including mixed clips of two different types of parts: animated clips with instructions about positive mother-child interactions and the mother-child dyad personalized clips, including positive feedbacks through subtitles and emojis. The six edited videoclips were sent weekly to the mothers' smartphones (two for each dimension of positive interactions). The child behavior was assessed by Strengthen and Difficulties Questionnaire (SDQ; mother-report; Goodman, 1997) in pre- and post-intervention moments. The within-group comparisons were performed by t-paired test. The significance of the level was established at 5%. The results showed that, in comparison to pre-intervention, the children improved pro-social behavior ($p = 0.01$), and reduced the total behavior problems ($p = 0.008$), in the post-intervention. This finding showed that the SBP improved the mother's perception of child behaviors. The program was feasible and advances being remote and combining animated and real mother and children interactions.



P2-H-147: Concordant still-face findings for computer vision and expert FACS coders

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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 sought to determine whether proportions of Duchenne and non-Duchenne smiles and cry-faces differ across FF, SF, and RE episodes, using computer vision and expert Facial Action Coding System (FACS) coding. 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 from which mouth opening was calculated. Images were input to a convolutional neural network (CNN) that output the presence and probability of the same facial AUS, indexing positive emotional expressions in infants and mothers, and negative emotional expressions in infants. The mean proportion of frames coded by AFAR was .70 for infants and .96 for mothers. Free-margin kappa was above .66 for all reported mother and infant AUs between AFAR and FACS over the entire sample. Identical significant still-face effects emerged from analyses using data from FACS coders and from the objective AFAR computer vision software. 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 did not increase significantly from the FF to the SF ($ps > .05$), but rose significantly between the SF and RE ($ps < .05$; Fig.1). Mothers demonstrated a decline in smiling from the FF to the SF and a rise from the SF to the RE ($ps < .001$; Fig.2). AFAR probability of expressions was robustly associated with the likelihood of the presence of expressions (rs from .79 to .99, $ps < .002$), suggesting that probability may index the intensity of expressions. Mouth opening was positively associated with Duchenne smile presence and intensity in mothers ($ps < .001$) and infants ($ps < .05$), and with Duchenne cry-faces intensity in infants ($ps < .001$). Expert coders and automated CNN-based software (AFAR) produced an identical pattern of still-face results, suggesting convergent validity. Substantively, this was the first description of Duchenne and non-Duchenne expressions in mother and infant during the FFSF. Finally, continuous measurements produced by AFAR suggested that mouth opening is an additional measure of positive and negative facial intensity among interacting mothers and infants.



P2-H-148: Neurobehavioral precursors of selective attention to the mouth: Social visual engagement scaffolds mechanisms of language learning

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Early patterns of social visual engagement, how infants look at communicative partners during social interactions, are shaped by infants' selective attention to the environmental features most relevant to them at their developmental stage. 6 months of age marks an important pattern shift as infants increase their attention to the mouths of caregivers to capture audiovisual speech cues (Lewkowicz & Hansen-Tift, 2012). Though hypothesized to be a key precursor to speech production, the neurobehavioral ingredients that scaffold this surge in mouth-looking are unknown. This study investigates prior trajectories of social visual engagement and brain development that predict shifting attention to the mouth at 6 months. The primary aim is to determine if trajectories of attention to the eyes of others, a socially adaptive skill present from birth, in the first 6 months of life predict trajectories of mouth-looking. Exploratory analyses aim to identify trajectories of white matter tract development associated with change in mouth-looking. Methods: Eye-tracking and diffusion MRI data were collected prospectively and longitudinally in the same infants (n=31, 10 female) at 6 and 3 pseudorandom time points, respectively, between birth and 7 months. All participants were full-term, healthy infants. Eye-tracking data were collected while infants viewed scenes of actress caregivers engaging in naturalistic interaction and percentage of fixation time for each of four regions-of-interest (eyes, mouth, body, background) was calculated. Atlas-based tractography was used to delineate major white matter tracts and fractional anisotropy values were generated for each. Growth curves were fit using functional principle component analysis (FPCA) and Functional Linear Regression tested associations between longitudinal trajectories (Yao, Müller, & Wang, 2005). Results: Curve-fitting using FPCA shows trajectories of eye and mouth-looking each have a primary and secondary principle component of variance with the primary corresponding to the amplitude of individual trajectories and the secondary to rapid increases in fixation over time (Fig. 1C). Linear regression reveals a significant positive correlation between the primary component scores for eye and mouth-looking for individual infants, $R^2 = .67$ and a significant negative correlation between the secondary scores for eye and mouth-looking, $R^2 = .31$ (Fig. 2A-B). Estimated regression functions between trajectories of visual attention and the developing brain suggest increases in eye-looking at 3 months influence the maturation of the uncinate fasciculus, which in turn, influences increasing mouth-looking at 5 months. Conclusions: Consistent with published literature, infants' attention to the mouth increases throughout the first 6 months, and most rapidly at around 180 days. Correlations between variance features of trajectories of social visual engagement reveal an important relationship between eye and mouth-looking: the earlier an infant most rapidly increases their attention to eyes, the earlier they begin to increase their attention to the mouth. Moreover, brain-behavior associations reveal the same pathways associated with elevated mouth-looking are also those particularly responsive to early experience with the eyes of caregivers. Early eye-looking may be an active ingredient in the mechanisms underlying more complex social attention and future analyses will test its relationship to language acquisition.



P2-H-150: For whom is the "Caring & Growing Together Program" effective in strengthening the mother-child interaction? Moderation analysis

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Parent-child interactions and social environment play a crucial role in overall child development (Leclère et al., 2014). A variety of interventions has shown medium-to-high effects on child outcomes (Yousafzai et al. 2019; Britto et al., 2017). Otherwise, in low-and-middle-income countries, the benefits of programs on developmental parenting still need further evidence. The present study was a quasi-experimental controlled trial aiming to analyze the moderator effect of mothers' and children's characteristics on the effectiveness of a longitudinal psychosocial intervention to strengthen mother-child interaction (Brazilian Clinical Trials Registry: RBR-6ct969). Participants were 67 mothers and their 12 months-old children (59.7% boys; 74.63% born preterm). Dyads were recruited in a public hospital, reference for high-risk deliveries, in Southeast Brazil. Children born between January-May/2015 were enrolled in the control group (CG; n=34), and those born between June-October/2015, in the intervention group (IG, n=33). Both groups were followed-up for 12 months and submitted to the same procedures. "Caring & Growing Together Program" consisted of two individual sessions (0 and 2 months old) of the Newborn Behavioral Observation (Nugent et al., 2007) plus six group sessions (0, 2, 4, 6, 9 and 12 months old), with maximum of five mothers per group, guided by the "Baby's Book". The program was developed by researchers of Federal University of Minas Gerais (UFMG, Brazil) in the context of Grand Challenges Canada-Saving Brains. At post-intervention, all dyads were videotaped individually in an 8-minutes "novel toy" activity when the child was 12 months old (corrected gestational age for preterm). The video clips were analyzed by a blind researcher using the Parenting Interactions with Children - Checklist of Observations Linked to Outcomes (PICCOLO), which captures parental skills, such as affection, responsiveness, encouragement, and teaching, generating a total score (Roggman et al., 2013). A between-groups comparison was performed for the PICCOLO total score, adjusted by child gestational age (GA), maternal years of schooling, and mother's age at childbirth. Additionally, a multiple linear regression was performed, including all these variables and their interaction with the group. The significance level was 5%. The IG and CG were similar considering child gender, mean maternal years of schooling and mothers' age at childbirth, but differed in the GA (t-test; $p=0.02$). Univariate analysis (Figure 1) showed significantly higher mean PICCOLO total score in mothers of the IG whose children were born ≤ 31 weeks GA than mothers of the CG ($p=0.05$; $d\text{-Cohen}=2.35$), but no significant difference between IG and CG was observed in the other GA categories. Mothers of IG who studied for less than 10 years also scored higher than those of CG (t-test; $p=0.02$; $d\text{-Cohen}=1.23$). No significant difference was detected in mothers who studied 10 years or more, either for mothers' age at childbirth. These results were confirmed on the multiple linear regression analysis (Table 1). The effects of the intervention in maternal parenting skills differed according to the GA and maternal years of schooling. These findings suggest that the intervention was effective for more vulnerable groups, specifically for extremely preterm infants and mothers less schooled.

P2-H-151: Sensory processing, temperament, and infant development



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There are individual differences in how people process sensory information including differences in thresholds and regulation of sensory information (Dunn, 2007). Sensory processing is linked to personality characteristics and health problems in adults (Aaron & Aaron, 1997; Benham, 2006) and to behavior and attachment problems in infants with sensory regulatory disorder (DeGangi, 2000). Retrospective adult findings link sensory sensitivity to relationship anxiety (Meredith et al., 2016), parenting that encourages dependency (Liss et al., 2005), and emotional reactivity (Jagiellowicz et., 2016). Little is known about the role of sensory processing in infant development. The purpose of this pilot study is to explore the relationship of sensory processing with temperament, aspects of development, including synchronous interactions with the caregiver at 3 months of age. Participants were 26 mothers and their infants who participated in a broader study about the effects of postpartum depression on infant development and family dynamics. At 3 months, mothers completed questionnaires about infants' temperament, sensory processing (Sensory Profile), developmental milestones (ASQ), and feeding and sleeping habits. Infants and mothers also participated in the still face experiment (play for 3 minutes, still face for 2 minutes, recovery for 3 minutes; data from play and recovery were used here). Results showed a positive association between sensation seeking and surgency ($r = .55$, $p = .003$), possibly reflecting the risk taking aspect of surgency (Rothbart, 2019). Infants with high sensation seeking were also rated as high in effortful control ($r = .39$, $p = .051$), foreshadowing perhaps difficulties with regulation. Negative affect was positively correlated with both low registration ($r = .58$, $p = .002$), and sensory sensitivity ($r = .44$, $p = .025$), indicating that infants who miss stimuli or become too excited with environmental stimulation may react negatively. Alternatively, negative affectivity interferes with the processing of sensory information. None of the sensory processing variables were related to developmental milestones but infants who tended to avoid stimulation slept more hours ($r = .42$, $p = .044$), and those who were high in sensory sensitivity had more eating difficulties, as perceived by mothers ($r = .39$, $p = .051$). Lastly, infants who were high in sensory sensitivity were engaged in more synchronous mutual gaze ($r = .39$, $p = .051$) with their mothers and infants who had difficulty registering sensory information experienced fewer synchronous vocalizations ($r = .46$, $p = .020$), and less shared attention on objects ($r = .40$, $p = .045$). These associations did not exist between temperament and synchronous. Overall, the results imply that sensory processing is related to infant temperament and possibly contributes uniquely to infant behaviors and interactions with the caregivers.

P2-H-153: Is distress during pregnancy context-dependent? Comparing United States (US) and the Netherlands

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Maternal distress and worry during pregnancy can compromise a woman's wellbeing and have been associated with alterations in offspring development; however, their etiology is not well



understood. The present study represents a comparison of maternal late pregnancy distress/worry between the United States (US) and the Netherlands. We hypothesized that women in the US would report higher levels of prenatal anxiety, depression, and worry about transition to parenthood, compared to their Dutch counterparts, because of more favorable policies/accessible services relevant to perinatal health in the Netherlands. Pregnant women in their third trimester of pregnancy (27- 40 weeks gestation) were recruited at two comparable sites in the Netherlands (n=327) and the US (n=228). Self-report of anxiety, depression, worry about transition to parenthood, and key covariates (i.e., parity, gestational and maternal age) was obtained. Women responded to the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987) and the State Trait Anxiety Inventory (STAI; Spielberger et al., 1989), both psychometrically sound and widely utilized in the perinatal period. Baby Preparation and Worry Scale (Baby-PAWS) was developed to assess concerns regarding own wellbeing, partner involvement, caregiving/non-parental childcare, following birth, demonstrating good internal consistency for both samples: US Cronbach's Alpha=.89; Dutch Chronbach's Alpha=.81. Analyses revealed higher depression, anxiety, and worry about transition to parenthood in the US, with large effect sizes. For EPDS ($t = 6.90, p < .01$), higher depression was noted in the US (meanUS = 7.91, SD = 5.41; meanNL = 5.08, SD = 4.19). For STAI state anxiety ($t = 6.27, p < .01$), US ratings were significantly higher (meanUS = 36.94, SD = 11.69; meanNL = 31.41, SD = 8.60), with a similar pattern ($t = 5.81, p < .01$) for the trait indicator (meanUS = 37.34, SD = 11.52; meanNL = 32.40, SD = 8.26). Baby-PAWS scores ($t = 3.76, p < .01$) were also higher for US women (meanUS = 32.58, SD = 12.56; meanNL = 27.50, SD = 7.86). Analyses of Covariance (ANCOVAs), conducted to control for maternal age, weeks of gestation, and parity, provided further evidence of significant cross-cultural differences (Table 1). Latent mean differences were also considered, with the latent prenatal distress construct indicated by EPDS and STAI state and trait indicators. The basic prenatal distress latent mean model provided a good data-model fit (Chi Square = 6.20, NS; RMSEA = 0.00; SRMR = 0.02) demonstrating a significant difference. The final model including covariates also demonstrated good fit (Chi Square = 13.16, NS; RMSEA = 0.00; SRMR = 0.02) and resulted in a statistically significant difference between US and Dutch expectant mothers ($p < .01$). Women in the US self-reported higher overall distress relative to Dutch expectant mothers (Figure 1). The US was estimated to be almost a standard deviation higher than NL on the latent stress continuum (latent effect size = .85), after accounting for covariates (latent meanNL = 0, $s^2 = 10.67$; latent meanUS = 3.53, $s^2 = 26.76$). Implications of this study concern perinatal policy and clinical services (e.g., emotional health support provided to mothers).

I-Emotional Development

P2-I-154: Maternal prenatal and postnatal emotional stress interact to affect child temperament

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Research suggests that maternal stress during pregnancy has a programming effect on the fetus. Although several studies have indicated adverse child outcomes including behavioral/emotional problems, such findings are not ubiquitous (e.g., DiPietro, 2012).



Previous studies rarely followed children beyond the first year of life, and often failed to control for maternal variables postpartum. The present study investigated relations between maternal pre-/post-partum stress and temperament in three-year-old children. Maternal emotional stress in pregnancy and postpartum period were expected to predict child temperament either additively, such that the degree of both independently predict outcomes, or in interaction, such that the impact of higher levels of pregnancy stress may be particularly pronounced among children whose mothers experienced higher levels of stress after the child was born. Women were recruited from five maternity hospitals in a Central European country during antenatal medical checks. Healthy women (N = 180) with singleton pregnancies who gave birth to a child without serious perinatal pathologies took part. Participants completed questionnaires in late pregnancy (T1), 9 months postpartum (T2), and 3 years postpartum (T3). These measures included the Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1994), Edinburgh Postnatal Depression Scale (Cox & Holden, 2003) and a list of life events at T1 and T2; the Fear of Birth Scale (Haines, Pallant, Karlstrom, & Hildingsson, 2011) at T1; and Children's Behavior Questionnaire (CBQ-VSF) (Putnam & Rothbart, 2006) at T3. Multiple linear regressions controlling for potential covariates (maternal age, parity, educational level, marital status, mode of delivery, gestational age at delivery and child's sex) were performed to assess the effects of pre-/post-partum maternal emotional stress on child temperament. High perceived stress both in pregnancy and postpartum period were marginally significant independent predictors of lower Surgency (the overall model was however significant). High childbirth-related fear and maternal depressive symptoms in pregnancy forecasted significantly lower Surgency. High levels of perceived stress in pregnancy predicted marginally higher Effortful control. A significant interaction between the effects of pre- and post-partum stress on Negative affectivity indicated that higher stress in pregnancy predicted lower Negative affectivity in children whose mothers perceived low levels of postpartum stress, but higher Negative affectivity when mothers reported high postpartum stress. In addition, frequency of stressful events experienced postpartum predicted higher Negative affectivity. Associations between maternal stress and child temperament were complex, with connections differing according to the timing and focus of mothers' stress, and with stress after the child's birth altering links between prenatal stress and child negativity. Our findings provide enhanced nuance regarding the manner in which children's early biological and social environments affect their emotional reactivity and regulation.

P2-I-155: Latent class trajectories of reactive and regulatory aspects of infant temperament

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Introduction: Individual differences in temperament have implications for the development of emotional and behavioral regulation. Previous studies that assessed trajectories of infant temperament have used latent growth trajectory analysis, which assumes that one trajectory adequately represents the underlying individual growth trajectories in the population. Latent class growth modelling (LCGM) allows for the possibility that there is more than one trajectory of growth in the population, each of which describes the pattern of change in a subset of individuals (Nagin, 2005). Identifying subgroups of infants who follow different developmental trajectories in temperament could assist in addressing questions about the development of



emotional and behavioral regulation. Aims: Determine: 1) the number and shape of latent trajectories for change in temperament during infancy, 2) if trajectories relate to each other across dimensions of temperament, and 3) whether trajectories predict later internalizing and externalizing behavior. Study Population: Participants were 1819 mother-infant pairs recruited to the Alberta Pregnancy Outcomes and Nutrition (APrON) study (Kaplan et al., 2014). APrON is an urban community sample of women recruited during pregnancy between June 2009 and July 2012 in Alberta, Canada. Methods: Maternal-report of infant temperament was collected at 3-, 6-, and 12-months using the very short form of the Infant Behavior Questionnaire - Revised and emotional and behavioral problems were assessed at 2 years using the Child Behavior Checklist. LGCM was used to identify the number of latent trajectories and the approximate proportion of infants in the population following each trajectory. To examine if the development of each dimension of temperament evolves contemporaneously with other aspects of temperament, we assessed dual trajectory models in which trajectories for Negative Emotionality, Regulatory Capacity/Orienting, and Positive Affectivity/Surgency identified in univariate analysis were simultaneously fit to the data. Finally, we evaluated associations between trajectory groups and measures of internalizing and externalizing behaviors using ANCOVA with trajectory group as a fixed factor and child age at outcome assessment as a covariate. Results: Four or five unique trajectories were identified within each temperament dimension (see Figure 1). Developmental coordination was observed between trajectories of negative emotionality and regulatory capacity, and between regulatory capacity and positive affect, but not between positive affect and negative emotionality, suggesting that there are important differences in the developmental coordination between the regulatory and reactive aspects of temperament. Negative emotionality and regulatory capacity predicted internalizing and externalizing behavior (see Figure 2). Specifically, infants who had high or increasing Negative Emotionality trajectories and infants who had a low Regulatory Capacity/Orienting trajectory had greater risk for dysregulation of emotion and behavior. Conclusion: Trajectories of infant temperament that are high in negativity and or low in regulatory capacity are associated with greater emotional and behavioral dysregulation.

P2-I-156: Intrapersonal dynamics: Physiological-behavioral coordination as a marker of prenatal emotion dysregulation

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Emotion dysregulation (ED) is a transdiagnostic risk factor for psychopathology (Beauchaine, 2015). ED may have special implications during pregnancy, as prenatal exposure to ED may influence fetal neurodevelopment via intrauterine changes (e.g., Doyle & Cicchetti, 2018). Indeed, multimodal indices of prenatal maternal ED correlate with newborn neurobehavior (Ostlund et al., 2019) and prenatal maternal hair cortisol concentrations (Conradt et al., under review). However, ED is a dynamic construct that can be modeled via repeated-measures designs. For instance, intrapersonal (within-person) emotional coordination, synchronized responsivity across behavioral and physiological emotion indices, may reflect wellbeing (Ekman, 1999) and can be used to assess dynamic changes in ED (Crowell et al., 2014). Intrapersonal emotional dynamics may thus have implications for newborn outcomes. We used a dynamical systems approach to assess prenatal maternal intrapersonal coordination of



physiology and behavior during the Trier Social Stress Test (TSST). We expected to find coordination between physiological and behavioral indices of similar emotional constructs across the TSST. We hypothesized to find respiratory sinus arrhythmia (RSA)-prosocial behavior and electrodermal activity (EDA)-anxious behavior coordination. We also developed new exploratory models to predict newborn outcomes with coordination. We recruited 162 third-trimester pregnant women with a range of scores on a self-report ED measure. Women underwent a psychophysiological assessment (measuring RSA and EDA) during the speech task of the TSST. RSA, the high frequency component of the power density spectrum, is a marker of affiliation, whereas EDA, the number of nonspecific responses, marks stress responsivity. RSA and EDA were calculated over 30-second epochs. Trained coders quantified participants' prosocial (social regulation; e.g., smiling) and displacement behaviors (anxiety; e.g., face-touching) during the speech (ICCs>.80). Shortly after birth, we administered the NICU Network Neurobehavioral Scale (NNNS) to assess early indices of emotion dysregulation. We used R to create multilevel dynamical systems models to examine coordination, such that behavior predicted minute-to-minute change in physiology (i.e., derivatives estimated using generalized local linear approximation), and vice versa. All indices attracted to respective set-points, the point of no change ($B_s \leq 0.60$, $p_s < .001$). Unexpectedly, EDA and displacement did not coordinate ($B_s < 0.03$, $p_s > .48$), though visual inspection suggests that participants were attracted to the set-point only if they began the speech either high or low in both EDA and displacement (Figure 1). RSA and prosocial behaviors were coordinated, though only when change in RSA was the outcome ($B = 0.02$, $p = .01$). Eigenvalue decomposition resulted in complex numbers ($-.61 \pm 0.4i$), indicating that these variables may form a cycle (Figure 2). Using dynamical systems, we measured intrapersonal coordination, which may have implications for ED and developing infants. As expected, RSA and prosocial behaviors coordinated, meaning that the two influenced one another across the speech. Upon finalizing new statistical models, we expect that women with more coordination will have newborns with fewer neurobehavioral indices of ED than those with low coordination. This project will advance developmental science by providing practitioners another way to assess prenatal risk.

P2-I-157: Testosterone and fathers' parenting unraveled: Links with the quality of father-child interactions

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Father involvement in childcare is widely recognized as being beneficial to children's social and emotional development. Individual differences in quality of father involvement in caregiving might in part be explained by fathers' testosterone (T) levels. We examined the links between fathers' ($n = 32$) salivary T levels and fathers' sensitivity during different types of interaction between father and their young child (12 to 30 months of age). During two home visits, video observations of father-child interactions were conducted to measure fathers' sensitivity during a challenging (discipline) and harmonious (free play) interaction. Fathers' saliva was collected right before and after each father-child interaction. The results showed that changes in fathers' T levels during the father-child interactions predicted fathers' sensitivity. Specifically, the more T increased during the challenging interaction, or decreased



during the harmonious interaction, the more sensitive the father was during that interaction as well as during a subsequent interaction. These findings suggest that parenting quality is most optimal when fathers' T system reacts in the expected direction given the context of the father-child interaction, i.e., a T decrease during a harmonious interaction and a T increase during a challenging interaction. Our study underscores the importance of taking biological factors into account when examining the role of fathers in early child development.

P2-I-158: Modulation of infants' physiological and behavioural responses to objects by subliminal affective faces

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In everyday life, our preferences and judgments are frequently governed by influences that we are not aware of. Indeed, several adult studies have shown that information presented at a subliminal level, and in particular emotions, can modulate the affective perception and subsequent judgments of conscious experiences both at a behavioural and neural level (Tamietto & De Gelder, 2010). Recently, a few studies have shown that even infants in their first year of life can process emotions at an unconscious level. For example, in a study by Nava et al. (2016), 3 month-old infants were presented with subliminal (100 ms) and supraliminal (200 ms) emotional faces using a classical backward masking paradigm, consisting in presenting the emotional faces immediately followed by a neutral face acting as a mask. The study showed that infants' arousal was similar both when the stimuli were supraliminal and subliminal, suggesting that infants' physiological activity reacts to emotional stimuli even outside conscious awareness. Interestingly, angry faces elicited stronger autonomic responses, which may reflect a negativity bias that can only be observed at an unconscious level by age 3 months. Here, we present two experiments conducted in 3 month-old infants aimed at testing whether the unconscious processing of emotions in infancy can modulate the preference and affective perception of neutral objects, hypothesising that angry faces may alter such perceptions stronger than happy faces. We measured changes in the autonomic response of infants, as assessed with skin conductance response, as well as looking times. In the familiarisation phase, N = 25 infants were presented with two neutral objects sequentially; in the priming phase, two neutral objects were subliminally primed with the angry and happy faces (see Fig. 1); in the last phase, infants saw again the two neutral objects presented alone. We found that both angry and happy facial expressions altered the arousal of infants to the neutral objects, as there was a higher arousal for the two neutral objects in the second than in the first phase. Moreover, the changes in arousal observed during the priming phase with the angry face predicted higher skin conductance to the subsequent presentation of the object alone (see Fig. 2). Parallel to this finding, we also found a negative correlation between skin conductance response and looking times, that is, an increase in arousal during the priming phase corresponded to a decrease in looking times, suggesting that, even if the emotion was presented at an unconscious level, infants progressively avoided looking at the object primed with the negative emotion. A control study conducted with a new sample of N = 25 infants indicated that when the objects were primed with neutral faces, infants' affective perception of the object was not altered. Altogether, our findings demonstrate that emotions, even if processed unconsciously, have a privileged route that may influence and shape infant's processing of objects.



P2-I-159: Subgrouping infants with early autism signs on the basis of temperament: Classification continuity and predictive utility

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Symptoms of autism spectrum disorder ('autism') co-occur at high rates with internalizing (depression, anxiety) and/or externalizing (inattentive/hyperactive, oppositional/aggressive behaviour) symptoms. Research on normative development suggests that insights into the variability of co-occurring symptoms in autism may be gained through consideration of child temperament characteristics - i.e., early-emerging and biologically-based emotional, behavioural, and attentional traits. Indeed, studies have reported a similar pattern of associations among temperament traits and internalizing and externalizing symptoms among school-aged children and adolescents with autism as for those with normative development. However, no studies have explored such relations in infancy when autism symptoms first emerge. Within a cohort of infants presenting with early signs of autism, we sought to (a) identify distinctive temperament subgroups at three key ages - around 12-months, 18-months, and 24-months - and (b) explore the utility of these temperament subgroups for predicting variability in concurrent social-emotional functioning. Participants were a community-referred sample of 103 infants (68% male) showing early signs of autism. Child temperament was assessed using the caregiver report Infant Behavior Questionnaire-Revised (IBQ-R) at 12-months (n=96 available) and Early Childhood Behavior Questionnaire (ECBQ) at 18-months (n=90) and 24-months (n=81). Child internalizing and externalizing symptoms and social-emotional competence were assessed using the Infant-Toddler Social and Emotional Assessment (ITSEA). We used latent profile analysis to identify temperament subgroups from IBQ-R/ECBQ subscale scores at each timepoint, cross-tabulations to examine subgroup classification patterns over time, and one-way ANOVA to explore between-subgroup differences across ITSEA domains. Three temperament subgroups were identified across all timepoints: sociable/well-regulated characterized by high social approach and self-regulation, active/negative reactive characterized by high activity, negative emotionality, and low self-regulation, and inhibited/low positive characterized by low social approach and positive emotionality. Infants were significantly likely to retain their classification among these subgroups across timepoints. At 24-months, a fourth reactive/regulated subgroup was characterized by intermediate emotional reactivity and self-regulation, and not associated with any particular subgroup classification 6-months prior. IBQ-R/ECBQ subscale means for each temperament subgroup at each timepoint are depicted in Figure 1, and longitudinal subgroup classification proportions and patterns are depicted in Figure 2. Higher social-emotional competence was reported among infants classified sociable/well-regulated at each timepoint, whereas inhibited/low positive children had high internalizing symptoms and active/negative reactive children had high internalizing and externalizing symptoms. Reactive/regulated infants had intermediate levels of social-emotional competence and internalizing and externalizing symptoms. The continuity of infants' subgroup classifications and patterns of predictive associations suggests that subgrouping by temperament may be a reliable and useful way of identifying infants with autism symptoms who are also at-risk of co-occurring internalizing and externalizing symptoms.



P2-I-160: Effects of the tempo on infants' responses to instrumental music

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Background and Aims: It is well known that the tempo of music influences the conditions of the listeners. Music played at a fast tempo enhances the adult listeners' arousal (Husain et al., 2002), and music at a slow tempo calms and relaxes them (Oaks, 2003). Conrad et al. (2011) reported that infants preferred slower lullabies to faster ones. However, it has not yet been clarified whether slow music has the effect of calming infants. This study investigated 3-5-month-old infants' responses to slow and fast instrumental music when they were lying alone. We measured the infants' heart rate as an index of their condition. **Methods:** Forty-two healthy infants aged 3- to 5-months (3m0d - 5m3d, M = 124d) participated in this study. The stimuli were four synthesized instrumental music of a lullaby (Zousan, Elephant): consisting of a music box version and an electric piano version. Each version was played either at a slow (56 beats/minute) or a fast (100 beats/minute) tempo. Each infant lay on a play mat with a few small toys hanging overhead during the experiment. The experiment consisted of three sessions: a silent session for 30 seconds, a music session for 15 minutes, which was again followed by a silent session for 30 seconds. If the infant started crying during the music session, the session was terminated and immediately followed by the last silent session. During the music session, the infants were randomly assigned to one of the four music stimuli, which was presented through speakers. The infant's heart rate was recorded using an electrocardiogram (ECG: BIOPAC Systems, MP160). **Results:** All the infants refrained from crying during the five minutes of the music session. Although some of the infants started crying after 6 minutes. The duration of refraining from crying did not vary among the music stimuli. We analyzed changes in the infants' heart rate during the five-minute the music session from the fist, silent, session. A 2 (tempo) * 2 (timbre) * 6 (time) repeated ANOVA indicated that the main effect of time ($F(5,190) = 3.228, p < .01, \eta^2 = 0.08$) and the interaction between time and tempo ($F(5,190) = 2.961, p < .05, \eta^2 = 0.08$) were significant. Post-hoc analyses (Bonferroni), indicated that the infants' heart rate was lower to slow than to fast music during the fourth and fifth minutes of the music session. This result was obtained only for the music box version of the music. **Conclusion:** The results replicated the finding that music prevents infants from crying for some time. This study also indicated that instrumental music played at a slow tempo sustains infants' heart rate at a lower level, which can be interpreted as the infants being in a calm condition. It was also suggested that the timbre of music might influence the infants' responses.

P2-I-161: Prenatal maternal emotion dysregulation has indirect effects on newborn growth and health through psychotropic medication usage

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Mounting evidence identifies poor fetal growth and development as predictive of later chronic illness and psychopathology (O'Donnell, Glover, Barker, & O'Connor, 2014; O'Donnell & Meaney, 2017). For example, infants with complications at birth (e.g., low birth weight) have a



higher chance of developing disorders such as coronary heart disease and type 2 diabetes as adults (Barker, Osmond, Kajantie, & Eriksson, 2009), are more likely to experience deficits in attention, academic performance, and executive functioning throughout childhood (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009), and are at an increased risk for internalizing psychopathology into adulthood (Boyle et al., 2011). It is therefore imperative to identify prenatal factors that hinder developmental processes. Emotion dysregulation, a transdiagnostic risk factor for psychopathology (Beauchaine, 2015), was associated with higher levels of maternal depression, anxiety, borderline personality, and self-injuring behavior in a pregnancy sample (Lin et al., 2019). Further, the newborns of these dysregulated mothers were more inattentive and displayed blunted arousal levels on a standardized neurobehavioral assessment (Ostlund et al., 2019). The study at hand will examine whether maternal prenatal emotion dysregulation is predictive of poor fetal growth and health, as measured within the first minutes after birth. Pregnant women (n=594) between the ages of 18 and 40 were recruited during their third trimester of pregnancy and completed a self-report measure of emotion dysregulation, the Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2006). Following delivery, hospital medical records were extracted for relevant maternal health and delivery information (e.g., psychotropic medication usage, pre-eclampsia, mode of delivery) and the following newborn outcomes: gestational age, birth weight, birth length, head circumference, and Apgar scores (Apgar, 1953). Exploratory factor analysis of outcome variables revealed two factors of newborn growth (includes birth weight, birth length, head circumference, and gestational age) and health (includes Apgar scales of heart rate, respiratory effort, reflex irritability, and muscle tone at 1 and 5 minutes after birth). Path analysis revealed that there was no main effect of prenatal maternal emotion dysregulation on newborn outcomes; however, prenatal psychotropic medication usage significantly predicted newborn growth ($b = -.369, p < .001$) and newborn health ($b = -.220, p = .022$). Mediation analyses with 1000 bootstrapped samples indicated that the indirect effect of emotion dysregulation on newborn growth ($b = -.306, p = .002$) and newborn health ($b = -.184, p = .048$) through psychotropic medication usage was significant. Emotion dysregulation has been identified as a core feature in both internalizing (Hofmann, Sawyer, Fang, & Asnaani, 2012) and externalizing behavior problems (Martel, 2009). As such, it is sensible that emotion dysregulation is associated with increased use of psychotropic medications. Further, results of the study at hand replicate prior findings that prenatal psychotropic medication usage may place newborns at risk for poor growth and adverse perinatal health outcomes (Calderon-Margarit, Qiu, Ornoy, Sisovick, & Williams, 2009). Interventions that target maternal emotion dysregulation may be one method to reduce intergenerational transmission of health risk and psychopathology.

P2-I-162: Change in frontal electroencephalogram (EEG) asymmetry from baseline to still face: Links to mother-infant interactions

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The goal of the current study was to improve our understanding of relations between qualities of parent-infant interactions and emotion lateralization, measured using electroencephalography (EEG). Asymmetric frontal EEG patterns reflect approach and



avoidance tendencies, with relative right activation associated with withdrawal emotions/motivation and left hemisphere activation linked with approach and positive affect. While EEG asymmetry has been studied across the lifespan, few studies have examined asymmetry in the context of emotional-eliciting tasks, with comparisons to baseline to ascertain the response to the emotional task, especially for infants. Parent-infant interactions represent one of the most critical and enduring aspects of infants' experience and development. The qualities of parent-infant interactions are related to social-emotional and cognitive developmental outcomes; however, exactly how parent-infant interactions shape the functional organization of the brain is only beginning to be understood. Interactional dynamics of thirty-eight mother-infant dyads were coded for maternal responsiveness, reciprocity of play, and intensity, during free-play (Gartstein et al., 2018), with EEG asymmetry data obtained in the context of a baseline task and the repeated Still-Face Paradigm (i.e., second episode; Haley & Stansbury, 2003). Maternal responsiveness refers to the mothers' interest and empathy towards the child, varying from avoiding or ignoring the child, to providing near constant responses to their activity. Reciprocity is defined as the level to which the dyad's actions and movements flow together, ranging from low levels of coordination and simultaneous movement, to high frequency of synchronization. Intensity refers to the level of exuberance and complexity in the interaction, including the volume of verbal exchanges, levels of parental enthusiasm, and amount of stimulation afforded by play with toys. All variables are coded on a 1 to 7 Likert-scale, with 1 being the lowest score possible and 7 being the highest. Results indicated that changes in alpha asymmetry from baseline to repeated Still-Face were related to responsiveness of parent-infant interaction ($r = .36$). Specifically, greater maternal responsiveness was associated with a more leftward shift in frontal alpha asymmetry from baseline to Still-Face. Thus, infants experiencing more responsive interactions with their caregivers demonstrated a propensity toward approach-related emotion/motivation even during the 2nd Still-Face episode, designed as a mild stressor to challenge regulation. With respect to reciprocity and intensity of play results, there was no significant association noted between reciprocity and frontal asymmetry, and only a trend level effect between intensity and asymmetry ($r = .20$). This pattern of results could be attributed to the age of participants, as younger infants are less mature interactional partners, engaging in fewer intentional reciprocal actions or high intensity exchanges during the play task.

P2-I-164: A developmental and contextual approach to the emergence of self-regulation among low-income, Mexican American children

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Mothers and infants reciprocally influence each other's behavioral, emotional, and biological functioning via co-regulatory processes, which are thought to serve as the foundation for children's developing capacities for self-regulation (Feldman, 2007). Limited work has evaluated these processes longitudinally among at-risk families. Contextual risk factors, such as maternal depressive symptoms or family economic stress, may compromise a mother's ability to provide a regulatory framework for her child (Goodman et al., 2011). Similarly, contextual opportunity factors, such as cultural values, may promote more adaptive and regulating mother-child interactions. The current study aimed to understand the impact of



prenatal risk, prenatal opportunity, and mother-infant dyadic reciprocity in pathways of children's emerging self-regulation. Prenatal risk was expected to predict less dyadic reciprocity at 12 and 24 months, whereas prenatal opportunity was expected to predict greater dyadic reciprocity at both timepoints. Greater dyadic reciprocity at 24 months was expected to predict greater child self-regulation at 36 months, which was expected to predict greater child self-regulation at 54 months. Data for the current study pulls from an ongoing longitudinal study of 322 low-income, Mexican American mother-child dyads (mean maternal age = 27.7; 86% born in Mexico). Timepoints for current analyses include a prenatal home visit (26-38 weeks gestation), and laboratory visits at 12, 24, 36, and 54 months postpartum. In line with established procedures (Sameroff et al., 1987), cumulative risk and opportunity indices were calculated using several sociodemographic, psychosocial, and contextual factors assessed at the home visit. Dyadic reciprocity was observed at 12 and 24 months during a mother-infant free-play task (CIB; Feldman, 1998). At 36 and 54 months, relevant observational and parent-report questionnaires were used to construct latent factors of children's self-regulation, including the CBQ (Rothbart et al., 2001), Dysregulation Coding System (Lin et al., 2014), HTKS (Ponitz et al., 2008), and the CPT (Bedwell et al., 2006). Measurement models for child self-regulation were estimated using confirmatory factor analyses (see Figure 1). Given adequate model fit, a structural equation model was estimated with risk and opportunity predicting longitudinally to dyadic reciprocity at 12 months, to dyadic reciprocity at 24 months, to children's self-regulation at 36 months, to children's self-regulation at 54 months (see Figure 2). Models were evaluated on several fit indices (χ^2 , CFI, SRMR, RMSEA). Mediation was tested using the joint significance test (MacKinnon et al., 2002). Prenatal risk predicted less dyadic reciprocity at 12 months. Dyadic reciprocity at 12 months positively predicted dyadic reciprocity at 24 months, which positively predicted self-regulation at 36 months. Self-regulation at 36 months positively predicted later self-regulation. The model accounted for 80% of the variance in 54-month self-regulation. Using the joint significance test, significant mediation from prenatal risk to 54-month self-regulation was inferred. Findings suggest that mother-child co-regulatory processes during infancy and toddlerhood promote children's developing self-regulation among an at-risk sample. Prenatal risk may compromise the quality of mother-infant interactions, thus inhibiting children's subsequent emerging self-regulation capacities.

P2-I-165: Testing the unique consequences of maternal sensitivity to distress versus non-distress for infants development

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Sensitive caregiving is characterized by timely, appropriate, and consistent parent responses to infant cues (Ainsworth et al. 1978). Decades of research has documented the enduring influences of early maternal sensitivity on children's development, including their later behavioral and emotional problems (Cassidy, 2016). Contemporary perspectives emphasize that maternal sensitivity in response to infant distress may have unique consequences for children's socioemotional development (Leerkes, 2012; Thompson, 1997). The earliest research testing this idea focused on infant attachment. Indeed, there is now consistent evidence indicating that sensitive responses to infant distress are uniquely associated with the



development of infant attachment security (Leerkes et al., 2009; Leerkes, 2010; Leerkes, et al., 2012; Leerkes et al., 2018; McElwain et al., 2006). Sensitivity to infants' non-distress cues, on the other hand, was not associated with infant attachment quality. A small number of studies have addressed context-specific sensitivity and socioemotional outcomes other than attachment security. This emerging literature suggests that sensitivity in response to infants' distress (but not non-distress) cues may predict lower levels of behavioral problems and lower levels of callous unemotional traits (Leerkes et al., 2009; Wright et al., 2018). The purpose of this study was to extend this body of research by testing the idea that that sensitivity to distress will uniquely predict infants' externalizing behavior problems (e.g., aggression) and internalizing behavior problems (e.g., depression, fear, and inhibition). Participants for this study are drawn from an ongoing longitudinal study of 162 mothers and infants. The current set of analyses are based on 54 participants who completed the 18-month visit. Data collection for the full sample will be completed by June 2020. Observations of maternal behavior during the Still Face Paradigm were collected when infants were 7 months old. Observations of mothers' behavior during the initial 2-minute play episode and the two, 2-minute reunion episodes were coded using the nine 3-point scales from the Global Ratings of Mother Infant Interaction at 7 months (Fiori-Cowley et al., 1999). Based on factor analytic results for this sample, composite measures of maternal sensitivity during play episode (i.e., "non-distress") and reunion episodes (i.e., "distress") were created. One year later when children were age 18 months, mothers reported on infants' externalizing and internalizing emotional and behavioral problems using the Infant Toddler Social Emotional Assessment (Briggs-Gowan et al., 1998). Maternal sensitivity to distress and non-distress were not significantly associated with overall externalizing or internalizing behavior problems. However, analyses focused on the subscales revealed that high levels of maternal sensitivity to distress uniquely predicted lower levels of depressive behaviors (see Table 1). In addition, high levels of maternal sensitivity to distress were marginally associated with less fear (see Table 2). Both of these associations were robust to controlling for infant biological sex, infant race/ethnicity, maternal education, and family income. Altogether, these findings represent promising preliminary longitudinal evidence that supports the hypothesis that sensitivity to distress has a unique significance on the development of emotional and behavioral problems during infancy.

P2-I-166: Association between infant temperament and maternal approach-withdrawal tendencies

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The tendency to pursue unfamiliar and novel experiences or to actively retreat from these interactions has been conceptualized as a component of temperament. In addition, these characteristic responses can be a function of extensive experience with caregivers (Bernier, Calkins, & Bell, 2016). While certain emotions are tied more directly to behavioral withdrawal (e.g., disgust) and others are tied to approach behaviors (e.g., interest/joy), several emotional reactions are a mix of approach and withdrawal motives. The aim of this study was to examine the relationship between maternal and infant approach and withdrawal tendencies and behaviors during a social rival condition along with measures of EEG activity (Diego, Field, & Hernandez-Reif, 2001). Behavioral and physiological data were collected from 50 mother-



infant dyads at 12-months of age ($M=13.06$, $SD=1.03$) during a task designed to elicit negative emotions along with infant approach motivation toward the mother. Specifically, mothers were instructed to ignore their infant and attend to a social rival (or non-social rival as a control). In many cases, the infant attempts to regain preferential attention from the mother. Past studies have demonstrated that this paradigm (Hart et al., 1998) induces distress in infants as well as increasing approach motivation (Mize & Jones, 2012). In addition, self-reports of the mother's approach and withdrawal predilections were measured using the Behavioral Inhibition Scale and the Behavioral Approach Scale (BIS/BAS; Carver & White, 1994) and infant temperament was measured by the Colorado Child Temperament Inventory (CCTI; Rowe & Plomin, 1977). Infant approach and withdrawal responses were coded using second-by-second ratings for: gaze, proximity, touch, vocals, affect and level of arousal. Three minutes of infant baseline EEG activity (across the scalp from frontal to occipital regions) was obtained. Asymmetry scores were calculated for each region, utilizing the alpha frequency band for infants (6-9 Hz, $\ln(\text{right}) - \ln(\text{left})$) (Bell, 2002). Paired sample t tests revealed that the proportions of approach behaviors (e.g., gaze, proximity, touch, total approach, and negative affect) were significantly higher during the social rival condition (ts ranged from -2.46 to -6.08, $ps < .01$) as well as a significant decrease in withdrawal behaviors (ts ranges from 2.85 to 6.08, $ps < 0.005$). Analyses also demonstrated a relationship between maternal BIS/BAS scores with infant temperament measures. BIS scores were related to infants emotionally ($r(50) = 0.34$; $p=0.02$) and approach tendencies whereas BAS-drive and BAS-reward responsiveness were related to infant activity and sociability (rs ranged from 0.30 to 0.37; $ps << 0.04$). Correlational analyses also demonstrated relationships between infant EEG asymmetry and approach behaviors (rs ranged from 0.35 to 0.67, $ps <.05$). Understanding the relationship between maternal propensities to display approach-withdrawal type behaviors and infant temperament are a key importance in understanding the complex relationship between caregivers and their influence on the emotional development of infants. The findings will be further discussed, associating maternal and infant patterns of inhibition and activation to inherent tendencies as well as socio-emotional experiences and neurophysiology during development.

P2-I-167: Distinguishing infant emotion reactivity and regulation: Time course and association with heart rate during still face paradigm

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Introduction: There is an increasing focus on identifying infant markers of later psychopathology with the aim of promoting early identification and intervention for prevention. Emotion dysregulation represents a putative marker of this sort (Nigg,2016). By examining the fine-grained time course of emotional reactions, this study investigates temporally defined behavioural and concomitant physiological markers of emotional reactivity and emotional regulation to both positive and negative emotional stimuli between ages 6 and 12 months. We address two related questions: Can reactivity and regulation be distinguished according to their (i) temporal characteristics and (ii) relationship with heart rate (HR), typically considered a measure of reactivity. Methods: 78 typically developing 6-month-old infants (mean age=6.38, $SD=0.58$) were observed in different mildly threatening (masks task), frustrating (toy retraction, arm restraint) and entertaining contexts (puppet show). Their behaviour was video-recorded and measures of reactivity (e.g. facial affect, vocalisations) and regulation (e.g. looking



behaviour, self-soothing) were coded. HR was simultaneously measured. Results: Figure 1 illustrates summarised and down-sampled data for reactivity, regulation and HR at group level during "still face" task. From this graph, we can see that changes reactivity and HR fluctuations are tightly locked temporally - gradually increasing from just before the start of the trial reaching a peak at around 80 seconds and then declining while regulation showed a different pattern - with. Decline before after the start of the trial and then a constant pattern. Bivariate correlations between composite scores of reactivity, regulation and HR during still face were examined. Regulation was not correlated with reactivity. HR during still face was correlated with reactivity in still face ($r_s = .31$, $p = .045$) and not regulation in still face. Discussion: These preliminary results support the dissociability of reactivity and regulation on mentioned tasks. First, the two elements had different temporal dynamics. Second, reactivity but not regulation was correlated with HR. We will expand our analyses to understand the dynamic features of the time-series data. By doing so, we may identify differences in the relative time-courses of emotion reactivity, and regulation, in response to an emotional challenge. These temporal dynamics of affect are worth exploring, as these micro-level emotion processes may cumulatively constitute a vulnerability to or risk factor for later psychopathology.

P2-I-168: Objective markers of mother and infant behavior predict intraindividual changes in maternal mood and anxiety

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Background: Developmental researchers have long been interested in the dynamic relationship between infant behavior and maternal mental health, particularly given the adverse cascading effects of postpartum mood and anxiety disorders on child outcomes. To date, however, the interplay between infant behavior and maternal mental health has not been studied naturalistically using objective, high-density data. Objective: The aim of the present study is to use objective, naturalistic markers of mother and infant behavior to predict daily within-person change in maternal mood and anxiety. Methods: N=51 mothers of infants (ages 1-10 months, $M=4.6$, $SD=2.5$) were obtained from a mobile-sensing paradigm leveraging wearable sensors to study mother-infant activity in the home. Mothers received 6 daily surveys regarding momentary negative affect (PANAS) and 1 daily survey regarding anxiety (GAD-2) for 7 days total. A diverse set of predictors of mom's mental state were also captured, including objective measures of infant cry duration and frequency, mother and infant nighttime sleep hours and sleep awakenings, as well as self-reports of maternal social support and confidence (Goodman & Gotlib, 1999). Objective measures were obtained automatically via continuous audio recorders worn by infants and actigraphs worn by mothers and infants for up to 72 hours over the course of the week. Results: Hierarchical linear models (HLMs) indicated that 42% and 45% of the variance in negative affect and anxiety, respectively, was within-person (Figure 1). Predictive HLMs were used to predict maternal mental state from within-person variability in objective markers as well as self-report measures. Predictors were tested in independent models with variable-specific, person-centered means included as predictors. We found that higher negative affect was associated with within-person decreases in maternal and infant nighttime sleep hours, maternal confidence, and social support (all $p < .001$). Higher anxiety was associated with within-person decreases in confidence ($p = .03$), social support ($p = .01$),



and unexpectedly, mother nighttime awakenings ($p=.03$). Findings held when including previously-reported negative affect and anxiety, as appropriate, as predictors. Higher than average cry frequency in the 1 and 3 hours preceding survey response--but not cry duration--predicted higher anxiety (both $p<.05$). Cry frequency did not predict increases in anxiety above the previously-reported anxiety level. Discussion: This study is the first to systematically investigate predictors of momentary maternal mental state using time-locked and objective markers of mother and infant behavior in the home. Lower than average mother and infant nighttime sleep hours, as well as confidence and social support, predicted a higher negative affect since the previous report. Lower than average confidence and social support also predicted higher anxiety since the previous report; in contrast, higher than average infant cry duration in the 1 and 3 hours preceding survey response did not explain any change in anxiety above the previously-reported level. Future work will investigate the unexpected finding that less than average mother nighttime awakenings predict higher anxiety; perhaps investigating length of awakenings. Findings point to possible avenues by which to support at-risk mothers, and speak clearly to the promise of ambulatory assessments for accessing mother and infant behavior in the home.

P2-I-169: The emergence of self-regulation from infancy through toddlerhood

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From infancy through toddlerhood, young children progress from relying on their caregivers as a source of external regulation to self-regulating their own affect and behavior. The development of self-regulation is a dynamic process that involves children's neural and physiological development as well as their cognitive and emotional development. Typically, the specific factors that contribute to infants' and toddlers' self-regulation are examined with cross-sectional studies. Here, we examine the emergence of self-regulation from infancy through toddlerhood using a cross-lagged panel model across a three-wave longitudinal study. One hundred fourteen children and their mothers participated in the Face-to-Face Still-Face Paradigm (FFSF) when children were 4-to-6-months-old. This task involves a mild social stressor and consists of a social play phase where mother and child interacted normally, followed by a two-minute still-face phase where the mother ceased all interactive cues, and then a reunion phase where the dyad resumed social interaction. Changes in the activity of the vagus nerve during the social stressor (still-face) - as measured by respiratory sinus arrhythmia (RSA)-- was used as an index of infants' regulation. Infants' physiological and behavioral responses to stress during the still-face and reunion phases were used as a measure of self-regulation. At 26 months and 36 months, children returned to the lab to complete a battery of executive function (EF) tasks examining response inhibition, including two Stroop tasks and a delay of gratification paradigm. Maternal sensitivity was measured during a dyadic puzzle-solving task. Parents also completed the Early Child Behavior Questionnaire (ECBQ; Rothbart & Bates, 2006) at 26 months and the Child Behavior Questionnaire at 36 months to assess three dimensions of toddlers' temperament, with a particular focus on the domain of effortful control. Performance on response inhibition EF tasks was standardized and combined into a composite for each child. Cross-lagged panel models were used to examine the stability of maternal sensitivity and regulation constructs across ages, as well as inter-relationships between variables (see Figure 1). Response



inhibition at 26 months was significantly predicted by: 1) greater distress during the reunion phase of the FFSF during infancy 2) concurrent maternal sensitivity on the puzzle tasks and 3) higher effortful control scores on concurrent parent reports on the ECBQ. Response inhibition at 36 months was associated with 1) response inhibition at 26 months 2) effortful control at 26 months and 3) concurrent maternal sensitivity. <p> These results highlight the importance of both infant and maternal factors for the development of self-regulation in early childhood. Moreover, these results underscore how mild distress can be adaptive for infants. Infant distress during reunion may reflect an ongoing 'interactive repair' process: through communicating their discomfort, infants are then afforded opportunities to correct affective mismatches and co-regulate with their caregivers, thereby building resiliency and improved regulatory skills over time (Tronick, 1989; DiCorcia & Tronick, 2011).

P2-I-170: Infant sleep disruption and postpartum depression: The mediational roles of maternal sleep and maternal adaptation to infant sleep

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Postpartum blues is a mild mental disorder women experience during the first week after childbirth that if ignored and untreated may continue to postpartum depression (PPD; Maliszewska et al., 2016). Emerging evidence indicates that roles of infant and mother sleep disruptions (Okun, 2016) as well as maternal adaptation to their babies sleep (MAIS; Countermine & Teti, 2010) are important determinants of mothers' PPD. Over the first several weeks of life, infants wake often all throughout the day/night. But after 6 months, sleep is more consolidated, thus infants wake less during the night. The current study aimed to investigate the direct and indirect effects of infant sleep quality on maternal PPD through maternal sleep quality and MAIS sequentially and whether the same pattern held in early vs. the later half of the infant first year of life. Data during infants' first year of life were drawn from a federally-funded study of parenting, infant sleep and child outcomes. Sample of healthy mother-infant dyads (N=167, 47% male) were utilized in the current study. In assessing infants' and mothers' sleep quality, average sleep wake duration in minutes averaged across seven consecutive nights at 1, 3, 6, 9 and 12 months were recorded using AW-64 actiwatches (Philips/Respironics, Inc.). Mother-reported adaptation to infant sleep was assessed via a composite measure of maternal adaptation formed by selected scales from the Sleep Practices Questionnaire (SPQ; Keller & Goldberg, 2004). Mothers' PPD was measured via the depression subscale of Symptom Checklist-90-Revised (SCL-90-R; Derogatis, 1975). The serial mediation analyses investigated whether mother sleep quality and MAIS mediated the relations between infant sleep quality and maternal depression. All paths for the serial mediation model are shown in Figure 1. The direct and indirect effects were computed using the bootstrapping procedure via the PROCESS macro in SPSS (Hayes, 2013). To capture the developmental effects of infant sleep quality on mothers' PPD during the early and later half of the first year, a series of separate mediational models was utilized with the same variables at different time points. The results showed significant mediational pathways across the first half of the year, but not in the second half. Specifically, there were significant sequential indirect effects of infant sleep wake duration at 1 month on maternal PPD at 3 and 6 months, such that longer duration of wake time in infant sleep predicted longer wake duration in mothers' sleep which in turn predicted lower MAIS which then predicted higher maternal PPD (Table 1).



These findings implicate that infant sleep quality in the early weeks post partum may have longitudinal effects on mothers mental well-being across the first six months postpartum, through its influence on mothers' own sleep and adaptation to their babies' sleep. These patterns were not replicated at later points in the post partum, suggesting that maternal depressive symptoms after six months may be owed to factors other than infant sleep. Results will be discussed in terms of the time course and antecedents of post partum maternal depression across the first year.

J-Translational Science and Policy

P2-I-171: Co-development of an innovative tool to support young children's parents

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Introduction: Infants living in low socioeconomic conditions are more at risk of developmental problems (Kayrouz, Milne & McDonald, 2017). Developmental problems have important negative consequences on the infant and its parents. Their presence affects infants' abilities to play, realize daily activities at home and participate in daycare activities (Leung, 2010 ; Benjamin, Lucas-Thompson, Little, Davies & Khetani, 2017). It is also associated with high level of parental stress and a lower quality of life (Hsieh, Lin, Huang & Li, 2014). As it is known that family interactions and opportunities offered in living environments strongly influence infants' development, interventions supporting these families in the establishment of a stimulating environment are critically needed to prevent these negative impacts (Irwin, Siddiqi & Hertzman, 2007). Objectives: In this regard, this study aimed to co-develop an educational tool on early childhood development that is accessible to all families, regardless of their socioeconomic status, and used in primary healthcare and community settings. The objectives were to determine which parents' information needs should be addressed in priority and which format would be the most appropriate to reach the families. Methods: Using a participatory action research process, eleven partners, from the Quebec city region, including parents, community workers, health professionals and managers joined forces with the researchers to develop the tool. Through two group working sessions, structured with the Technique of Research of Information by Animation of a Group of Experts (Gervais & Pepin, 2002), they reached consensus regarding the information and the format of the tool. Results: In an attractive and useful format of a scale to measure child's height, this tool will respond to three priority information needs of parents. First, it will address their needs of strategies to use in the daily routine to stimulate their children's autonomy development in a pleasant way. Explanations about the graduation of the strategies according to the child's age and abilities will be given. Second, it will respond to the parents' needs of knowledge regarding the signs indicating that an early screening is recommended to ensure the infant is developing well. Third, it will inform parents of the available resources that can refer them to the right professionals or services for their infant. Conclusions: This tool could help parents create a positive environment for their infant's development and guide them in case of needs of professional help. It could also be used in primary healthcare and community settings as an intervention promoting infant development. Moreover, the process conducted to develop this



tool could inform service decision makers about the particular things to consider to adapt interventions for families living in low socioeconomic conditions so that they could be more accessible for them and meet their needs.

P2-I-172: Bedtime coparenting quality and nighttime parenting practices as predictors of infant sleep duration across the first year

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For many parents, the development of infant self-regulated sleep is a desired developmental achievement during the first year. Perhaps as a consequence, parents' ability to understand and respond to their child's needs at night and how nighttime parenting and coparenting influences infant sleep regulation have become important concerns to both clinicians and researchers. Recent work (Voltaire & Teti, 2018) has demonstrated that nighttime parental interventions in response to infant non-distress (parent-initiated nighttime interventions) predicted poorer infant sleep regulation across the first year, suggesting that parent-initiated nighttime interventions with infants are detrimental to infants' ability to develop self-regulated sleep. The present study extended these findings by 1) examining socio-demographic and psychosocial predictors of parent-initiated nighttime interventions in the first year and 2) investigating the unique role of observed bedtime coparenting quality and parent-infant nighttime interventions in predicting infant sleep regulation across the first year. Videorecorded data from 5 occasions (1, 3, 6, 9, and 12 months postpartum) were used to identify parent-initiated nighttime interventions, denoted by behavior directed to a non-distressed infant (e.g., infant is asleep or awake but non-distressed). At 1 month, mothers also reported their age, income, education, coparenting, and anxieties about their infants' nighttime needs. Videos were also used to code bedtime coparenting quality at 1 month (McDaniel & Teti, 2015). Stepwise regression analysis indicated that the total number of parent-initiated nighttime interventions in the first year postpartum was significantly predicted by maternal nighttime anxiety ($B = .204$; $p < .05$) and perceived positive coparenting at 1 month ($B = -.081$; $p < .05$). Specifically, higher levels of maternal nighttime anxiety and lower levels of perceived coparenting support, early in parenthood, predicted higher rates of parent-initiated interventions in the first year. Maternal age, education and income were not significant predictors. A growth model, including bedtime coparenting and nighttime parenting practices as predictors of infant sleep duration, confirmed that higher levels of parent initiated interventions were independently linked to a flatter increase in infant sleep across the first year ($y = -.075$; $p < .05$). Observed bedtime coparenting hostility at 1 month was independently linked not only to initial levels of infant sleep but also the rate of change in sleep over time such that infants of parents who exhibited higher levels of hostile/competitive coparenting slept for fewer minutes at 1 month ($y = -24.82$; $p < .05$) with a steeper increase in infant sleep duration across the first year ($y = 2.22$; $p < .05$). Collectively, these findings show that mothers who experience less supportive coparenting and more anxiety about their infants' nighttime needs at 1 month are at risk for engaging in nighttime parenting practices that may impede the development of infant self-regulated sleep across the first year. These findings contribute to a clearer understanding of early and salient predictors of nighttime parenting competence and infant sleep regulation. Intervention programs that address maternal concerns around infant nighttime needs and encourage partner support and cooperation, prenatally or early in



parenthood, may be helpful in improving nighttime parenting competence and infant sleep.

P2-J-173: Following baby back home: Evaluation of home based parenting support for low-birth-weight preterm infants

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The benefit of home visiting programs on the mortality, health and development of at risk families and their children have been documented with some of the most effective programs have been provided by nurses and nurse/social worker teams (Donovan et al., 2007; Meghea, You, & Roman, 2015; Olds et al., 2014). Low-birthweight (LBW) preterm infants are at increased risk for death and long term health, development and behavioral morbidity (Willis, 2008). They present significant and unique financial, physical and emotional challenges to their families due to their medical fragility. The time of transition to home after discharge from Neonatal Intensive Care Unit (NICU) is a time of particular need for families; including the coordination of health care and other services. Home visiting programs which target LBW preterm children have previously been shown to improve some aspects of parenting and parent/child interaction, but there has been little evidence demonstrating improved health of these high risk children (Goyal, Teeters, & Ammerman, 2013; Spencer-Smith et al., 2012). The Following Baby Back Home (FBBH) program supports families as they manage their high-risk LBW preterm infants after discharge from the NICU. Home visiting teams, which include a Registered Nurse and licensed social worker, facilitate appointments to the family's medical providers, monitor health and development, and work to assure follow up appointments to subspecialists when needed. Parents of LBW preterm infants, in general, face greater challenges in parenting their children. FBBH teams monitor for parental mental health and parenting behaviors and make referrals as needed. FBBH infants were matched with children in the control group based on 1:1 propensity matching (D'Agostino, 2005) based on infant's demographics, mother's demographic and prenatal behaviors, socio-economic, and medical conditions. The sample includes 418 children in the FBBH group and a propensity matched control group of 418 children (see Table 1). The non-FBBH matched control group infants had significantly higher odds (aOR=7.40 [95% CI=2.56-21.44], $p<.001$) of infant mortality than those managed in the FBBH program. Healthcare utilization differed across groups (see Table 2) where infants in FBBH were significantly more likely to have more visits in the 1st year of life where immunizations were provided and to have significantly higher odds of having had at least 4 immunization visits in the 1st year. Infants in FBBH are significantly more likely to have both routine and non-routine medical appointments from discharge from NICU through their 1st birthday, but also more hospital and emergency department use. A goal of the FBBH intervention is to work with parents to educate and support them as they care for their medically fragile infants, to attempt to assure that they receive the medical care necessary to maintain the health of their infants, and to facilitate compliance with their medical regimens. We speculate that the education and support provided by FBBH resulted in the families using medical care more frequently when needed which resulted in more healthcare utilization of every type earlier in development, which leveled off to include mainly routine and specialty care as the infants develop.



P2-J-174: Effects of material properties on grasping in 11-months-old infants

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The effects of material properties on infants' reaching for objects have been rarely investigated. Although there have been studies examining infants' material-dependent object exploration, few have investigated the relevance of object rigidity for infants' kinematic reaching patterns. Therefore, the aim of this study was to examine infants' unimanual reaching movements for objects of different rigidity following visual and visual-haptic object exploration. 11-months-old infants and, for purposes of comparison, adults were tested. Two objects weighing 500 grams were manufactured, which had two handles made out of different soft and rigid materials. Participants were encouraged to lift the objects while their reaching movements were measured using a quantitative motion capture system (Vicon). In the visual condition, material rigidity was presented only visually by knocking and pushing the handles down with a stick (see Figure 1). In the visual-haptic condition, participants manually explored the objects and therefore gained visual and haptic material information. We expected increased reaching frequency towards the rigid handle due to its higher functionality for lifting heavy objects. Results showed that infants grasped the soft object handle more frequently than the rigid handle in both conditions. Adults, by contrast and as expected, consistently grasped the rigid handle. Analyses of kinematic variables revealed differences in terms of material rigidity. Infants' maximum movement speed, trajectory straightness and hand aperture were significantly higher in soft than in rigid materials in both conditions. Adults, however, showed straighter trajectories towards rigid than soft materials in both conditions. Reaching kinematics also differed with respect to the perceptual condition. In both age groups, movement duration was significantly lower in the visual-haptic than in the visual condition. In addition, infants' number of movement units were lower and trajectories were straighter in the visual-haptic condition compared to the visual condition (see Figure 2). The results provide empirical evidence that material properties and their visual or visual-haptic encoding influence infants' reaching movements. 11-months-olds showed a clear preference for grasping soft materials, whereas adults constantly reached for rigid materials. This indicates that infants' reaching behaviour is not guided by the functionality of the material at 11 months. Furthermore, infants' kinematic variability in reaching movements not only declined after visual-haptic encoding of the materials, but was also lower in soft materials over both conditions (see Figure 2). These results demonstrate that infants' kinematic reaching patterns are influenced both by material rigidity and perceptual condition.

P2-J-175: Successful object exploration during infancy is associated with advanced postural and locomotor skills

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INTRODUCTION. Postural control and locomotor skills have been shown to facilitate early reaching and object exploration. For example, the development of independent sitting frees



infants' hands for reaching and object exploration (Harbourne, Lobo, Karst, & Galloway, 2013; Lobo & Galloway, 2008), allows visual inspection (Soska, Adolph, & Johnson, 2010), and advances visual-manual coordination (Bertenthal & von Hofsten, 1998; Hopkins & Rönqvist, 2002; Rochat & Goubet, 1995; Thelen & Spencer, 1998). The onset of crawling and walking allows children to approach objects, carry them around, and share them with others (Karasik, Tamis-LeMonda, & Adolph, 2011), thus, further facilitating object exploration. The question is whether the beneficial effects of advanced gross motor skills would be observed for both simple and more sophisticated object manipulations. As early object exploration is a path to children's cognition (Jouen & Molina, 2005), it is important to understand the role of gross motor skills in the development of object exploration. The goal of the current study was to explore the relation of infants' postural and locomotor skills to their simple and difficult role-differentiated bimanual manipulation (RDBM) of objects. METHODS. In this longitudinal study, eighty-five infants (52 males) were tested for: 1) RDBM (poking, stroking, pushing, spinning, pulling, or inserting movable parts of a toy or multiple toys) during play with 20 complex toys monthly from 9 to 14 months; 2) gross motor development (sitting, crawling, standing, and walking onsets) using Touwen's (1976) Group III Neurological Assessment Scale monthly from 6 to 14 months. From the RDBM assessment, the number of performed RDBMs (simple: poke and stroke; difficult: pull, spin, insert, push) was determined. All analyses were performed in HLM. RESULTS. Infants with more advanced crawling, standing, and walking skills performed significantly more difficult RDBMs, whereas there was no significant relation between infants' onset of gross motor milestones and their performance of simple RDBMs (see Tables 1 for estimated statistical parameters). DISCUSSION. Current results suggested that advanced locomotor skills might facilitate infants' sophisticated object exploration and manipulation. Interestingly, the advantage of locomotion was recorded only for the difficult (likely more sophisticated) RDBM object exploration, which may require understanding of object affordances and an ability to plan and implement appropriate manipulations, rather than for the simple, often accidental, type of object RDBM. We propose that postural and locomotor experience provide ample opportunities for infants to manipulate objects and explore their affordances, properties, and relations among different objects or parts of the same object, which, in turn, produces superior performance in RDBM.

Poster Session 3

A-Motor and Sensorimotor Processes

P3-A-1: Positive effects of START-Play intervention on reaching and cognitive outcomes in young children with motor delays

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Introduction: Reaching ability allows infants to explore objects and to gather information about the environment to advance their cognitive development (Corbetta & Snapp-Childs, 2009; Gibson, 1988; Lobo & Galloway, 2013). Motor delays can negatively impact reaching, object exploration, and cognitive outcomes (Bornstein et al., 2012; Jouen & Molina, 2005). The START-Play intervention was designed to advance cognition by improving sitting, reaching, and problem-solving abilities in young children with motor delays (Harbourne et al. 2018). Here we evaluate the effects of the intervention on reaching and cognitive outcomes. Methods: Participants were 134 children (39.8% females), 7-16 months old (prematurity-corrected age) at the beginning of the study (M=10.7, SD= 2.7); 67 (50%) had mild and 67 (50%) had severe/moderate motor delays. Children were randomly assigned, stratifying by severity level of delay, to receive their usual care (control group) or their usual care plus START-Play intervention (START-Play group) for three months. They were assessed at baseline, post-intervention (immediately after the three-month intervention), and at a follow-up 6 months after baseline. Each assessment was video-recorded; assessors and coders were blind to group assignment. The reaching assessment consisted of five 20-second trials, where children were encouraged to interact with an interesting toy presented at hip, chest, and eye level. Reaching behaviors coded using Datavyu software (intra-rater: 97.2±2.1%, inter-rater: 96.8±1.8% reliabilities) were: 1) frequency of all object contacts; 2) frequency of bimanual object contacts; and 3) number of times switching among behaviors per minute (bouts of behaviors). Cognitive outcome was measure using the Bayley-III cognitive subscale. Piecewise generalized linear mixed modeling was used to analyze trajectories of reaching behavior and cognition across time in the control and START-Play groups during the three months of intervention and the three months of follow-up. Results: Results suggested START-Play intervention improved children's reaching ability. There was a significant time by group effect on frequency of all object contacts ($p=.034$) and bimanual contacts ($p=.044$) in which the START-Play group increased their frequency of contacts from baseline to post-intervention at a faster rate than the control group (all contacts relative rate [RR] = 1.47 [START-Play] vs. .113 [control]; bimanual contacts RR = 1.66 vs. 1.16). Among children classified as having moderate/severe motor delays, there was a significant time (baseline to 6-month follow-up) by group effect on bouts of reaching behavior ($p=.026$) in which the START-Play group increased their bouts of reaching at a faster rate than the control group (RR = 1.56 vs. 1.10). For both groups, there were significant changes in cognition from baseline to post-intervention and follow-up ($p<.001$), with no significant group difference in rates of change when aggregating across severity levels. However, among children with moderate/severe motor delays, the START-Play



group demonstrated greater growth in cognition from baseline to follow-up than the control group ($p=.031$, Hedges' $g = .32$). Conclusions: START-Play intervention advanced reaching and cognitive skills for young children with motor delays over and above usual early intervention, with more lasting improvements identified for young children with moderate to severe motor impairments.

P3-A-2: Movement during nighttime wake episodes reflects the onset of crawling and walking

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Despite an overall decrease in night wakings over the first year, infants experience a spike in night wakings when gaining new motor skills. For example, infants who can crawl awaken more often at night than infants who cannot yet crawl and the onsets of pulling-to-stand and walking disrupt sleep-wake regulation (Scher, 2005; Atun-Euny & Scher, 2016; Berger & Moore, 2019). To address the underlying mechanisms of this relationship, we describe how infants' nighttime wake episodes (WEPs) serve as opportunities to practice new motor skills. Do the types of movements produced during nighttime WEPs change as infants expand their locomotor repertoires? Parents of three infants kept diaries of infant sleep schedules and motor milestone onsets. Video data were collected using Nanit, a commercial home baby monitor, which livestreams video of the infant's crib to parents' smart devices. 98 hours of video of infants in their cribs from the nights before, of, and after infants first began crawling ($n = 2$; 1 male) and walking ($n = 1$ male) were coded using a video-coding software for identifying frequencies/durations of behavior. Motor behaviors during nighttime WEPs were coded from video (see Table 1 for definitions). To meet criteria, WEPs had to occur 10 minutes after sleep onset, last five or more minutes, and have codable movement at least once every 3 minutes. A WEP ended with the last movement before five minutes of continuous stillness. On average, infants exhibited twice as many movements per WEP minute on the night of locomotor onset ($M = 2.65$, $SD = 1.74$) than the nights before ($M = 1.81$, $SD = 0.88$) and after ($M = 1.54$, $SD = 0.33$). There were twice as many types of movements during WEPs on the night of locomotor onset ($M = 11.00$, $SD = 2.65$) than the nights before ($M = 5.67$, $SD = 2.08$) and after ($M = 5.67$, $SD = 1.15$). Types of movements during WEPs were more variable during the night of locomotor onset than on the nights before or after. Type of movement was related to skill onset: the only time an infant crawled during a WEP was on his night of crawling onset and the only time an infant stood independently during a WEP was on his night of walking onset. The only night infants rotated on hands-and-knees during a WEP was the night they learned to crawl. Infants shifted sleep position the most on the night after skill onset. Mean proportions of movement types out of total movements are displayed in Figure 1. Data collection is ongoing. Infants moved more and expressed greater diversity in movements during WEPs when they reached new locomotor milestones. We also demonstrated that Nanit, a commercially available video baby monitor, is a useful research tool and can provide a detailed glimpse into infants' nighttime crib environments. Infants may experience more disrupted sleep around motor milestone onsets because they are utilizing wake episodes as opportunities to practice their motor skills, prolonging wake episodes and further fragmenting sleep.



P3-A-3: Manual exploration and mental rotation: Crawling 9-month-old infants profit from rotations

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Studies show that the opportunity to explore an object prior to seeing it in a mental rotation task enhances infants' performance on that task (e.g. Slone, Moore, & Johnson, 2018). The current study investigated the question of which part of the manual exploration leads to the beneficial effect. Prior studies (Schwarzer, Freitag & Schum, 2013; Soska, Adolph & Johnson, 2010) suggest that two candidate procedures might be rotations and haptic scans. In order to test which of these manual exploration procedures performed prior to a mental rotation task leads to enhanced spatial object processing, we constrained infants' exploratory experiences with a Shepard-Metzler object by presenting it in an apparatus that allowed either only rotations or haptic scans. A second important influence on mental rotation performance in infancy is crawling experience, meaning that especially crawling infants are able to mentally rotate objects (e.g. Schwarzer, Freitag, Buckel & Lofruth, 2013). Therefore, a first experiment was conducted with infants that had crawling-experience for at least 4 weeks, to investigate the impact of different exploration procedures. 19 9-month olds (M = 9 month, 19 days, SD = 7 days; 5 m, 14 f) participated in experiment 1 and were randomly assigned to a rotation or a haptic scan group. Participants could either rotate a simplified Shepard-Metzler-object around 240° or execute haptic scans on the fixed object, which was presented from three perspectives covering 240° of the object. Infants had three minutes to explore the object. Afterwards they were tested for mental rotation by watching the original and the mirror-object consecutively rotating through the left 120° in a continuous motion. Looking-times were recorded. The analysis is based on preference scores (in %) for the mirror-object. A univariate ANOVA (rotation vs. haptic scan) revealed a significant effect for condition ($F[1,17] = 4.96$, $p = .04$, partial $\eta^2 = .226$). A post-hoc analysis indicated a significant familiarity preference ($t[11] = -3.02$, $p = .026$) in the rotation condition, whereas infants in the haptic scan condition performed at chance level ($t[7] = -.14$, $p > .05$, ns.). To see if this effect also occurs for non-crawling infants, a second experiment was conducted, including 20 9-month-olds (M = 9 months, 15 days, SD = 8 days; 13 m, 7 f) with no or less than 4 weeks crawling-experience. Methods in experiment 2 equal the methods from experiment 1. A univariate ANOVA (rotation vs. haptic scan) revealed no significant group differences ($F[1,18] = .099$, $p > .05$, ns.). Post-Hoc tests revealed no significant preferences, neither in the rotation condition ($t[12] = .53$, $p > .05$, ns.) nor in the haptic scan condition ($t[6] = .77$, $p > .05$, ns.). The preliminary results support the hypothesis that rotating an object provides important spatial information that is beneficial for mental rotation. They confirm results from previous studies showing that exploration and crawling experience have an effect on spatial object processing, and, in addition, support the idea that one specific exploration procedure, namely rotation, might be essential.

P3-A-4: Cascading effects of 6-month motor skills on 12-month motor and cognitive development in extremely preterm and full term infants

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Introduction Motor development of extremely low gestational age (ELGA > 28 weeks) infants is affected by the first months of life throughout childhood and adolescence, even in absence of major brain damages (de Kievet et al., 2009; Mansson & Stjernqvist, 2014; Sansavini et al., 2014). Despite this evidence, studies examining the predictive value of early motor assessment on later motor development in the ELGA population are very scarce. Early motor development may also have cascading effects on the cognitive domain (Lefebvre et al., 2016; Oudgenoeg-Paz et al., 2017; Zuccarini et al., 2017). However, studies examining the specific contribution of early gross and fine-motor skills on 12-month cognitive development in the ELGA population are lacking.

Aims and Hypothesis The current study aimed at analyzing whether 6-month gross and fine-motor skills were related to 12-month gross- and fine-motor and cognitive development and predict 12-month motor and cognitive delay, controlling for 6-month cognitive skills and neonatal status (ELGA vs. full-term- FT). We expected to find significant intra-domain and inter-domain relationships and early motor skills predicting later motor and cognitive delay.

Methods Twenty ELGA infants with no major cerebral damages and 20 FT (GA \geq 37 weeks) infants were observed longitudinally at 6 and 12 months (corrected age for ELGA infants). Gross and fine motor skills and cognitive skills were assessed with the Griffiths Mental Developmental Scales (Griffiths, 1996) by a trained psychologist.

Results Hierarchical linear regression analyses showed that 6-month gross-motor skills predicted 12-month gross-motor skills ($\beta = .73$, $p < .001$), fine-motor skills ($\beta = .58$, $p < .001$) and cognitive skills ($\beta = .65$, $p < .001$). Six-month cognitive skills contributed to explain an additional amount of variance of 12-month gross-motor skills ($p = .023$), whereas neonatal status contributed to explain an additional amount of variance of 12-month cognitive skills ($p = .005$). In addition, logistic regression analysis revealed that gross-motor skills predicted 12-month gross-motor delay ($B = -.27$; $OR = .766$).

Conclusions Findings revealed that early gross-motor abilities have intra-domain cascading effects on motor development, cross-domain cascading effects on cognitive development and they can be considered an early index for identifying delay in the gross-motor domain. In addition, results showed that, besides early gross-motor skills, cognitive skills and neonatal status may affect, respectively, later gross-motor and cognitive outcomes. Our findings highlight the importance of repeatedly assessing gross-motor skills in healthy ELGA infants in the first year of life in order to identify infants delayed in these abilities and implement timely interventions. This may reduce the impact of impaired early gross motor skills on later development, both within the motor domain and across other domains.

P3-A-5: Infant and toddler hand preferences predict differential stacking ability in toddlerhood

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Objective. Early hand preferences impact how infants play. Of note, object stacking emerges more quickly for infants with early, stable hand preferences, both left and right, than infants without a preference or with an unstable right preference (Marcinowski et al., 2016). It is unknown whether hand preferences continue to predict the development of object stacking following initial emergence through toddlerhood. Children who exhibit a stable, lateralized



hand preference during infancy and toddlerhood are expected to stack taller towers, than children who show no preference or are unstable. Methods. A sub-sample of 61 infants (28 females) were recruited from a larger longitudinal project (n=380) and brought into the lab for 16 monthly visits during infancy (6-14 months) and toddlerhood (18-24 months). Researchers gave infants a handedness assessment and behavioral coders marked which hand was used to acquire each object from video. A proportion of right-hand use to total hand use was calculated per visit. During toddler visits, researchers assessed participants for toddler handedness and stacking. The toddler handedness assessment comprised 29 objects, each object designed to elicit a role-differentiated bimanual manipulation (RDBM), or a bimanual manipulation where one hand (non-preferred) supports the manipulation and/or exploration of the object by the other (preferred) hand. Coders marked which hand performed the exploration and a proportion of right-hand use was calculated per visit. For the stacking assessment, toddlers were given 4 sets of stacking toys and coders marked from the highest tower produced within a 30 second trial across all presentations at each visit. Using group-based trajectory modeling, participants were grouped into infant (Stable/right, Shifting/right, Left, No) and toddler (High/right, Moderate/right, Left, No) handedness trajectory classifications. Primary hypotheses were tested using longitudinal multi-level modeling. Results. For both infant and toddler preferences, no slope differences were found for stacking ($p>0.11$). Toddlers who had a shifting/right preference had significantly lower intercepts ($p<0.01$), than other infant preference groups (Figure 1). Toddlers with a high/right preference had significantly higher intercepts ($p<0.01$), than all other toddler groups (Figure 2). Conclusions. Although hand preferences did predict stacking performance, our predictions were not fully supported. Infants with an early, shifting right preference did not perform as well as other more stable, lateralized preferences; while toddlers with a right preference performed better, than all other toddler groups. Infants with an unstable preference and toddlers with a high proportion of right-hand use performed as expected; yet, in both age periods, children without a hand preference performed similarly on stacking tasks to children with stable, lateralized preferences. Exhibiting a stable, lateralized preference may play a role in the development of play, but other factors may be at work. For example, parents are more likely to use their right hand and engage their infants' right hands during play (Michel & Harkins, 1988); thus, scaffolding may be more effective for toddlers with a stable right preference. Handedness does explain differences in trajectories of stacking; nevertheless, neither stability nor direction wholly explains the relation of lateralized hand use to stacking.

P3-A-6: Infants' spontaneous locomotor activity at home

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A century of research on the development of walking examined how well infants walk and how adaptively infants navigate obstacles. But researchers still know little about infant's spontaneous locomotor activity. Previous research is largely limited to single visits in structured lab playrooms for relatively short periods of time (10-30 minutes). Thus, previous work cannot reveal whether infants' activity in a novel playroom is representative of what they do in the familiar home environment or over longer time periods, and it cannot address whether home-related or temperamental factors contribute to everyday locomotor activity. We video-recorded 29 walking infants (13-, 18-, and 23-month-olds, 15 boys; final N = 36 infants,



12 per age group) during everyday activity at home (2 hours for each of two visits within a week). In addition, we measured room dimensions and mapped open space to describe environmental opportunities for locomotion, and mothers completed the CBQ-VSF temperament scale. We aimed to: (1) characterize how much infants locomote during natural activity at home; (2) test whether the quantity and distribution of activity changes across development; (3) test the stability of locomotor activity across time--within and across days; (4) determine whether the amount of available space in the home influences infants' locomotor activity--how much they move and where they go; and (5) test whether infant temperament is related to locomotor activity. Preliminary analyses of 29 infants (1 hour per visit) indicates that infants move in short bursts of time-distributed activity (see timelines in Figure 1). The average bout of locomotion lasted only a few seconds ($M = 1.71$ s) and infants produced $M = 193.57$ bouts of locomotion per hour, with brief bursts of movement separated by longer periods of rest. Average bout length and number of bouts per hour did not differ by sex or change across age, all $ps > .10$. The short bouts of locomotion added up. Infants spent $M = 21.5\%$ of each hour in motion, and time in motion was consistent across age, $p = .73$. Although time constrained (in highchairs, car seats, caregivers' arms, etc.) is largely dictated by caregivers, time in motion is presumably determined by infants. Figure 1 reveals large individual differences in infants' locomotor activity (e.g., time in motion ranges from 5% to 38% of each unconstrained hour). Locomotor activity is relatively stable from one visit to the next: time in motion ($r = .47$, $p < .01$), number of bouts per hour ($r = .37$, $p < .05$), number of falls ($r = .77$, $p < .01$), and time constrained ($r = .36$, $p < .06$); see Figure 2. Home size ranged from 46.6 to 173.3 mt^2 ($M = 76.5$). Further analyses will include steps/hour, surfaces and locations visited, and test whether space to move and infants' temperament (surgency scores) are related to individual differences in infants' locomotor activity. Findings may have clinical relevance for identifying infants at risk and for designing therapeutic interventions to facilitate locomotor activity in infants with typical development and developmental disabilities.

P3-A-7: Developmental change of sensorimotor modules during early infancy

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From early developmental phase, human infants exhibit complex and various spontaneous whole-body movements. It is often assumed that sensorimotor experiences evoked by such kinds of spontaneous movements have an essential role for maturation of sensorimotor modules. Although motor output patterns have been well characterized, whether and how a human infant acquires and augments these types of motor modules remains unclear. In this study, we collected detailed whole-body motion data from neonates and infants, and quantifiably estimated sensorimotor modules using musculoskeletal dynamic simulation (Figure). We first conducted a full-body motion capture of the spontaneous movements of 11 neonates (within seven days after birth) and 10 infants (three-months-old) with 12 infrared cameras. After obtaining the 12 joint movements with 26 degree-of-freedom through inverse kinematics, a total of 144 muscle activities and proprioceptive sensory feedbacks were estimated by a musculoskeletal dynamic simulation. Next, we quantified the sensorimotor interaction by calculating the information flow between all muscle pairs of muscle activities and proprioceptive sensory inputs using the Granger causality. Finally, we identified sensorimotor modules infantile sensorimotor modules among muscle activities and



proprioceptive sensory inputs based on Infinite Relational Model (IRM). We consequently demonstrated that the infants had a smaller number of modules than that of the neonates for leg sensorimotor interaction, whereas had about the same number of modules for arm sensorimotor interaction (the comparisons between neonates vs infants were as follows, number of arm modules 7 vs 8; number of leg modules 13 vs 8). By combining the measured kinematics and musculoskeletal dynamic simulation, we identified the infantile sensorimotor modules among muscle activities and proprioceptive sensory feedback during spontaneous movements. Our results demonstrated a developmental reduction of the sensorimotor modules in leg, which is consistent with previous research that suggests the argumentation of motor modules in the early developmental phase.

P3-A-8: Are body movements a cue for understanding the infant's mood?

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We still only have a relatively superficial knowledge of the infant's emotional expression and its development. Many studies on parental understanding of vocalization or facial expression have demonstrated that adults interpret and respond to these cues very early on. Using videos, Irwin (2003) has examined whether parent and nonparent can detect infant distress in the visual and acoustic signals within the cry. Participants rated distress in 3-, 6-, 8-, and 12-month-old infants' cries that were manipulated to isolate the infant's facial expressions, vocalizations, and body movements. The results showed that parent and nonparent rating did not differ for high- and low-distress cries on the basis body movements. In order to further determine the contribution of body movements to the infant's emotional expression, the present study aims to test the interpretation of this signal before infants show a clear control of their vocal, facial and gestural expression. The EMO-MOVE task consists in 20-second long videos of 4-month-old infants filmed in a positive or a negative mood. Stimuli were prepared in order to provide only the facial cue (FAC condition), the vocal cue (VOC condition), or the motor cue (MOV condition). The ECO condition was the original film. An E-Prime® presentation is used to random the stimuli in blocks for each condition and to record the participants rating of the valence (positive / negative) and intensity (visual scale) of the emotion, and the confidence of their response (visual scale). Each block of stimuli is presented twice. In a first experiment, 44 mothers (mean age 32.7 y) were presented with 10 videos in the FAC, VOC, MOV or ECO condition (11 in each group). Results showed that the MOV condition was the most ambiguous condition. However, mothers identified the infant's mood in the MOV condition consistently in 3 videos, i.e. at a higher rate than chance (E, F, M; Fig. 1). A second experiment was completed on a larger sample. Forty students (mean age 22.6 y) were presented with 12 videos in the MOV or ECO condition (22 in each group). Results showed that the MOV condition was still ambiguous but that the students identified consistently the infant's mood in 5 videos (B, C, D, E, F, Fig. 2). However, students sometimes reversed their conclusion between the ECO and MOV conditions (C, D). These experiments showed that even if they are not easy to grasp, body movements contribute in a certain way to the infant's emotional expression (Trevarthen, 1986). Mothers and students indeed a few times coincided on their interpretation of the infant's mood based on this signal. Beyond this conclusion, more research is needed to better understand why were body movements sometimes interpreted as revealing a positive mood, whereas the infant was identified as having a negative mood when all the cues were available?



P3-A-9: Parent sensitive play predicts the development of problem solving skills in young children with motor impairments

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Objective: Parents who are sensitive to their child during play, encourage social exchanges, and support exploration of objects and environment, which promotes problem solving (Cress, et al, 2007, Smidt & Cress, 2004). In this abstract, sensitive play is defined as parent provision of cognitive opportunities and/or pausing after presenting opportunities to allow for the child to execute a self- initiated response. We hypothesize that parents that demonstrate sensitive play will significantly contribute to their child's development of problem-solving skills. The purpose of these analyses was to evaluate the impact of early parental sensitive play on the development of problem solving in young children with motor impairment (MI). Methods: Children with MI (n=67, Meanage=10.52 months [SD=2.76]) or typical development (TD) (n=15, Meanage=5.71 months [SD=0.74]) were enrolled at sitting emergence and assessed at 5 timepoints across 12 months. Parent behavior was coded from a 5-minute parent-child interaction assessment (Datavyu) to identify: frequency of parent pause (PP) of at least 1.5 seconds after presenting a language or object opportunity, and duration of parent provided cognitive opportunities (CO) that support exploration and learning. The Assessment of Problem-Solving in Play (APSP), a sensitive measure of problem-solving in young children with TD and MI, was used to assess problem solving at all timepoints. The APSP is behaviorally coded and yields a single weighted score that quantifies change in exploratory skills during play. Multilevel modeling was performed to evaluate associations between PP, CO, and APSP across time. Results: Parents of young children with TD and MI increased their frequency of PP and duration of CO similarly over time (time x group interaction $p's \geq .703$); however, parents of children with TD spent more time presenting CO on average across timepoints than parents of children with MI ($p=.024$). A greater number of PP's relative to baseline was associated with increased rate of change in APSP scores ($p=.025$). A greater duration of CO presentation at baseline was significantly associated with higher APSP scores on average across timepoints ($p=.042$). Conclusions: Parents of children with TD provided more cognitive enrichment during play than parents of children with MI. Regardless of their child's motor ability, as parents increased their frequency of pausing in play, the linear trajectory of their child's APSP score was permanently changed. A higher duration of CO at baseline was associated with higher average APSP across time, discounting motor ability. Parents are their child's first teacher and our findings suggest that early changes in parental behavior are associated with long-lasting effects on their child's play and development of problem-solving skills. Encouraging a parent's sensitive play with their child could be one avenue by which Early Intervention services could change and optimize child developmental outcomes.

P3-A-10: Revisiting mobile paradigms and their data analyses

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To understand the outcome caused by an action, young infants need to detect associations between motor actions and sensory consequences, i.e. they need to detect sensorimotor contingencies. Many operant conditioning studies have used the mobile paradigm to investigate contingency detection in infants aged 2-4 months (Angulo-Kinzler, 2001; Heathcock, Bhat, Lobo, & Galloway, 2005; Rovee & Rovee, 1969; Thelen, 1994; Watanabe & Taga, 2006, 2009). One of the infant's limbs would be attached to a mobile and, when moved, would move the toy too. If the connected limb moves more than the unconnected ones, the detection of contingency is inferred. In such studies, Sullivan & Lewis (2003), Tiernan & Angulo-Barroso (2008), Watanabe & Taga (2009) rejected 40-60% of infants because they scored less than minimum learning rate. In addition, a control condition was often missing (Angulo-Barroso et al., 2017; Merz et al., 2017; Watanabe & Taga, 2006) so that the observed effect could simply have been caused by increasing excitation during the experiment rather than contingency detection. Studies in our lab (Jacquey et al., 2019) using a similar paradigm have confirmed the difficulty of replicating contingency detection. What causes such high participant rejection and poor replicability? In this work, we investigated differences in experimental parameters, data analysis and individual development. In 10 pilot studies with 100 infants aged 3-8 months we tested various stimulus saliencies (human face, lights, sounds), action saliencies (number of contingent limbs, fixed/variable activation threshold), stimulus regions (distal/proximal, lateral/central). From the pilots we derived a new study with a on-off audiovisual stimulus in the proximal space, contingent on the movements of one arm (which we called the "master" arm, and the other - the "slave" arm), with a variable threshold. The participants wore identical wireless bracelets on their wrists; each bracelet had a display, buzzer, and accelerometer. We tested 20 and 17 infants in respectively the test and control groups, aged 6 months. In the test group, when master-arm acceleration exceeded the threshold, both bracelets simultaneously emitted identical lights and sounds. The stimuli presented to the control group were equivalent but noncontingent. In addition to acceleration means, we analyzed extreme value distributions and conditional probabilities of stimuli. One analysis was based on the suggestion by Butko & Movellan (2010) that to optimize contingency detection, infants should alternate moving and freezing. This would yield more extreme values in the distribution of accelerations. Another analysis was based on Watson (1984), who had suggested that the short time span after a movement-stimulus couple should have a particular role in detection, and should cause a higher stimulus probability in this window compared to other times. Ages and Stages questionnaire-3 additionally allowed to test the association between individual development and detection. Our study suggests fast contingency detection only in the test group, lasting 2-3 minutes (Figure1). Consistent with our assumptions, the increase of extreme values is steeper for the master than slave hand in the test group; exceeding both "unconnected" arms in control group (Figure 2). The probability analysis is not shown here. Our study proposes a robust experimental protocol and analysis technique.

P3-A-11: Heartbeat of infant drummer: Allostatic regulation of cardiovascular system in auditory-motor integration at three-month-old

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It remains an open question how humans develop the musicality to coordinate the auditory and motor systems to produce a rhythm (organized pattern of time intervals) with limb movements such as seen in drumming behaviors (Zattore, Chen, & Penhune, 2007). Previous studies showed that even young human infants were able to integrate auditory and motor systems such that they would enhance oral or limb movements in response to the congruent auditory feedback (Rochat & Steriano, 1999; Rovee-Collier, Hayne, Colombo, 2001; Watanabe, Homae, & Taga, 2011). However, little is known about the physiological process in the auditory-motor integration in young infants, although musical performance has influences on stress response and arousal level (Chanda & Levitin, 2013). The current study investigated the behavioral and heart-rate changes related to the congruent auditory feedback of spontaneous limbs movements in 40 three-month-old infants. Four virtual drum-kit devices were attached to the forearms and the lower legs of each infant. The session consisted of the three periods: Pre-period (2min), Test-period (8min), and Post-period (2min). During period Pre- and Post-period, the volume of the speakers was muted in order not to feedback the auditory stimulus contingent to their spontaneous movements to the infants. During Test-period, infants were able to listen to and induce the contingent auditory feedback to their spontaneous movements. According to presence or absence of fussy state during the sessions, we divided the participants to the two subgroups: non-fussy (n = 28) and fussy group (n = 12). Results showed that, consistent with the previous studies, infants increased the frequency of limb movements in response to the congruent auditory feedback regardless of fussy state. Interestingly, we found that the event related heart rate change before and after the onset of auditory feedback (Figure 1) was inhibited gradually over time during Test-phase in non-fussy group, while the fussy infants didn't show the inhibition of the heart rate change (Figure 2). Furthermore, the inhibition of the heart rate change was significantly associated with the decreased variance of movement intervals. These findings suggest that the gradual inhibition of heart rate change may be related to the increase in prediction of the congruent auditory feedback and the goal-directed behavior. The allostatic regulation of cardiovascular system in auditory-motor integration might provide a base for development of musicality to coordinate the auditory and motor systems to produce a rhythm.

P3-A-12: Neural correlates of anticipation in infancy

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Recent research has implicated the prediction of socially rewarding cues as an important aspect of learning in infancy (Tummeltshammer, Feldman, & Amso, 2019; Zhang et al., 2019), particularly in the social domain. Efforts to identify the neural correlates of predictive learning have yielded important information about brain areas involved (Emberson et al., 2019), but the poor temporal resolution of methods used to localize activation has limited the ability to establish how much anticipation is involved in predictive learning. The Stimulus Preceding Negativity (SPN) is an event-related potential (ERP) component that is thought to reflect activation of the dopamine reward system (Van Boxtel & Böcker, 2004), and anticipation of a stimulus or feedback on task performance (Brunia, van Boxtel, & Böcker, 2012). The SPN has been shown to differentiate the expectation of social and non-social information in children (Stavropoulos & Carver, 2014). We have thus far measured the SPN using high-density EEG



(EGI Inc., 128 channels) in a total of seven infants (Mage = 10.83 months, SDage = .97 months; 5 girls) using an associative learning paradigm. Five infants provided usable ERP data. The paradigm is presented in the form of an 8-minute presentation in which a predictor stimulus (S1) preceded a dynamic social or non-social stimulus (S2). S1 was either a colorful square or an X, S2 was either a woman breaking into a smile (social) or a toy truck moving down a ramp (non-social). Counterbalancing was applied such that a square predicted the social stimulus and the X predicted the non-social stimulus for half of the infants, and the X predicted the social stimulus and the square predicted the non-social stimulus for the other half. A paired-sample t-test evaluated the effects of condition with respect to SPN mean amplitude within a time window of -210 to -10ms before the appearance of the dynamic social and non-social stimuli. Preliminary analysis of SPN mean amplitude revealed a trending, yet non-significant effect of stimuli condition ($t(4) = -1.56$, $p = .194$, $d = -.43$), where the infants on average showed an increase in SPN response in anticipation of the social condition ($M_{amp} = -5.32$, $SD_{amp} = 6.35$) compared to the non-social condition ($M_{amp} = -2.9$, $SD_{amp} = 4.56$). These preliminary results suggest to us the feasibility of a novel infant ERP task used to quantify the neural basis of anticipation involved in predictive learning in the first year of life. Each infant exhibited a pattern of greater SPN response in anticipation of social stimuli compared to non-social stimuli. Previous research found a similar pattern in pre-school (Engle et al., 2019, under review) and school-aged children (Stavropoulos & Carver, 2014). Power analysis based on these previous studies with slightly older children suggests that a sample size of 30 infants will be needed to find significant differences between anticipation of social versus nonsocial stimuli. Ongoing research in the lab will look to increase the sample size to draw more meaningful conclusions regarding these preliminary results.

B-Developmental Neuroscience

P3-B-14: Explicit memory development over the first year of life: An ERP study in The Gambia and the UK

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Introduction: Infants and children in low- and middle- income countries are frequently exposed to a range of poverty-related risk factors, increasing their likelihood of poor neurodevelopmental outcomes. In order to identify the impact of risk as early as possible and therefore inform effective interventions, culturally appropriate markers of brain function are needed from birth. Here, the developmental changes in explicit memory over the first year of life were investigated, using event related potential (ERP) and behavioural measures in infant cohorts in the UK and The Gambia, West Africa. This work forms part of the Brain Imaging for Global Health (BRIGHT) project which investigates markers of cognitive development in Gambian (N=214) and UK (N=61) infants from birth to 2 years. Hypothesis: Pre-explicit memory measured at 1-5months is positively associated with and infants' explicit memory



functioning at 8-12 months. Method: At 1 and 5 months of infant age, longitudinal developmental changes were measured on an auditory ERP habituation and novelty detection paradigm. At 8 and 12 months of age, infants completed a deferred imitation task, during which they were presented with novel actions and their imitation was measured after a delay. Infants also completed the Mullen Scales of Early Learning (MSEL) at 8 and 12 months. Results: For the ERP task, typical developmental changes towards a robust novelty response were observed in the UK cohort, but not the Gambian cohort. Similarly, habituation responses became stronger in the UK cohort, but not the Gambian cohort. For the deferred imitation task, age-related improvements in imitation were observed in both cohorts, but overall levels of imitation were reduced in the Gambian, compared to the UK cohort. Investigating associations between the ERP and the imitation measure, it was found that the magnitude of the developmental change in novelty detection between 1-5 months was associated with the magnitude of the developmental change in imitation at 8-12 months (Figure 1, $r_{UK} = .502$, $p_{UK} = .039$, $r_{Gambia} = .215$, $p_{Gambia} = .032$). Preliminary analyses suggest that the developmental change in ERP novelty detection is not associated with the developmental change in the MSEL between 8-12 months ($r_{UK} = .219$, $p_{UK} = .141$, $r_{Gambia} = .062$, $p_{Gambia} = .556$). Discussion: We found an association between two measures of early explicit memory, whereby the rate of developmental change of early novelty detection within the first 6 months of life was found to be associated with the developmental change in imitation seen across the second 6 months of life. Based on preliminary analyses, no association was found between early novelty detection and general neurocognitive development between 8-12 months, suggesting a domain-specific association. These findings provide a first indication for the utility of electrophysiological markers to measure early correlates of infants' longer-term neurodevelopmental in two different populations.

P3-B-15: Assessing the development of visual working memory in a global context: The India project

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Visual working memory (VWM) is a highly limited cognitive ability utilised thousands of times per day. The development of the VWM network is affected by early adversity, including poverty, malnutrition, poor sleep hygiene, and other developmental factors. While some children can be trapped in an intergenerational cycle of adversity, the plasticity of the brain networks that underlie VWM makes this cognitive system a prime target for early assessment and intervention. Participants of the present study were local residents of Uttar Pradesh, the most populous region of India, and a region with some of the worst human development indicators worldwide. Participants' VWM was assessed at either 6 or 9 months of age, and re-tested 12 months later. The lab-based task used to assess the VWM of infants used eye-tracking accompanied by optical neuroimaging with fNIRS. The task involved showing a display of coloured squares on either side of the screen, one side of which changed every 500ms. In addition to the lab-based VWM task, participants were assessed using anthropometry to assess stunting and wasting, as well as other associated factors, such as nutrition, sleep, air quality, and indicators of socio-economic status. The optical neuroimaging



results reveal task-specific functional activation in regions commensurate with previous US and UK-based studies (see coloured clusters in Fig. 1). Crucially, many of these regions overlap with regions identified in a meta-analysis of the adult VWM literature from studies using fMRI (cyan circles in Fig. 1). Additionally, there is a relationship between performance in the task, and SES in several key VWM regions. The eye-tracking results also demonstrate a stable and consistent relationship between looking behaviour in the VWM task across both years, although this relationship is affected by socioeconomic status and gender of the infant. In addition, the stability of some of the looking behaviours across years is strongly affected by the physical growth of the participant, highlighting the importance of nutrition in cognitive performance. The findings from the present study demonstrate that VWM is a core cognitive function associated with many indicators of cognitive and physical development. Neural activation in the task is correlated with looking behaviour, with key regions of the VWM network engaged in a task-specific manner. On-going analyses are examining how brain activity is modulated by early adversity, including how the brain might compensate for poor nutrition and low physical growth in infancy. The implications of these results in the context of global and cross-cultural development will be discussed.

P3-B-16: Functional brain development of visual motion perception in full-term and preterm infants

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This study investigated full-term and preterm participants' electrical brain responses to two types of radial motion that both rely on the medial superior temporal (MST) area of the dorsal visual processing stream. Babies were tested longitudinally at 4-5 and 11-12 months, and again at 6 years of age on the visual motion paradigms of "optic flow" and "looming". Analyses of visual evoked potential (VEP) and temporal spectral evolution (TSE, time-dependent amplitude changes) were performed on high-density EEG data recorded with a 128/256-channel (infants/children) sensor array. Results for optic flow (3 directions: forwards, reversed, random motion) and looming (3 speeds: fast, medium, slow) showed that at 4-5 months, prelocomotor full-term and preterm infants could not distinguish between any of the directions or speeds in response to optic flow (Figure 1) and looming (Figure 2). At 11-12 months, the full-term infants showed reduced N2 latencies in response to optic flow, clearly differentiating between simulated forwards (± 250 ms) and reversed self-motion (± 300 ms), and random visual motion (± 350 ms). In addition, they showed looming-related brain activity closer to the loom's virtual collision, and at a fixed time-to-collision of about 600 ms. The preterm infants, on the other hand, showed no improvement from 4-5 to 11-12 months in response to optic flow and looming. At 6 years, preterm children showed an improvement in visual motion perception from 11-12 months. However, compared to full-term children they still displayed significantly longer latencies in response to forwards optic flow, and looming-related brain activity at times twice as long from collision. When timing their looming-related responses, full-term children responded at a fixed time-to-collision of 200 ms. Preterm older infants and children showed more variable timing, suggesting they were relying on the lower-order variables of the loom's visual angle and velocity when timing their looming-related brain responses. In addition, synchronized alpha-beta band activity was seen only in the full-term



infants and children at twelve months and six years. Thus, preterm participants did not show an increase in frequencies in the time-frequency domain as they got older as compared to full-term participants who showed an increase from around 4-8 Hz at 4-5 months to 10-60 Hz at 11-12 months and at 6 years. The emergence of these faster oscillations could indicate a gradual progression from less specialized oscillatory cell assemblies at four months to a more adult-like pattern of motion processing where cell assemblies have fewer but more specialized neurons resulting in improved motion perception. Further, the possible impairment of the dorsal stream responsible for processing visual motion could explain why the preterm participants showed no such progression in oscillatory patterns during the first six years of life. It was concluded that the observed differences between full-term and preterm participants are a result of prematurity leading to an underdeveloped or impaired visual system and showing signs of a dorsal stream vulnerability.

P3-B-17: Patterns of language profiles at 30 months: An on-line screening on low-risk preterm and full-term children

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Introduction In line with population-based studies, language development is characterized by a high variability between the second and third year of life, with approximately 15% of late-talkers, showing a delay in expressive vocabulary size (≤ 10 th percentile) in absence of neurological, sensory or cognitive deficits (Zubrick et al., 2007). Relationships between late-talker condition and cognitive weaknesses (Bello et al., 2018) as well as risk factors increasing the probability of being late-talker (Zambrana et al., 2014) have been recently documented. Preterm birth (gestational age-GA < 37 weeks) has been reported as a risk factor, with a higher risk for very preterm children (Sansavini et al., 2011; Vohr, 2014), but less concordant findings for low-risk preterm children (Perez-Pereira et al., 2014, Putnick et al., 2017). Screening tools, such as the parental questionnaires MacArthur-Bates Communicative Development Inventory (MB-CDI, Fenson et al., 2007), have been widely used to early identify late-talkers. The present study aimed to identify the patterns of language profiles in low-risk preterm (PT) and full-term (FT) children at 30 months and the relationships of language profiles with cognitive development, motor development and with individual and environmental risk factors. **Methods** One hundred low-risk PT children of Italian mother tongue, without major cerebral damage, congenital malformations, sensory impairments, or cognitive deficits, and 100 FT children, comparable for gender, socio-economic status and mother tongue, participated at 30 months (corrected age for PTs). Parents filled out the Italian versions of the following questionnaires: MB-CDI infant and toddler short forms for language (word comprehension, word production, incomplete and complete sentences production, Caselli et al., 2015), PARCA for cognitive development (Cuttini et al., 2011), and EMQ for motor development (Libertus & Orioli, 2014). Latent Profile Analysis (LPA) was used to identify classes of children sharing similar patterns of language profile. Differences among classes in cognitive and motor scores were tested with ANOVAs. Predictors of class membership were investigated with multinomial logistic regression adjusting for neonatal condition (PT vs FT), gender, length of neonatal hospitalization, maternal and paternal education levels. **Results** LPA identified four classes of children: those in class 1 (20.9%) were late-talkers, whereas increasing lexical size and

grammar ability were observed from class 2 (21.6%) with mainly incomplete sentences, to class 3 (24%) with balanced use of incomplete and complete sentences, and class 4 (33.5%) with main production of complete sentences. Cognitive and motor scores of class 1 were lower than those of class 4. Cognitive scores of class 2 were also lower than those of class 4. Longer neonatal hospitalizations and lower level of paternal education increased the probability of assignment to class 1. Conclusions Four different patterns of language profiles at 30 months were found in low-risk PT and FT children: late-talkers, characterized also by lower cognitive and motor scores and associated with longer neonatal hospitalization and lower level of paternal education, and three other profiles with increasing language mastery and cognitive abilities. These findings suggest the need for a person-centered and cross-domain approach for identifying late-talkers and implementing early interventions.

P3-B-18: Spontaneous preferences for fast-moving objects in young chicks

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Evolution has shaped brain mechanisms to help young animals orienting toward specific kinds of stimuli. For example, human newborns, as well as naïve domestic chicks (*Gallus gallus*), share similar preferences for face-like stimuli (Morton and Johnson 1991; Rosa-salva et al. 2010). The latest has become an ideal animal model to investigate biological predispositions (Di Giorgio et al. 2017). Chicks are mature and mobile at hatching and can be tested with controlled and limited experience (Versace and Vallortigara 2015). Amongst all biological predispositions documented, some have been described regarding specific patterns of motion, e.g. biological motion (Vallortigara et al. 2005), self-propelled motion (Mascalzoni et al. 2010). Recently, a study reported an unexpected preference in young chicks for slow-rotating objects (Wood 2017). Using an automated tracking method, I failed, however, to find such a preference using a simple rotating blue cube. No preference was found. To determine whether the shape of an object could influence chicks' preference, I tested another type of object, a digital embryo such as that used by Wood (2017). The digital embryo was either coloured in red or blue (the same colour than the cube). In this case, I found a strong and robust preference but for the fast- (not for the slow-) rotating object. Given that the chicks' visual system is characterized by high temporal resolution (flicker threshold is about 100 Hz) I used a high-frequency screen (120 Hz) and presented the stimuli with a high-frame frequency (120 frames per second, fps) in these experiments. Thus, I wondered whether the preferences observed could be influenced by the frame-frequency and repeated the experiments by presenting the stimuli with a low-frame frequency (24 fps). However, the low-frame frequency (24 fps) produced even stronger preferences for the fast-rotating object. I conclude that there is no spontaneous preference for slow-rotating objects but instead a preference for fast-rotating objects, which is modulated by the shape and the frame frequency of the stimuli displayed. It is unclear whether differences related to strains or simply the use of monitors with a low-refresh rate can explain the discrepancies with the previous study.

P3-B-19: Family SES is associated with maturation of brain networks in 6 months-old babies



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A rapid maturation of brain functional connectivity takes place in the first six months of life (Vértes & Bullmore, 2015). Using the computational methods of graph theory (Bassett & Bullmore, 2017), fMRI and EEG studies have shown developmental changes in the connectivity properties of brain networks (e.g., Gao, Alcauer, & Elton, 2014; Xie, Mallin, Richards, 2019). Generally, an increase in local efficiency (clustering coefficient) and global efficiency (path length) is found, which is due to the strengthening of long-range connexions that increase the small-world properties of brain circuits (Zao, Shu, & He, 2019). Several studies have explored environmental variables that affect brain maturation. Particularly, the socioeconomic status (SES) has been largely related to brain and cognitive development (Brito & Noble, 2014). Employing EEG, some experiments have found a decrease in power in both resting state (rsEEG) and event-related potentials protocols in infants born in low SES families (Conejero, Guerra, Abundis-Gutierrez, & Rueda, 2018; Tomalski et al., 2013). Moreover, recent fMRI studies reported different trajectories of network efficiency indexes in childhood depending on the SES (e.g., Gao et al., 2014). High SES children increase their clustering index faster in comparison to low SES participants. However, this approach has not been applied to rsEEG in infants. Our study aimed to explore the influence of SES in networks' efficiency indexes in 6 months-old infants. For this purpose, we evaluated over one-hundred infants in a four minutes rsEEG and computed the functional connectivity in alpha and theta bands employing a high-density (128 channels) net. Also, family SES was computed as the average of the z-transformation of the familiar income, parents' occupation and parents' educative level. We expected an increase of clustering coefficient and small-world index and a reduction of the path length in high compared to low SES babies. So far, we have pre-processed the EEG data of 54 babies, and have obtained valid data for 33 infants (mean age = 191.52 days, SD = 7.57, 14 females). Our results indicate that path length and clustering coefficients are not related to SES in the theta band. However, in alpha frequencies, SES is marginally associated positively with clustering ($p = .10$) and small world ($p = .07$) coefficients, and negatively with the path length ($p = .06$) index. The combination of brain specialization (clustering coefficient) and more efficient integration of information (path length), which reflects the so-called small-world properties, is increased with brain maturation. Our results show some evidence that SES may be related to electrode-based brain network efficiency in infants. This result is in consonance with previous literature showing a tendency towards a variation in network topological properties with development. Further, our data show evidence that home environment impacts the development of brain networks at a very young age.

P3-B-20: The neural correlates of understanding emotion-dependent actions in 10-month-old infants

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By the end of the first year, infants use others' emotional expressions to interpret environmental events and build expectations on how people should behave based on emotional cues. Such competence relies on infants' ability to understand that a social message



relates to a specific event determined by the emoter and that the emotional cues can be used to infer something on a certain event or object (Moses, Baldwin, Rosicky & Tidball, 2001). This phenomenon is known as social referencing. Behavioral research has indeed shown that 9- to 12-month-olds are able to connect the affect of an actor to his/her action, as they recognize that he/she is likely to take a hold of an object that had previously elicited a positive affect (Phillips, Wellman & Spelke, 2002), but not a negative one (Barna & Legerstee, 2005). To our knowledge, only one electrophysiological study (Carver & Vaccaro, 2007) investigated the relation between patterns of brain activation and social referencing. Results showed that 12-month-olds allocate more attention to stimuli associated with negative adult emotion than to those associated with positive or neutral emotion, as reflected by early attentional evoked potentials. Although the behavioral evidence previously mentioned suggests that the ability of linking others' emotions to their following actions is already at play well before one year of age, no study has to date explored the brain activation patterns in infants younger than 12 months. Therefore, we designed an affective priming paradigm to investigate whether 10-month-old infants detect congruency and learn to build expectations between emotions and following actions directed towards unfamiliar objects. We expect to detect attentional processes indexing novelty detection at early-mid latencies and high-level processing mechanisms, such as memory updating in response to unexpected targets at a later stage of processing (Chennu et al., 2013). While event-related potentials (ERPs) are recorded, infants watch priming videos of two actors touching unfamiliar objects while presenting a happy or a disgusted expression (both through face and voice), for a total of 2 seconds. Each video is followed, as a target phase, by an image of the same actor either holding the object (congruent with happiness) or pushing the object away from them (congruent with disgust), for 1400 milliseconds. Preliminary analyses on thirteen 10-month-olds (5 females, average age 10 months and 11 days) show a tendency for incongruent trials to elicit more negative evoked potentials than congruent trials between 1100 and 1400 milliseconds, especially pronounced in central clusters, $F(1, 12) = 4.1$, $p < .066$, $\eta^2_p = .26$. At an earlier level of processing, although an attentional component (N_c) is present on fronto-central clusters and significantly different from baseline, $t(12) = -2.22$, $p = .023$, no differences are observable between the different conditions. Further data collection and analyses are underway.

P3-B-21: The development of filial preferences is strongly influenced by duration of exposure and predispositions in domestic chicks

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Filial imprinting has become a model to understand the onset of social behaviour, memory and learning in neonate animals (McCabe 2019). It allows the young of precocial birds species to learn the characteristics and get attached to any conspicuous visual stimulus they are exposed to during a sensitive period soon after hatching (Bolhuis 1991). Increasing preference for the imprinting stimulus associated with longer duration of exposure (in hours) has been described (Bateson 1973; Jackson and Bateson 1974). Nevertheless, the exact time course of filial imprinting preference during the first days of life remains relatively unexplored. This study aims to investigate the development of filial imprinting preference in domestic chicks using an



automated method allowing us to track efficiently chicks' behaviours for long times. Soon after hatching, chicks were individually placed in an enclosure where stimuli were displayed on two opposite screens. The duration of exposure and the type of stimuli were manipulated and we scored the amount of time spent at the imprinting stimulus across days. Our study shows the importance of long exposure with a stimulus to produce robust filial imprinting preferences. Three days of exposure to a stimulus produce strong and stable preferences, whereas one day of exposure produces a preference for the imprinting stimulus only if a predisposed stimulus is used. When subsequently exposed to two different stimuli during the sensitive period, chicks prefer the last stimulus with which they have been exposed to. Chicks remember the first stimulus they have been exposed to, but their preferences are strongly influenced by predispositions for different stimuli. Our study suggests that predispositions influence learning when not fully consolidated driving animal preferences toward more conspicuous stimuli.

P3-B-22: EEG asymmetry and infant temperament: Links with regulatory behaviors

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Electroencephalography (EEG) asymmetry is informative with respect to infant temperament and behavior (Fox, 1994). Specifically, greater relative left activity is associated with approach behaviors and preference for novel stimuli, whereas greater relative right activation is linked with avoidance and negative affect. The neurological underpinnings of infant regulatory behaviors during an aversive event is underexplored, and links with temperament largely neglected. The present study considers infant temperament attributes ascertained via the Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003), frontal EEG asymmetry and infant regulatory behaviors measured during the 2nd episode of the repeated Still Face Paradigm (SFP; Tronick et al., 1978; Haley & Stansbury, 2003). It was hypothesized that infants scoring higher on Negative Affectivity (NA) scales would display greater right frontal activation during SFP. It was also expected that infants with greater left frontal activation would demonstrate more frequent self-soothing behaviors during SFP. Mothers with infants 6-12 months of age (N=62) were recruited from the Eastern Washington/Northern Idaho area and completed the IBQ-R (Gartstein & Rothbart, 2003). Infant self-soothing behaviors (hand waving, kicking feet, looking to mother, banging on table, playing with cups, hand/object to mouth, and vocalizations) were coded from video as being present or absent every ten seconds throughout the SFP by reliable coders (ICCs>.60), with the number of different self-soothing behaviors summed across epochs. EEG was recorded during this episode and analyzed per standard procedures (Bell & Cuevas, 2012). Frontal asymmetry scores were computed by subtracting the natural log (ln) power at left frontal (F3) from ln power at right frontal (F4) to assess the differences in the 6-9 Hz alpha band. A negative frontal EEG asymmetry score reflects greater right frontal activation. A three-factor solution emerged from an exploratory factor analysis of eight coded infant regulatory behaviors, utilizing Principal Axis extraction with Oblimin rotation. The three factors obtained were Factor 1 - Locomotor, Distress, Playing with Cups (negatively loading); Factor 2 - Kick Feet, Hand-to-mouth; Factor 3 - Vocalizations and Handwaving (average factor loading = .56). These factors were correlated



with asymmetry indicators measured at baseline and the second SFP episode, as well as the IBQ-R negative affectivity scales: Fear, Distress to Limitations, Sadness, and Falling Reactivity/Recovery (negatively loading). Significant correlations were observed for regulatory behavior/Factor 3, the SFP asymmetry score, IBQ-R Distress to Limitations and Falling Reactivity (Table 1), in the predicted direction. Greater observed regulation was associated with relative left frontal activation, higher Falling Reactivity, and lower Distress to Limitations. Hierarchical regression analyses predicting regulatory behavior/Factor 3 were conducted, separately for asymmetry and IBQ-R indicators, controlling for infant sex and age. The SFP asymmetry was predictive of regulatory behavior/Factor 3 after controlling for covariates and baseline asymmetry, whereas IBQ-R scores were not associated with significant effects, accounting for overlapping variance (Table 2). This pattern of results is indicative of complex relations between infant temperament, regulatory behavior, and frontal activation during a social stressor.

P3-B-23: Should atypical visual behaviors be considered repetitive motor stereotypies or sensory behaviors in infants /toddlers with ASD

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Background: Atypical visual behaviors (VB) have been shown to be the most common type of Restricted and Repetitive Behavior (RRB) for infants, toddlers, and preschoolers with autism spectrum disorder (ASD) (e.g., Watt et al., 2008). For motor behaviors involving spinning, flipping, and tossing objects, most ASD and RRB instruments include them under motor stereotypy subscales, while it is just as likely that these are visual behaviors since the child usually watches the motion produced closely. However, there is disagreement in the field for measuring sensory reactions (SR) in general (Cascio et al., 2016; Schaaf & Lane, 2015). In factor analytic studies, SRs are either associated with motor stereotypies or considered separate depending on the rotation solution selected. Sensory instruments differ in terms of whether a separate visual or mixed (combining senses) subscale represents them. These inconsistencies creates a challenge with the DSM-5 (APA 2013) addition of atypical sensory reactions as a separate RRB criterion. In this study, the relationship of VBs to RRBS versus sensory behaviors is examined with a new, combined RRB and SR instrument. Objectives: To examine the comparative association of Visual Behaviors (VB) to Motor Stereotypies (MS) and Repetitive Play behaviors vs. other atypical sensory behaviors. Method: Participants in this cross-sectional study were 70 children with ASD, ages 17 to 47 months (M= 29.4 months, SD=7.1 months, 83% male). Instruments. The Infant-Toddler Restricted and Repetitive Behavior Inventory (IRRBI) was used. It is a combined clinician observation and parent interview instrument. The RRB scales are Motor, Repetitive Play, Insistence on Sameness, and Restricted Interests. Its sensory items are based on Seeking and Avoiding in Motoric/Proprioceptive, Auditory, Visual, Tactile, and Olfactory areas. Procedure. An experienced developmental pediatrician diagnosed the children using DSM-5 criteria using a Best Estimate Diagnosis with accompanying cognitive and autism severity assessments. She concurrently administered the IRRBI. Analyses. Pearson correlations were conducted to examine the association between variables. Alpha level was adjusted to <.01 due to the large number of correlations examined. Results: VBs were significantly correlated only with MS



items that also give a visual effect (e.g. Spinning Self X Looks out of Side Vision (includes at objects), $r=.42$, $p<.001$), and one other motor item (Walks on Toes X Looks out of Side Vision, ($r=.32$, $p<.01$). There were no significant correlations with MS such as pacing, rocking, flapping hands or posturing fingers, hands or arms. VBs were correlated to some Repetitive Play items that also could have a visual component, such as Lining Objects Up ($r=.32$, $p<.01$). On the other hand, VBs did not correlate with many other sensory items, with the exception of Seeking Vestibular Input by having parent toss them around or rough-house ($r=.31$, $p<.01$). VBs showed no correlation with Tactile Seeking or Avoiding or Auditory Seeking or Avoiding behaviors. Conclusions: The results of this study suggest that Visual Behaviors that are often considered under RRB repetitive motor scales may have a unique visual sensory component. Since VBs are poorly understood, further research is needed to understand their role in autism symptomology.

P3-B-24: Newborns' ability to detect utterance-level prosodic violations: A NIRS study

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Introduction. How does prenatal experience with prosody influence early speech perception? Interestingly, newborns are able to detect word order violations if words in the test sequences are presented prosodically independently (with a list condition), but not if they are embedded in full utterance-level prosodic contours (Benavides-Varela & Gervain 2017). The reason why newborns seem to be unable to track word order inside utterance-level prosodic units remains an open question. One possible explanation lies in the role of prenatal experience. Given that speech heard in utero is low-pass filtered by maternal tissues, individual sounds and words are mostly suppressed but prosody is preserved. Therefore, newborns' experience with melody and rhythm may prompt them to focus on familiar prosodic patterns like entire utterance-level contours. If prenatal experience plays such a crucial role early in language development, we predict that the infant brain should be already capable of detecting prosodic violations in utterance-level contours at birth. Methods. The current study investigated this prediction, using near-infrared spectroscopy (NIRS) in 1-5-day-old French-exposed newborns ($n=25$). We used the same 4-word-long sequences (e.g. et appelle de aller) and experimental design (Figure 1) as in Benavides-Varela & Gervain (2017). The only modification was that in the deviant blocks, the last repetition of the sequence, carrying the violation, had an ill-formed prosodic contour, obtained by time-reversing it (and super-imposing it on the intact segmental information with word order preserved). The 24-channel NIRS probe queried the frontal, temporal and parietal areas bilaterally. Results and Conclusion. Channel-by-channel comparisons show a greater oxyHb concentrations for the deviant blocks in two channels 19 and 22 in the right hemisphere (Figure 2). These results suggest that newborns are already capable of detecting utterance-level prosodic violations at birth, possibly based on experience with speech prosody prenatally. The right hemispheric localization of the differential response confirms previous results regarding the right lateralization of speech prosody since birth.



P3-B-25: Associations between cortisol levels and sleep behavior in infants and toddlers up to 36 months of age

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Objective: To examine whether sleeping behavior is associated with dysregulated cortisol levels in infants and toddlers up to 36 months of age. **Rationale:** Healthy sleeping behaviors are essential for optimal early growth and development. Early sleeping behaviors may be disrupted by dysregulated levels of cortisol (very high or blunted levels of cortisol), which is a marker of toxic stress in young children. **Methods:** The following databases were searched in October 2019 for peer-reviewed, quantitative articles published between 2009 and 2019: PubMed, CINAHL, Psychology and Behavioral Sciences Collection, and PsycINFO. The search formula was "(child OR infant) AND cortisol AND sleep behavior." Limits set (when available) included English language, humans, ages newborn and infant (up to 36 months of age), and scholarly (peer-reviewed) journals. Mental and behavioral health outcomes were excluded, as were physical health outcomes that were a direct result of adversity (i.e. abusive head trauma). **Results:** See Figure 1 for a flowchart depicting the search and selection process. In summary, titles and abstracts of 110 papers were screened for eligibility and nine observational studies were included for review. Table 1 provides a summary of the studies reviewed. Sleep behavior was measured with actigraphy, video surveillance, diaries (maternal reports of infant sleep) and questionnaires regarding nighttime crying and sleeping patterns. Cortisol was collected from saliva samples and hair samples. Six studies provided evidence that infants and toddlers had poor sleep behavior in conjunction with higher waking cortisol levels. Two studies showed that good sleep behavior is associated with lower waking cortisol levels. One study provided evidence that a blunted cortisol response predicted poor sleep behavior. **Discussion:** Higher and blunted levels of cortisol suggested poor sleeping behaviors, and lower levels of waking cortisol indicated good sleep behavior. This research suggests that cortisol is a useful biomarker when understanding sleep behaviors in infants and toddlers. Future research could extend this work and examine the interplay among internal and external factors on the association between dysregulated cortisol levels and sleeping behaviors in infants and young toddlers.

P3-B-26: Infant cardiac orienting responses during information processing differentiate fetal alcohol spectrum disorders classification

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Objective: Prenatal alcohol exposure (PAE) has been identified as one of the leading preventable causes of developmental disabilities but early identification of those impacted has been challenging. A promising alternative to traditional infant assessment is the assessment of infant neurophysiological encoding of environmental events using cardiac orienting responses (CORs), which predict later intellectual status (O'Connor, Cohen, & Parmelee, 1984). These responses are characterized by a specific pattern of heart rate (HR) deceleration



in the presence of novel or interesting stimuli with the trough reflecting the degree of sustained interest to the stimuli (Lansink, Mintz, & Richards, 2000). CORS have been shown to be sensitive to the impact of PAE in humans (Kable & Coles, 2004; Kable et al., 2016; Kable et al., 2015) and in animal models of PAE (Hunt & Phillips, 2004; Morasch & Hunt, 2009) but have not yet been used to predict later Fetal Alcohol Spectrum Disorder (FASD) status. Methods: Mother-infant dyads (n=167) from the Ukraine were recruited during pregnancy based on the mother's use of alcohol. Groups included (1) low or no alcohol users in the month around conception and no drinking in pregnancy or (2) moderate to heavy alcohol users (≥ 4 binges of ≥ 5 standard drinks/day; ≥ 5 binges of 3-4 drinks/day; or > 10 episodes of 1-2 drinks/day). Participants were then seen at 6 months when CORs were collected and in the preschool period when they were categorized as having fetal alcohol syndrome (FAS), partial FAS (pFAS), or as having alcohol-related neurodevelopmental disorder (ARND) using the modified Hoyme guidelines (Hoyme et al., 2016). Participants in the FAS and pFAS group were combined for analysis. 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. Heart rate responses were aggregated across the first 3 habituation and dishabituation trials and converted to deviation values relative to each participant's baseline HR. For those with PAE, z-scores at each second were computed relative to participants with no PAE. Z-scores of > 1 were then summed by condition to compute a risk index for assessing individual risk. Results: Figure 1 displays group means across the 12 seconds post-stimulus onset for habituation and dishabituation trials. Significant group differences were found on total deviation scores of the habituation ($F(3, 232) = 3.645, p < .013$) and dishabituation trials ($F(3, 209) = 2.667, p < .049$) with the pFAS/FAS having the highest levels of deviation scores (see Figure 2). Conclusions: CORs collected in infancy may be useful in identifying alcohol-affected individuals in need of early intervention services.

P3-B-27: Ability to process complex tones is diminished in newborn with brain injury

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Pitch extraction from complex acoustic stimuli is important for speech and melody perception and, especially relevant to newborns, for the perception of the pitch characteristics of infant directed speech. For pitch processing of complex tones with the fundamental removed (low pitch), information from neural temporal encoding of the stimulus' envelope and fine structure may be used to derive the pitch percepts (Wile & Balaban, 2007). FFRs are far-field auditory evoked responses that have the advantage of allowing assessment of responses to continuous, more naturalistic stimuli, such as those found in speech (Krishnan et al, 2004), as well as of non-speech complex sounds (Wile & Balaban, 2007). In our previous work, low pitch processing was observed in newborns using the frequency following response (FFR) as a method for detection (Phan et al, 2007). Brain injury in the newborn period has been shown to



affect the auditory pathway such that the neural transmission is prolonged (Karmel et al, 1988). Thus, the aim of the current study was to investigate the effect of neonatal brain injury on this type of pitch processing. We hypothesized that the ability to detect pitch information, measured by FFR will be affected in neonates with brain injury. The FFR to complex tones (650, 950;1250 Hz in cosine phase with opposite polarities and duration of 500 ms) was recorded on 68 neonatal ICU infants, who were stratified into two groups: infants with no indication of brain injury (n=58) and infants with brain injury detected on CT, MRI and/or CUS (n=10). All of the infants had normal hearing screenings based upon otoacoustic emissions testing. Two measures of pitch processing, envelope (f300) and LP-related (f350) responses in the FFR sum and difference spectra, were examined. Statistical analyses of these responses revealed that the groups differed in their responses to envelope information. When compared to the group with no evidence of brain injury, infants in the brain injury group had significantly lower responses ($F(1,66)=5.088$; $p<0.03$). Moreover, infants with brain injury also responded poorly to the LP-related information ($F(1,66)=5.002$; $p<0.03$). These findings suggest an atypical neural profile of auditory pitch processing in infants with evidence of brain injury during the newborn period that could have implications for subsequent language processing and language acquisition.

P3-B-28: The impact of iron deficiency and early maternal interactions on functional connectivity in low- and middle- income countries

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Iron deficiency anaemia (IDA) is common among infants and young children in low- and middle- income countries (LMICs). As iron is necessary for many neurodevelopmental processes such as myelination, and synaptogenesis (Lozoff & Georgieff, 2006), IDA has been linked to sub-optimal cognitive, motor and socio-emotional development, as well as to impact on both structural (Algarin et al., 2017) and functional connectivity (Beard, 2008) with long-lasting effect. Previous studies have found that infants with IDA are emotionally disengaged and have dull affect (Corapci, et al., 2006), and mothers with IDA are less engaged during interactions with their infants (Perez et al., 2005). Recently, it has been hypothesised that the quality of early maternal interactions may play a key role in neurodevelopment during the first years of life (Sethna et al., 2017; Dégeilh, et al., 2018). For example, infants that received a high level of maternal touch showed greater functional connectivity in regions belonging to social brain networks in comparison to the infants who did not (Brauer, et al., 2016). Longitudinal follow-up of infants with IDA has shown a pathway from IDA to reduced maternal interaction in early childhood and negative long term effects on social behaviours (Doom et al., 2019). However, little is known about the impact of IDA on mother-infant interactions in LMICs, and the longer term effects on functional connectivity. This may be further compounded by other health and socio-demographic factors, including social and economic support and maternal mental health (Murray & Cooper, 1997). The Brain Imaging for Global Health (BRIGHT) project is delivering longitudinal measures of brain and cognitive development from birth to 24 months in Gambian and UK infant (Fig 1). Over the past decades, knowledge of neurodevelopment in LMICs was very limited due to challenges of conducting

neuroimaging studies in these settings. Within the BRIGHT project, we implemented functional near-infrared spectroscopy (fNIRS) in the Gambia, to advance understanding of neurodevelopment in LMICs (Blasi, et al., 2019). Regular intervals of data acquisition throughout the first 2 years of life allowed to capture the rapid neural development that occurs during this time. At every visit, functional connectivity was estimated while infants were presented with social videos of adults singing nursery rhymes alternated with videos of toys. Data were collected from the temporal and inferior frontal brain regions, using the NTS optical imaging system (Gowerlab Ltd.). In this work, we will present a pathway analysis of how IDA and early maternal interactions can affect functional connectivity, to better understand the mechanisms underlying impaired brain development in LMICs (Fig 2). These findings will advance our understanding of the impact of risk factors on brain network development in LMICs and whether early maternal interactions play a role in moderating the negative impact of anaemia on brain connectivity development. Moreover, these results might have a crucial role in targeting future interventions.

P3-B-30: Using ambiguous rhythmic stimuli to examine top-down processes in infant auditory rhythm perception

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Across cultures, infants are exposed to music, and sensitivity to beat and rhythm are present in early development. From rhythmic patterns, people extract the beat - the regular temporal intervals we tap or dance to. Beats can be perceptually grouped into structures called meter. For example, a repeating 6-beat rhythm pattern can be perceived as three 2-beat groups (march meter) or two 3-beat groups (waltz meter) (Fig. 1). A previous study from our lab found that without priming, 7-month-olds presented with the repeating ambiguous rhythm of Figure 1 show electroencephalographic (EEG) steady-state responses at all three frequencies present in the stimulus, representing beat, duple and triple levels (Cirelli et al., 2016). However, adults primed to hear the ambiguous rhythm pattern in one metrical interpretation or another show with more energy at frequencies corresponding to their metrical interpretation (Nozaradan et al., 2011). Here we test this in infants. Event-related potential (ERP) responses are also reflect auditory processing. Specifically, the mismatch negativity (MMN) is automatically elicited at around 100 - 200 ms after stimulus onset by occasional unexpected 'deviant' sounds in a sequence of standard sounds (Näätänen & Alho, 1995). Though the MMN is automatic, it can be modulated by top-down processes, such as perceptual saliency. For example, deviants on strong, as opposed to weak beats elicit larger amplitude MMN in infants (Winkler et al., 2009) and adults (Bouwer et al., 2014). Sometimes the MMN response is followed by a positivity called the P3a around 250 ms after stimulus onset, that appears only for awake, attentive participants (Basirat, et al., 2014). While previous studies show infants can discriminate different metrical structures, it is not known whether they can maintain a metrical interpretation through intrinsic or top-down processes in the case of an ambiguous rhythm. We investigated 6-month-olds' (N = 16; 8 per group to date) steady-state and ERP brain responses to the 6-beat rhythm pattern of Figure 1. Half were primed to hear the pattern in duple meter and half in triple meter through loudness accents either on every second or every third beat. Periods of priming (4 repetitions of the pattern with accents) were inserted before test trials, which consisted of 16 repetitions of the ambiguous unaccented pattern. To examine



MMN, rare pitch deviants occurred on either beat 4 (strong beat in the duple interpretation; weak in triple) or beat 5 (strong in the triple; weak in duple) of the unaccented stimulus. To direct attention to the auditory stimulus, a visual stimulus of coloured balls increased suddenly in size on the first beat of every repetition of the pattern. Data collection is ongoing, but preliminary results show clear energy peaks at the frequencies of interest in the steady-state responses. The ERPs show a trend for larger MMN and P3a to whichever beat was stronger in both duple and triple groups (Fig 2). These preliminary results suggest infants may be able to impose a top-down internally-generated metrical structure on ambiguous auditory rhythms, an ability that would aid early language and music learning.

P3-B-31: Neonatal intensive care unit and behaviors of stress and self-regulation of preterm neonates

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The Neonatal Intensive Care Unit (NICU) is the initial context of survival of the preterm neonate. However, the NICU is a risk factor for development, due to the physical characteristics and stressful procedures to which preterm neonates are submitted (Anand & Whit Hall, 2007; Grunau & Tu, 2007). Indicators of stress in the neonatal phase should be identified and managed through environmental approaches that support the bio-behavioral regulation of preterm neonates to minimize the negative impacts of stress on the development (Coughlin, Gibbins, & Hoath, 2009; Bastani, Rajai, Farsi, & Als, 2017). The present study aimed to compare potentially stressful procedures and developmental care approaches of the NICU environment, and stress and self-regulation behaviors of preterm neonates in groups differentiated by the NICU design in which the neonates were hospitalized. The study sample comprised 40 preterm neonates split into two groups, of which 20 preterm neonates (gestational age mean = 30 weeks [\pm 2]; birth weight mean = 1,390 grams [\pm 501]; post-natal age mean = 3 days [\pm 1]) were hospitalized in a NICU design of the open room (OR NICU) and 20 preterm neonates (gestational age mean = 30 weeks [\pm 2]; birth weight mean = 1,338 grams [\pm 361]; post-natal age mean = 4 days [\pm 1]) were hospitalized in a NICU design of the single room (SR NICU). The stressful procedures of the NICU environment were evaluated through the Neonatal Infant Stressor Scale - NISS (Newnham, Inder, & Milgrom, 2009), analyzing data from the electronic records of the preterm neonates. The developmental care approaches of the NICUs and the stress and self-regulation behaviors of the preterm neonates were evaluated through observation protocols. In the treatment of the data, descriptive statistical analyses, and between-group comparison (OR NICU vs. SR NICU) using the Mann-Whitney test were performed. The data were analyzed using SPSS (version 25.0, Chicago, IL, USA) and the significance level of the study was $p \leq 0.05$. The results showed that both NICUs presented potentially stressful procedures, and developmental care approaches similarly. The preterm neonates hospitalized in the SR NICU presented fewer total stress behaviors ($p = 0.03$), and specifically in the motor system stress behavior ($p = 0.01$) in comparison to the preterm neonates hospitalized in the OR NICU. Also, the preterm neonates hospitalized in the SR NICU presented more total self-regulation behaviors ($p = 0.001$), and specifically in the sleep-wake self-regulation behaviors ($p = 0.001$) in comparison to the preterm neonates hospitalized in the OR NICU. The associations between the NICU design of the single room protective environment and the self-regulation behaviors of the vulnerable preterm neonates



indicate these strategies to neutralize the negative impacts of the stressful of the NICU environment.

P3-B-32: Neural correlates of spatial-numerical associations in 7 months-old infants: An fNIRS study

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Introduction Humans represent numbers on a mental number line with smaller numbers on the left and larger numbers on the right side. Although cultural artifacts -such as the direction of reading and writing- can modulate the directionality of this representation, a growing number of studies have demonstrated a left-to-right oriented spatial-numerical association (SNA) also in young infants and newborns. However, to date it is unclear whether the SNA expressed prior to any significant experience with language or culture-specific biases rely on similar brain mechanisms than the SNA observed in adults. The current study aims to filling this gap, by exploring SNA in 6-7 month-olds infants while measuring their brain activity with functional Near Infrared spectroscopy (fNIRS). **Methods** In the present study we used an adaptation of the paradigm used by Di Giorgio et al. (2019) in newborns to investigate SNA while controlling for continues physical variables. Participants included in the analyses were 13 full-term caucasian infants (mean age = 7 months and 6 days). They were familiarized for 7-9 seconds with a central stimulus (17.5 cm x 17.5 cm), which depicted 12 squares. In the test phase, either the same (i.e. control) or a deviant numerosity was presented bilaterally for 2.5 seconds. The deviant numerosity was either larger (i.e. 36) or smaller (i.e. 4) with respect the familiarization. The infants' 1st gaze direction in the test was classified SNA-compatible or SNA-incompatible. An fNIRS (ISS Imagent; wavelengths: 690 nm & 830 nm) was used to record from frontal, temporal and parietal areas in left and right hemispheres. The array consisted of 32 standard channels with a source-detector distance of 2.5 cm. A 3x2x16 repeated measures ANOVA with HbO as dependent variable and conditions (SNA-compatible/SNA-incompatible/control), hemisphere (left/right) and channels (from 1 to 16) as independent factors was initially carried out. Paired t-tests were then conducted to identify the channels modulated by the conditions. **Results** Preliminary analyses showed a significant channel x condition interaction $F(30,360) = 1.521, p = .042$. Significant differences between numerically deviant and control conditions were observed in a bilateral group of frontally located channels (all p's <0.05), as well as in channel 16 over the right posterior parietal cortex (SNA compatible vs Control: $t(12) = -2.359, p = .036$; SNA incompatible vs Control: $t(12) = -1.925, p = .078$). Qualitative differences between SNA compatible and SNA incompatible were also observed in left and right parietal channels. **Conclusions** This study has provided a first suggestive evidence about the brain mechanisms underlying SNA in infants. Definitive conclusions await further analyses and the completion of the full, expected sample.

P3-B-33: Cortical activation to interactive contingency in 6-month-old infants: An event-related fNIRS study



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Objective: Live social stimuli are an important aspect of human perception, but it remains unclear if brain processing of live interactive social stimuli differs substantially from processing of non-interactive social stimuli. Our previous fNIRS study revealed that 6- to 8-month-old infants showed increased activation in the right TPJ region in response to contingent responsiveness of a social partner during real-life interactions (Hakuno et al., under revision). In the current study, we examined 6-month-old infants' brain activity across the right temporal (temporoparietal junction: TPJ and superior temporal sulcus: STS) and frontal (medial prefrontal cortex: mPFC) regions in response to social contingent stimuli in an event-related design. Methods: Ten 6-month-old infants participated in the study. In the session, the experimenter served as the social partner and interacted with the infant using picture books and puppets in a semi-structured context. The experimenter's speech and gestures were roughly scripted for consistency across infants. There were two experimental conditions: the contingent (C) and non-contingent (NC) conditions. The two experimental trial types were presented in a random order. In the C trial, the experimenter smiled contingently with no temporal delays when the infant looked at her face during interactions. In the NC trial, the experimenter's response to the infant was delayed by 3 s. During baseline, the experimenter behaved in the same manner as in these experimental conditions but made no contingent responses. To investigate infants' cortical activation, we used a multichannel NIRS system covering the infant's right temporal and frontal lobes in an event-related design. Results and Conclusions: In the comparison between the C and NC conditions, the cluster-based permutation test revealed a greater hemodynamic response for the C condition than the NC condition over the right TPJ region in 6-month-old infants ($t = 6.10$, $p = 0.001$) (Figure 1). Although we did not find clear condition-specific responses in the frontal region, these findings are consistent with previous studies with a block design that have shown that the right TPJ region is highly responsive to social contingency already in the first year of life, and that social contingency is likely to be an important ostensive cue derived from live social interactions, which leads to enhanced brain activation over the right TPJ. We are currently increasing data in an event-related design and neural activation to social signals across both the temporal and frontal regions will be discussed at the conference.

P3-B-34: The role of low-level visual cues on the neural responses to faces in infants

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Several behavioral and neural evidence suggests that visual images of faces are processed by specialized neural and cognitive mechanisms. Event-related potentials (ERPs) recorded from adults have shown that faces elicit larger and quicker N170 responses when compared to non-faces stimuli (Yovel, 2016). The P1 component has also been reported to be sensitive to faces (Goffaux, Gauthier, & Rossion, 2003; Itier & Taylor, 2004). In adults, low-level visual cues (e.g., luminance, global contrast) drive the P1 face-sensitivity, while the N170 seems to reflect the actual perception of a face (Rossion & Caharel, 2011). Two ERP components, the



N209 and P400, are sensitive to face manipulations over the first year of life (Halit, de Haan, & Johnson, 2003). The amplitude of the N290 component showed larger response to faces when compared to ideally-matched control stimuli (i.e., phase-scrambled faces) in 3-month-old infants. No difference was found in the amplitude of the P400 component (Halit, Csibra, Volein, & Johnson, 2004). We investigated infants' P1, N290, and P400 responses to faces and houses and their phase-scrambled versions at 6 and 12 months of age. Scrambled stimuli were created using a Fourier phase randomization procedure. This procedure keeps the global low-level properties of the original images while degrading the texture. We predicted that the P1 responses would be accounted for by low-level visual cue. N290 and P400 responses should not be accounted for by low-level visual cues. Developmental changes could occur on the responses of the N290 and P400 components. Ten 6-month-old infants (M age 190 days) and 8 12-month-old infants (M age 369 days) were presented with intact and scrambled faces and houses. Amplitude values around the peak of the P1 (Oz, O1-2, Iz, and I1-2), N290 (TP7-10, P7-10, and PO7-10), and P400 (P7-10, PO7-10, Iz, I1-2, Oz, O1-2) were analysed as a function of Stimulus Type (face vs. house) and Texture (intact vs. scrambled) as within-subject factors and Age (6 vs. 12) as a between-subject factor. Figure 1A depicts the grand average ERPs for faces and houses as a function of Stimulus Texture and Age. The P1 was of larger amplitude for scrambled than intact stimuli at 12 ($p < .001$) but not at 6 ($p = .619$) months of age (Texture x Age: $F(1,3) = 4.96$, $p = .026$). Figure 1B shows the scalp maps at the peak of the N290 ERP component as a function of Stimulus Type, Texture, and Age. The amplitude of the N290 was larger for 12- than 6-month-old infants ($F(1,16) = 4.54$, $p = .033$). At 6 months, the N290 was larger for faces than houses ($p = .017$), and for scrambled than intact stimuli ($p = .003$). There were larger N290 response to faces than houses for the intact ($p < .001$), but not scrambled stimuli ($p = .372$), at 12 months of age. Lastly, there was a significant three-way interaction on the P400 amplitude ($F(1,16) = 119.64$, $p < .001$). Simple effects showed a different interaction of Stimulus Type and Texture at the two ages (Figure 2). The P400 amplitude was larger for scrambled faces than both intact faces and scrambled faces ($ps < .001$). Intact faces elicited larger P400 response than scrambled faces and intact houses ($ps < .009$) at 12 months of age. These preliminary results suggest that, similarly to adults, the P1 responses at 12 months are sensitive to the low-level properties of the stimuli. The N290 showed face-sensitive responses at both ages. The same effect was evident on the P400 only at 12 months.

P3-B-35: Age specific interaction between face race and face gender in infant ERP responses to faces

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Previous studies have explored how race and gender modulate infants' responses to faces (Marquis & Sugden, 2019). Although race and gender intersect in social understanding, little research has examined how these dimensions interact in infancy. We aimed to test whether race and gender exert interactive, rather than additive, effects on infants' ERP responses to faces. We hypothesized that face gender and race would interactively impact ERP components associated with face processing (N290, P400), and that this effect would increase from 3 to 9-months of age due to increased perceptual experience and narrowing. We utilized data from a cross-sequential study of infant ERP responses to faces varying in race and gender. Stimuli



were selected from the SUMO face database (Sudgen & Moulson, 2013). For each infant, "own-race" faces matched the self-reported race of the infant's mother, while "other-race" faces did not match the self-reported race of the infant's mother or father. The final sample included 24 3-month-olds, 26 6-month-olds, and 18 9-month-olds, and was ethnically representative of the area. Time-windows (Figure 1) and regions of interest (ROI) (Figure 2) for the N290 and P400 components were selected from prior studies. We ran linear mixed effects models to analyze mean amplitudes using a random intercept for participants and a linear factor for age. Results revealed main effects of ROI alone and in interaction with age ($p < .001$) on N290 amplitudes. For the P400, ROI ($p < .001$), age ($p < .001$) and race ($p = .015$) had significant main effects, with a significant interaction between face gender and face race ($p = .002$) that further interacted with age ($F[1,1275] = 3.97, p = .046$). The latter three-way interaction on P400 amplitude was examined by running separate models for each age group. A significant effect of ROI was found at all ages ($p < .001$). There was an additional effect of race in 3-month-olds only ($p = .024$), reflecting higher mean amplitude for other-race stimuli, and a significant interaction of face gender and race ($F[1,323] = 18.39, p < .001$) in 9-month-olds only. The latter interaction was driven by a main effect of face race for both female ($p = .003$) and male ($p < .001$) stimuli, and by a main effect of face gender for own-race ($p = .013$) and other-race stimuli ($p = .012$) on 9-month-olds' P400 amplitudes. This interaction resulted from a higher P400 amplitude for female own-race faces and male other-race faces compared to female other-race and male own-race faces. Taken together, these preliminary results show age-specific effects of race and gender on infant face perception that were most evident on the P400 component. In 9-month-olds, the P400 amplitude was significantly higher for own-race female faces and other-race male faces, suggesting a race dependent gender effect that is not present in younger infants. Given that research regarding the interaction of race and gender in infant facial processing is sparse, further analysis of this data could yield new information on the impact of experience on infant facial perception and their developing understanding of race and gender.

C-Perception

P3-C-36: Both young and older infants distinguish between native and accented rhythm but have different preferences

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Newborns can discriminate languages that are prototypes of different rhythmical classes (Mehler et al. 1988, Nazzi et al. 1998). As they gain experience with the ambient language, infants (aged about 4 months) begin to discriminate it from a rhythmically close foreign language (which they disfavor), and also discriminate between regional varieties of their language (Bosch & Sebastian-Galles 1997, Nazzi et al. 2000). Yet, with an expanding lexicon and/or exposure to native-language varieties, older infants seem to find regional differences less salient (Cristia et al. 2012, Kitamura et al. 2006, Phan & Houston 2008), perhaps because during later infancy, when learning words, they start focusing on cues to phoneme identity, and therefore prosody (including rhythm) may, in some languages, lose its perceptual primacy.



To date it is unknown what type of phonetic information infants attend to when discriminating accents, because previous studies almost exclusively used natural speech material in which the contribution of individual cues was not controlled. Adults can discriminate regional accents solely on the basis of rhythmical cues, namely temporal relations between stressed and unstressed syllables (White et al. 2012). Our question is whether infants, too, can use temporal cues alone to distinguish accents. We hypothesized that infants would perceptually distinguish native and accented rhythm and that this ability might change with age, declining when the first words are learned (second half of first year). Infants, aged 4, 6, 8, and 10 months acquiring Czech were tested in a central fixation paradigm. The stimuli were Czech IDS-mode well-formed sentences with low-frequency words produced by three women imitating natural and edited model recordings with typical versus atypical Czech rhythm, the latter showing altered durations of stressed and unstressed syllables (Fig. 1). Five trials per accent type, each containing various utterances from all 3 speakers, were used in pseudo-randomized order. First look duration was analyzed using mixed-effects linear models with Accent (+native, -accented) and Age (3 contrasts) as fixed effects, per-participant random intercepts and per-trial-order random slopes for Accent. Accent interacted with Age (est.=-2.93s, SE=1.28, t=-2.30), revealing that 4-month-olds looked on average 2s longer to the native than to accented rhythm ($p=.046$), while the 10-month olds tended to look on average 1.3s longer to the accented than to the native rhythm ($p=.098$); Fig 2. Data collection is ongoing; aiming at $n=16$ per age, current analyses with $n=[8-13]$ per age. We found that infants discriminate native and accented rhythm at 4 and most probably also at 10 months but manifest different preferences across development. The 4-month-olds' longer looking to native rhythm is in line with studies demonstrating native-language and native-variety preferences in young infants (Moon et al. 1993). Interestingly, older infants seem to remain sensitive to rhythmical deviations, which contradicts our expectation that with increasing age infants' attention to prosody would decline. The differential direction of the young and older infants' results could be attributed to a familiarity preference in the younger and a novelty preference in the older group (Hunter & Ames 1988). The 10-month-olds' looking behavior indicates that with rhythmical cues present, older infants do notice and pay attention to accent variation.

P3-C-37: Measuring infants' sensitivity to face-like stimuli in the mid-peripheral visual field

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Human infants are highly sensitive to social information in the environment. Already before birth, the fetus in the third trimester of pregnancy shows a preference for schematized face-like configurations over inverted configurations (Reid et al., 2017), a widely documented finding soon after birth (Johnson & Morton, 1991). Thus far, the vast majority of infant research on the development of social information processing in the first year of life has primarily relied on images presented within the central and parafoveal visual areas on computer displays. This is a simplification of a much richer natural environment in which social information potentially derives from a wider visual field. In addition, face images presented on a screen encompass a mixture of low- and high-level visual features which can influence infant orienting behaviour and have not always been controlled. The present study is the first to examine infants' sensitivities to high-level visual information at high eccentricities carefully controlling some



low-level visual features (i.e. luminance, spatial frequency, contrast and orientation) underlying the face stimuli. It aims to investigate: (1) how far in the visual periphery infants are able to detect face-like stimuli and (2) how low- and high-level visual content affects visual field sensitivities. Eleven (9 females) full term 9-month-old infants were presented with face-like stimuli at 6 different mid-peripheral locations, i.e. 50°, 55° and 60° to the left and to the right of a central attention grabber. Two participants were excluded from the analysis for not providing any valid trial and the sample consisted of 9 infants (Mage=271 days; SD=9.6). Face-like stimuli were obtained from a black and white photograph of a female face (from Macchi Cassia, Turati, & Simion, 2004) which was filtered with specific low-level visual features (luminance within 25 cd/m²; spatial frequency of 55 cycles per degree and maximal contrast attained in the middle of the presentation time) to be comparable to a basic Gabor patch already used in a previous study (FIG.1). Moreover, both upright and inverted faces were presented across the visual field in order to explore whether visual detection in the mid-periphery is orientation-specific. Head/eyes orientation to peripheral targets were measured on each valid trial. Preliminary results did not show any significant difference between detection rates for upright and inverted faces. Similarly, no side effects emerged across left and right hemifields. Stimuli orientation and side were then collapsed. 9-month-olds' performance differed significantly across eccentricities ($F(2,14)=7.673$, $p=.006$). On average, detection rates at 50° were significantly higher ($M=87.09$, $SE=5.28$) than 60° ($M=40.21$, $SE=7.58$, $p=.006$) (FIG.2). The present data replicated previous research with non-social stimuli and set the limit of 9-month-olds' peripheral visual field at 50°. These results suggest that when low-level visual features are comparable, detection of social and non-social information does not differ at the edge of the visual field. The trend can only be confirmed with a larger dataset and final results will be presented at the conference. This information is crucial for our understanding of social and non-social information processing in the wider visual environment.

P3-C-38: The detection of green stimuli across the adult and infant visual fields

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The mature visual field extends to over 90 degrees eccentricity from the line of sight (To, Regan, Wood & Mollon, 2011). In adults, two kinds of photoreceptors underlie the different regions of the visual field: central vision is driven by trichromatic cones that offer high acuity and colour vision, while peripheral vision is processed by achromatic rods that offer high sensitivity but poor colour vision (e.g. To, Gilchrist, Troscianko & Tolhurst, 2011). In early postnatal retina, the morphology and distribution of cones and rods is constantly changing, and at around 8 months, the retina is still maturing (Hendrickson, Bumsted-O'Brien, Natoli, Ramamurthy, Possin, & Provis, 2008). This has direct implications on how colour is processed in infancy and early childhood. Davida Teller's seminal research has offered important insights into infant colour vision, but her research has been limited to the foveal and parafoveal regions (e.g. Packer, Hartmann & Teller, 1984; Kelly, Borchert & Teller, 1997; Teller, 1998). The current study is the first to compare adult and infant colour vision at higher eccentricities, more specifically we will examine how adults and infants respond to green Gabor patches presented at 12 different eccentricities, ranging from 35deg up to 60deg in the left and right peripheral visual fields (see Fig. 1A and B). We chose green because the green phosphors have the best



time constants (Stevens, Ozawa, Ban, & Hersh, 1975) and we wanted to minimize the optical blur that might arise from using all three phosphors. In the Adult Experiment, we asked 38 adults (27 females and 11 males) to keep their eyes fixated at the centre of the display and to press the left or right key to indicate where the peripheral green target had appeared. Performance was generally the same across the near and mid-peripheral regions and only declined significantly for eccentricities beyond 55deg (see Fig 2A). In the Infant Experiment, we video recorded the infants' behaviour: If the infants looked centrally at the start of any trial, the trial was deemed valid and we measured whether they directed their attention/gaze towards the peripheral target. After testing five infants (two females and three males), infants' attention/gaze was drawn to peripheral targets that were presented up to 60o to the left or right of a central attention grabber (see Fig 2B). Interestingly, performance was highest in the mid periphery (around 35deg), dipped around 40-50deg, and then improved again. This anisotropy suggests regions of increased sensitivity to the green Gabor patch in the periphery, perhaps corresponding to regions with increased M-cone density in infancy. Testing is ongoing and a larger dataset will be required to confirm this trend.

P3-C-39: PupillometryR: An R tool for measuring infant visual behaviour through pupil size

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Eye-tracking has become a key paradigm to unlock infant looking behaviour during tasks. As well as gaze location, eye-tracking has the potential to collect information on changes in pupil size throughout the task, providing a robust window into infant cognition. Pupil data, however, can be notoriously difficult to manage, requiring filtering and pre-processing prior to analysis. Furthermore, due to the limited availability of functions and the existence of different pre-processing pipelines and conventions, many researchers are forced to use multiple software bundles or even coding languages to analyse pupil size data. PupillometryR is a package designed to work with the R statistical software package, and which has been designed to specialise in pre-processing, visualising, and analysing complex pupil data. PupillometryR allows researchers analysing pupil size data to follow a single pipeline to clean and filter pupil data, perform window-based or timecourse-based analyses, and to visualise results ready for presentation, with a focus on transparent and clear plotting techniques for visualisation of complex data. The aim of this study is to present a demonstration of real infant eye-tracking data analysed through the PupillometryR pipeline and highlight how the package allows R users to analyse pupil data within a familiar setting. In particular, I focus on the multiple options available for analysing and visualising pupil data, and discuss how those analytical outcomes can be interpreted by researchers, with particular reference to the kinds of experiments used by infant researchers. PupillometryR and walkthroughs are freely available for download from github at www.github.com/samhforbes/PupillometryR.

P3-C-40: The success of continual machine learning in an infant-inspired setting



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How do young children learn so many visual objects so quickly? The remarkable capabilities of infant learners have been an inspiration to researchers in machine learning (ML), but conventional ML technologies solve a much more limited set of tasks. For example, computational models for learning visual object categories assume that: 1) a large labeled training dataset is available for each task; 2) training data is available all at once, so the learner can sample randomly from the entire dataset (i.e. batch learning). Under these assumptions, deep neural network learning has produced dramatic performance gains in tasks such as face, object, and speech recognition. However, these assumptions do not accord with how infants learn object categories and their names, in that they do so continually and with minimal supervision. For example, moments when caregivers name objects are rare relative to the quantity of visual inputs, requiring inference to determine the correct referent (Tamis-LeMonda, 2019; Clerkin, 2017). Moreover, a child processes a continual stream of visual inputs and it is not at all clear how much of that data is available for future learning (Vlach, 2017). This poster reports on recent empirical findings that demonstrate the feasibility of continual machine learning within a developmentally-motivated object learning task. Our results indicate the value of closer interactions between the developmental and computational learning communities. Recently, computational approaches to continual object learning have been developed (Kirkpatrick, PNAS, 2019; Rebuffi, CVPR, 2017), in which the algorithm learns one object class at a time. Fig. 1 shows the accuracy of several leading methods on a dataset of 200 toy-like objects. Each x-axis unit denotes learning a new object. The graph shows testing accuracy, across all seen objects, as a function of time. The visibly consistent decline in accuracy, known as catastrophic forgetting, arises when the model focuses on recently-seen objects at the expense of previously-seen ones. While these methods use a variety of strategies to mitigate forgetting, and easily outperform a naive baseline (shown in red), their final accuracy is well-below the batch learner (shown as an X). Our primary finding is that a subtle change in the learning paradigm, in which the learner sees objects with repetition, results in dramatically different performance (Stojanov, CVPR, 2019). This is illustrated in Fig. 2, where each learner now sees each object 10 times in a randomly-interspersed order. While the use of repetition is new to continual ML, it is the classic insight into forgetting (Ebbinghaus, 1913) and has been captured in mathematical models of learning (Walsh, 2018). Repetition arises in all aspects of human behavior, e.g. children encountering the same toy during play. Prior work has established that children gain significant experience with a small number of objects early in development (Clerkin, 2017). As Fig. 2 shows, the performance of the methods under repeated exposures now approaches that of the batch learner. We introduce a novel continual learning algorithm ("Our model" in Figs. 1 and 2) which outperforms prior approaches. This work demonstrates that grounding machine learning in the properties of infant learning can lead to advances in machine learning. The next step is to use such models to better understand the mechanisms and optimal temporal structure of repetitions for infant learning.

P3-C-41: The foundations of semantic networks in infancy: A focus on fifteen-month-olds



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How is the adult lexical-semantic network first established? The current research examines the foundations of semantic networks in infancy by exploring the emergence of associative links (e.g. tree/bird) and taxonomic links (e.g. dog/cow) between words. Delle Luche et al. (2014) showed that 18-month-old infants listen longer to taxonomically related lists of words than to unrelated lists, demonstrating sensitivity to the semantic relationships between words. This was achieved using the all-auditory head-turn procedure (Kemler-Nelson et al., 1995). In the absence of visual referents, a preference for related words over unrelated words in this paradigm indicates activation of words in a lexical-semantic network rather than in a perceptual system. To date, however, the order in which associative and taxonomic representations emerge is still unresolved (associative links develop first: Perraudin & Mounoud, 2009; taxonomic relations precede associative ones: Markman & Hutchinson, 1984; simultaneous development: Arias-Trejo & Plunkett, 2013). In a series of 5 experiments, we explore the early sensitivity to these two types of word-to-word relationships at 15 months. In the first three experiments, each testing 24 infants, we used the head turn preference procedure to examine infants' preference for lists of related vs. unrelated words, when manipulating the relationship between words (Exp 1: associative and taxonomic, Exp 2: purely associative or Exp 3: purely taxonomic). Infants were presented with 3 pairs of alternating words in the related conditions (e.g. cat-pig) versus 3 pairs of different, unrelated words (e.g. duck-nappy) in the unrelated conditions. We found longer listening times in Exp 1 and 2 but not in Exp 3, suggesting a primacy of associative links over taxonomic ones. However, in Exp 4 which was a replication of Exp 2 (purely associative links) with a completely different set of words to establish that the effect could be generalized across items, we found no evidence of a preference for related lists over unrelated lists. In Exp 5, we re-run the comparison between associatively related words and unrelated words, using a slightly different paradigm to examine if the effect found in the original experiment was due to the associative relationship between words and not driven by individual words. This modification to the design is achieved by yoking stimuli to act both as target words and unrelated words in associatively-related (e.g. tree/bird, mummy/hair and daddy/car) and unrelated (e.g. bird/mummy, daddy/tree, car/hair) word-pair lists, similar to the design used by Willits et al. (2013) with 24-month-olds. Thus, the main aim of this fifth experiment is to establish whether associative links between words drives longer looking times to lists of associatively related pairs of words compared to lists of unrelated pairs of words, at 15 months. A preference for associated words would provide further evidence for the emergence of associative semantic networks in the lexicon of 15-month-olds and support the suggestion that taxonomic links emerge later from experience-based associative relationships.

P3-C-42: Individual differences in attention predict audiovisual minimal pair learning in 14-month-olds

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Across the first two years of life, children skillfully hone their ability to learn words. In laboratory tasks, 14-month-olds readily map dissimilar sounding labels to novel objects. However, seminal work using the Switch Task Paradigm by Werker and colleagues (Stager & Werker, 1997; Werker et al., 1998) demonstrates that 14-month-olds struggle to map phonetically similar minimal pairs--lexical neighbors that differ by a single phoneme (e.g., bin vs pin). Subsequent work suggests that minimal pair learning is supported when multiple talkers produce the novel labels (Rost & McMurray, 2009), referential support is provided (Fennell & Waxman, 2010), and when less cognitively-demanding testing protocols are used (Yoshida et al., 2009). One area where infants' ability to learn minimal pairs has been understudied is within the context of audiovisual speech. Previous research suggests that infants benefit from audiovisual speech information in phoneme perception (Teinonen et al., 2008) and word learning (Havy et al., 2017). Further, work by Bahrick and colleagues (2010) illustrates that infants increase their attention to multimodal information in challenging learning situations. Here, we assess 14-month-old's ability to learn minimal pairs across when visual speech information is simultaneously presented. If infants are able to leverage visual speech information in learning minimal pairs, we hypothesize that infants should show evidence of learning. For the current study, thus far we have collected data from 23 14-month-olds (13 girls) in the Switch Task, across two conditions: visually distinctive (bin vs din; n=11) or visually similar (bin vs pin; n=12). Our planned sample size is 32 infants (16 per condition). Infants were habituated to two novel object-label pairs (see Figure 1) and then tested on 4 Same trials (object-label pairs from habituation were maintained) and 4 Switch trials (object-labels from habituation were violated). Learning is indexed by longer looking on Switch vs Same trials--a reflection that infants have learned the object-label mappings and have noticed the violation of the original pairing. Preliminary analyses using an omnibus ANOVA (condition x trial type) did not reveal any main effects or interactions (all p values > .05), suggesting that, as a group, infants failed to learn minimal pairs from audiovisual speech. However, exploratory analyses suggest an interesting relationship between the time to habituate and word learning performance (see Figure 2). Specifically, a Pearson correlation revealed that longer habituation times are correlated with a Switch preference ($r = -0.49$, $p < .01$) and based on a median split, infants who took longer to habituate showed a robust Switch preference ($p = .02$). These exploratory analyses suggest that individual differences in infants' attention to audiovisual speech may influence minimal pair object-label mapping. Interestingly, infants who are quicker to habituate appear to fail to take advantage of the visual speech information, and perform similarly to infants from previous auditory-only minimal pair studies (e.g., Stager & Werker, 1997; Werker et al., 1998). Taken together, our results suggest that visual speech information may facilitate minimal pair learning, but only if infants are attending to it.

D-Communication 1 (speech perception, phonology and word-level processes)

P3-D-43: Older infants' multisensory matching predicts expressive language but only in a social context

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An important and yet often overlooked first step for language development is a child's ability to attend to and to stay focused on communicative partners. Selective attention is a critical and foundational component of language learning and cognitive development. Within this ability to effectively distribute attention, infants must also effectively seek out and focus on redundant, multisensory information that informs the perceiver about coherent sources of interest (Bahrick & Todd, 2018), such as a parent directing their speech to the child. Children who exhibit significant difficulties processing and integrating information across visual and auditory domains are often candidates for Specific Language Impairments (SLI) or other developmental deficits (e.g., autism spectrum disorder). The primary aim of this study was to examine whether older infants would show enhanced multisensory matching skill as a function of the information being viewed (i.e., social v. non-social dynamic events), and whether any differences in such skills would differentially predict some indicator of their emerging language skill (e.g., expressive vocabulary). Thirty-five monolingual English infants (19 females) were included in the final analysis (median age=23.7 months, SD=1.44), all full-term at birth with no known developmental issues (80% were Caucasian). Infants were tested with the Multisensory Attention Assessment Protocol (MAAP; Bahrick & Todd, 2018) in which they saw/heard two different series of lateral events (12 trials of each; 24 total) that moved, but only one in synchrony with the soundtrack: (1) Social - women telling stories using infant-directed speech, and 2) Nonsocial - objects (e.g., wooden blocks) hitting a surface in an erratic pattern (see Figure 1). Side of match was counterbalanced across trials and presentation order was counterbalanced between infants. The primary dependent measure was proportion of intersensory matching (MSImatch), calculated by dividing the total looking time to the screen by the total amount of time looking to the side of the match (scale 0 to 1.00). After MAAP, mothers filled out the MCDI: Words and Sentences. A 2x2 mixed ANOVA with order (social first, non-social first) and condition (social, non-social) was conducted, finding a significant main effect of condition $F(1,33) = 4.77, p = .036$, but no other significant effects or interactions (all p 's > .05). As a group, infants were more accurate at attending to the AV matched when viewing the women reciting stories: MSImatch for the social condition ($M=.44, SD=.11$) was significantly higher than for the non-social condition ($M=.39, SD=.08$). Next, we examined the ability of MSImatch to predict expressive language levels. A linear regression with MSImatch values for both social and non-social events were regressed onto the MCDI and the resulting model was statistically significant, $F(2, 34) = 4.048, p = .01$, with an adjusted R^2 value of .31. Although the overall model was significant, only MSImatch in the social condition significantly predicted expressive vocabulary, $\beta = .55, p = .001$, but not MSImatch in the non-social condition, $\beta = .09, p = .53$. These results suggest that infants' ability to locate and sustain attention to synchronized speakers and voices differentially predicts their functional vocabularies. This will be discussed in the context of social attention and language learning.

P3-D-44: 24-month-olds' sensitivity to generic and non-generic statements

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Categories powerfully license inferences about the shared properties of members. The conceptual challenge children face in linking relevant properties with categories, however, is not trivial. One means by which children can acquire property knowledge is by hearing a



speaker attribute properties to kinds (e.g., "Lemons are sour"). Children, however, must distinguish between situations in which a speaker is referring to particular objects (e.g., the lemons they are cutting) versus situations in which a speaker is referring to a property of the kind (e.g., lemons in general). One way to make this distinction is to attend to the form of a speaker's utterances. Natural languages convey whether a property is specific to an individual through noun phrases (NPs) that are non-generic (e.g., "These lemons are sour") or more broadly associated with the kind through NPs that are generic (e.g., "Lemons are sour"). Research to date has demonstrated sensitivity to this distinction in children as young as 2-and-a-half years (e.g., Graham et al., 2016; Nayer et al., 2010). In this experiment, we examined the emergence of sensitivity to the generic/non-generic distinction from a new direction by testing 24-month-olds' recognition of a fundamental semantic implication of generics, namely that generic utterances imply a large set of objects (vs. a smaller set of objects). Using an eye-tracking paradigm, 24-month-olds ($n = 30$) were presented with split screen displays of small (2) vs large (10) sets of familiar animals (see Figure 1). Using a within-subjects design, children heard either generic NPs ("Bears climb trees!") or non-generic NPs ("These bears climb trees!"). Children's eye gaze was recorded as they listened to the unfolding speech. For analytic purposes, sentences were aligned at the noun onset (see Figure 2). Participants' proportional looking to the larger set was analyzed using a Growth Curve Analysis with Trial Type (Generic, Non-Generic; deviation-coded) as the main predictor, and Time as a main effect. Key results included a significant effect of Trial Type as well as an interaction of trial type on the linear term, indicating lower proportion of looking to Generic statements compared to Non-Generic statements, and a linear rise in fixations for Generic statements over time, $ps < .001$. Our results suggest that 24-month-olds were more likely to consider the larger set of objects when hearing non-generic noun phrases. Contrary to our predictions, when hearing generic noun phrases, children were initially more likely to consider both sets of images with increasing attention to the larger set as the noun phrase unfolded. This initial pattern may reflect children's interpretation of generics as referring to kinds in general, rather than specific animals. Together, these results indicate that 24-month-olds process generic and non-generic statements differently, potentially signaling different expectations about reference. We are currently following-up on this study by investigating whether children make similar inferences with unfamiliar animals, to see if these patterns replicate with novel labels.

P3-D-45: The role of phonological similarity in infants' category and word learning

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Previous research has shown that labeling allows the formation of categories in cases where infants are unable to form categories without labels (e.g. Waxman & Markow, 1995; Ferry et al., 2010) or in silence (Althaus & Mareschal, 2012). Used contrastively, labels cause infants to divide a visual continuum into two categories (Althaus & Westermann, 2016; Havy & Waxman, 2016). However, the underlying mechanisms are poorly understood. One possibility is that different-sounding labels act as features that make the two types of objects appear more dissimilar (cf. Sloutsky & Fisher, 2012). Dissimilar-sounding labels should then have a larger impact compared to similar-sounding labels. Another possibility is that infants use labels as category markers, and different labels signal the presence of distinct categories. The identity



of the label should then not play a role. To investigate, we familiarized two groups of 16-month-olds ($N=48$, average age 501 days) with two sets of objects (Categories 1 and 2, Figure 1) together with two labels. Infants heard either the labels "moogle" and "kiff" (dissimilar-label condition) or "moogle" and "koogle" (similar-label condition) for the two categories, respectively. After familiarization we tested word recognition with an intermodal preferential looking trial. Categorization was tested in a silent novelty preference trial. Here, infants saw one novel item from a target category next to a hybrid item containing features from both categories (Figure 1). A hybrid preference would indicate the formation of two separate categories, as infants respond to feature co-occurrence. The final trial contained an out-of-category (OOC) object consisting of novel features (Figure 1) to assess successful task engagement. Results from the word recognition test indicated that infants in both conditions failed to map the words onto categories (similar labels; $M=0.51$, $SE=.02$, $t(20)=0.26$, $p=0.8$; dissimilar labels; $M=0.53$, $SE=.04$, $t(20)=0.72$, $p=0.48$). However, results from the hybrid test showed that infants in the dissimilar-label condition had formed separate categories ($M=0.58$, $SE=0.04$, $t(21)=2.06$, $p=0.05$), whereas infants in the similar-label condition failed to do so ($M=0.53$, $SE=0.04$, $t(20)=0.86$, $p=0.39$). Only infants in the dissimilar-labels condition showed a trend for a preference for the OOC object (dissimilar labels: $M=.61$, $SE=.06$, $t(20)=1.94$, $p=.07$; similar labels: $M=.53$, $SE=.03$, $t(23)=.87$, $p=.39$). While the task of mapping two labels to two objects has been shown in lab-based tasks at a similar age (e.g. Schafer & Plunkett, 1998), the visual variability may have made this more difficult in the present study. However, with dissimilar labels infants were able to learn separate categories, whereas infants in the similar-label condition struggled. This is in line with findings that even 2-year-olds treat phonological neighbours of familiar words as instances of the latter (Swingley, 2016). Overall looking times during familiarization were longer in the similar-label than in the dissimilar-label condition, suggesting that the lack of OOC preference was due to confusion about the visual stimuli, rather than lack of engagement. Clearly, in order to have a beneficial effect on category learning, labels must be quite dissimilar. We will discuss these results in the context of an interactive view of infants' simultaneously developing phonological and categorization skills.

P3-D-46: Peer social interaction and language development in bilingual infants with ASD

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Autism spectrum disorder (ASD) is often associated with language delays. Although bilingualism is increasing in the United States, and is the norm worldwide, very little research has been done to understand bilingual development in infants with ASD. Of the studies that have examined bilingual infants with ASD, many find levels of language proficiency similar to monolingual infants with ASD, despite a theoretical increased risk of delay. Critically, however, the field lacks a rigorous quantitative understanding of the language environments of bilingual learners, particularly those with ASD. Recent advances in automated measurement allow for efficient collection of objective measures of the simultaneous interactions and language use in inclusive preschool classrooms--an important language environment for many infants with ASD. Here we utilize automated objective measures of language and movement to quantify the language experiences of monolingual and bilingual preschoolers in ASD inclusion



classrooms, asking how peer input affects infants' language development. Thirty-nine preschoolers, 12 with ASD (8 bilingual), 12 typically developing (TD; 6 bilingual), and 15 with developmental delays (DD; 4 bilingual) from 4 inclusion classrooms, participated. During observations every 2-4 weeks, infants wore lightweight vests equipped with Language ENvironment Analysis (LENA) recorders to measure vocalizations and two Ubisense radio frequency identification tags to proximity/orientation. Ubisense measures of proximity/orientation were used to determine instances of social contact (infants < 2 m apart and oriented towards one another) and synchronized with LENA data to assess when each infant produced/received vocalizations to/from each of their peers. Using linear mixed effects regression models, we predicted each infant's vocalizations while in social contact to each peer from their previous vocalizations to that peer (language output), that peer's previous vocalizations to them (language input), their diagnosis, their language background (bilingual, monolingual), and interactions between language background and peer input and between language background and diagnosis. As can be seen in Figure 1, we found a main effect of peer input such that infants who received more language input from their peers at time t were more likely to produce language output to those same peers at time $t+1$, $X^2(1)=30.58$, $p<.00001$. We also found an interaction between language input and language background such that monolinguals had a greater effect of peer input on language output than bilinguals, $X^2(1)=22.23$, $p<.00001$. Finally, as can be seen in the figure, the difference between monolingual and bilingual infants was driven by those with ASD and DD, as these groups showed a greater effect of language background on the relationship between language input and output. Overall, the language input infants received from their peers increases their subsequent language output to those peers--even while controlling for their own previous levels of talking. However, the effect of peer input was greater for monolingual than bilingual infants, especially for infants with ASD or DD, suggesting that social interaction and language exchange with peers is a potential target for intervention to support language development in these at-risk groups.

P3-D-47: Patterns of maternal interactive behaviors and dual vocabulary development in low-income Mexican-American children

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Children learn the words of their native language(s) from interactions with their caregivers. Although previous research has found that the language children hear during those interactions predict vocabulary outcomes, it is not clear how the quality of early interactions affect vocabulary development. Further, language minority children are tasked with developing vocabulary both in the minority language used in the home but also in the majority language. Understanding the factors of early interactions that may promote or disrupt vocabulary trajectories in both languages are key to better understanding how to foster language skills in language minority children. In this study, patterns of maternal interactive behaviors during toddlerhood were examined in their relation to children's later vocabulary development in both Spanish and English among a low-income sample of 318 Mexican-American families. At child age 24 months, mother-child dyadic interactions during a free play task were recorded and later coded for maternal verbal and non-verbal behaviors that promote or disrupt the interaction: acknowledging, elaboration, gaze, vocal appropriateness, and overriding



behaviors. At 36 and 54 months, child expressive vocabulary was assessed using the Picture Vocabulary subtest of the Woodcock Muñoz Language Survey - Revised Normative Update. Residualized scores were created to account for maternal language use in English and Spanish and child sex. Given that maternal education was related to English vocabulary, it was additionally included in the residualized score for 36 and 54 month English vocabulary. Using a latent class analysis, we identified five distinct patterns of maternal interactive behaviors: Minimal Engagement (n = 14; 6.4%); High Responsivity and Minimal Overriding (n = 92; 42.4%); Moderate Responsivity and Overriding (n = 66; 30.4%); High Overriding (n = 21; 9.7%); High Responsivity, Moderate Elaboration, and Moderate Overriding (n = 24; 11.1%). English expressive vocabulary at 36 and 54 months was particularly sensitive to maternal interactive behaviors characterized as minimally responsive (i.e., lack of acknowledging and shared gaze), whereas Spanish expressive vocabulary at 36 and 54 months was sensitive to maternal interactive behaviors that were high in overriding and low on responsivity. Mothers belonging to the Moderate Responsivity and Overriding profile had children with significantly greater increases in Spanish expressive vocabulary from 36 to 54 months compared to the High Overriding class. Our results identified several combinations of maternal interactive behaviors in low-income Mexican-American mother-child dyads. Further, Spanish and English vocabulary development are each supported or compromised by unique combinations of these maternal interactive behaviors. These findings have implications for moving beyond the word gap to characterizing how early interactions affect low-income children's vocabulary trajectories. Additionally, our results highlight the need to better understand the factors that contribute to low-income, language minority children's vocabulary growth in each of their languages over time.

P3-D-48: Uniting monolingual and bilingual learning: Typical vs. atypical words shape toddlers' real-time sentence processing

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A challenge faced by bilingual infants is the presence of mixed-language sentences, where two languages are used in a single utterance (Look at the caballo/Mira el horse). Examining the processing of these sentences provides insight into bilingual language development, as infants tend to have unequal knowledge of their two languages and show larger disruptions when hearing a switch from their more frequently-heard dominant language to their non-dominant language (Byers-Heinlein et al., 2017). It has been proposed that bilinguals' processing of different sentences can be explained by domain-general principles: sensitivity to typical patterns in the input and the frequency with which words are encountered (Potter et al., 2019). That is, bilingual toddlers successfully recognize familiar words in their dominant language across typical (single-language) and atypical (mixed) sentence contexts, but struggle to recognize a word in their non-dominant language following a language switch. We hypothesized that this reduced word recognition is not specific to bilingualism, but instead is common to any language processing context in which incoming words vary in frequency. As in the bilingual study, we examined monolingual toddlers' language processing of typical and atypical sentence frames and target words. Thus, this investigation examined common principles that underlie language processing in monolingual and bilingual environments. Method. Participants were 21-27m monolinguals (N=34). We monitored toddlers' eye



movements as they viewed pairs of images and heard sentences labeling one item. Infants were tested on words that occurred in Typical or Atypical sentence frames (e.g., Look at the... vs. Examine the...) to approximate the experience of bilinguals tested on predictable single-language vs. unexpected mixed sentences (Fig.1). Target nouns were either High- or Low-Frequency labels for the same object (e.g., horse/pony, bird/goose), creating a parallel to words produced in a bilinguals' dominant vs. non-dominant language. This design allowed us to test whether monolingual toddlers, like bilinguals, have greater difficulty recognizing less frequent words across different contexts. Results. We computed toddlers' mean accuracy in looking to the target object, and found reliable evidence of comprehension in all conditions ($M=.66$, all $p<.001$), showing that monolingual infants understood both High- and Low-frequency labels. A 2x2 within-subjects ANOVA (Frame: Typical vs. Atypical; Label: High- vs. Low-Frequency) tested how sentence context and word familiarity affected comprehension. The effect of Frame was not significant [$F(1,33)=.25$, $p=.62$]; infants were equally able to identify words following typical and atypical sentence frames. However, there was a significant effect of Label [$F(1,33)=4.36$, $p=.04$, Fig.2], suggesting low-frequency words were harder for infants to identify in real time. Discussion: Monolingual toddlers' reduced recognition of low-frequency words is consistent with the finding that bilinguals show weaker word recognition in their non-dominant language. Thus, across monolingual and bilingual environments, toddlers understand their input and construct knowledge through experience with words encountered more vs. less frequently. While bilinguals are often described as facing distinct challenges from monolinguals, our data suggest that the same basic learning principles can explain early language learning in both environments.

P3-D-49: Pedagogical codeswitching during book sharing relates to infant language

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It is estimated that nearly two-thirds of children globally are growing up in bilingual homes (Crystal, 1997). Given that language skills are a strong predictor of academic success (Pace et al., 2018), it is important to understand the relations between bilingual home environments and child language learning. Codeswitching, using more than one language during a conversation, is a common practice in bilingual homes. There is contradicting data, however, on how codeswitching relates to child language skills. Some studies suggest that language mixing can have negative associations with language learning (Byers-Heinlein 2012), while others suggest a more positive relation (Heredia & Altarriba, 2001). There are many reasons why caregivers codeswitch, including to teach or to convey emotion or humor (Hopewell & Gonzalez, 2019). However, few studies have considered how the codeswitching context may affect child language outcomes. This study focuses on code-switching utterances used for pedagogical reasons. A pedagogical utterance happens when a mother makes a remark designed to teach while codeswitching (e.g. Mira la nariz! Mira la nose). Other utterances happen when the mother codeswitches for other reasons, such as is the case with the idiom "Oh my god!". Looking at parents codeswitching from Spanish to English, we hypothesized codeswitching for pedagogical purposes would positively relate to infant vocabulary sizes, while codeswitching for other purposes would not. This study was conducted with 31 Latina



mothers and their 14-month-old infants from low-income homes (Mincome = \$24,693, Range \$7200 - \$60,000). Mothers were videotaped for 5 minutes while engaging in a book sharing activity with their infant. All videos were in Spanish and all incidents of codeswitching were to English. Videos of the book sharing were transcribed and code-switching utterances (either across sentences or within sentences) were identified. Code-switching utterances were then coded as occurring for either teaching purposes or other reasons. Infant Spanish vocabulary at 14 months was assessed via the MacArthur Bates Communicative Developmental Inventory (Fenson et al., 2007), which is a parent-report measure of child language ability. Out of the 31 mothers in our sample, 22 codeswitched at least one utterance (range 1-48). Caregivers who codeswitched more overall had infants with larger vocabularies in Spanish ($r=.481$, $p=.023$). More specifically, the number of pedagogical code-switching utterances was positively related to infant vocabulary ($r=.531$, $p=.011$), but the number of other code-switching utterances was not ($r=.159$, $p=.480$). This suggests that codeswitching can have a positive influence in children's learning processes, especially when done for teaching purposes. Ongoing analyses will examine whether the back-and-forth interaction between parents and children that has been shown to promote children's language development (Hirsh-Pasek et al., 2015) mediates the relation between pedagogical code-switching and child language outcomes. We predict that codeswitching will not only relate to children's vocabulary development directly, but will also influence the dynamics of their interaction with their mother.

P3-D-50: Bilingual infants disengage faster and switch attention more frequently than monolingual infants

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Introduction Infants adapt to the external world by sampling and modelling it. The more variable the environment, the more sampling (exploration) is required to build better models and make better predictions. Exposure to different environments may therefore result in different models and predictions. One variable in the infant's environment is the number of languages that the child regularly hears. Infants who regularly hear two or more languages are necessarily exposed to more varied and less predictable language input than infants who regularly hear only one language (see, e.g., Bosch & Ramon-Casas, 2011). These 'bilingual' infants are also likely to receive less input from each language than 'monolingual' infants from their one language. Given these exogeneous sampling constraints, how does the bilingual infant keep pace (developmentally) with its monolingual peers? We propose that they do so by placing less weight on consolidating familiar information in order to orient sooner to (and sample) new stimuli. In other words, whereas monolingual infants are drawn to familiar stimuli so they can build detailed representations of their language environment, bilingual infants may err on the side of exploration and collect more samples from their more varied environments. **Why might variation in language input affect attention?** Building models of the external world may involve domain-general processes, including the integration of action, perception, and multisensory information processing. **Hypotheses** We hypothesised that infants exposed to bilingual environments will (1) more quickly abandon the visual processing of a stimulus to shift attention to a novel stimulus and (2) more frequently switch attention between two visual stimuli. **Methods and Results** We administered three eye tracking tasks to 7- to 9-month-old

infants who were being raised in either bilingual (n = 51) or monolingual (n = 51) homes. Experiment 1 attempted to replicate the first (and one of only three studies) to find a bilingual advantage in infants (Kovacs & Mehler, 2009). Participants were presented with 9 pre-switch trials during which they learned to anticipate the appearance of a reward on one side of the screen, followed by 9 post-switch trials when the reward was presented on the other side. We could not replicate the finding that bilinguals but not monolinguals can inhibit their learned behaviour and redirect their attention during the post-switch trials. Experiment 2 tested the hypothesis that bilinguals would be faster at disengaging their attention by presenting infants with dynamic visual stimuli. The bilingual infants were faster at disengaging their attention from a central visual stimulus in order to shift it to a peripheral visual stimulus ($p=.017$). Experiment 3 measured switching frequency. Infants were presented with fifteen 5-second trials that each contained two visual stimuli. Linear mixed effects models demonstrate that the bilingual infants switched attention between the two stimuli more frequently than the monolingual infants ($p<.001$; Fig.1), even when taking into account time spent looking at the stimuli ($p=.008$; Fig.2). Conclusion In sum, we found that infants exposed to bilingual environments disengage attention faster and switch attention more frequently than infants exposed to a monolingual environment.

P3-D-51: A comparison of automatic and manual measures of caregiver-infant turn-taking

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The Language Environment Analysis (LENA®) automatically analyzes children's language environment and provides estimates of three primary measures: the number of adult words heard by the child (Adult Word Count, AWC), the number of child's language-related vocalizations (Child Vocalization Count, CVC), and the number of adult-child back and forth exchanges (Conversation Turn Count, CTC). Of these three measures, CTC has recently received the most attention, as it is interpreted as a proxy for quality "serve and return" caregiver-child interactions (see www.lena.org; Gilkerson et al., 2017; Zimmerman et al., 2009), and thus a key component of high-quality language environments. Considering LENA's ubiquitous use by researchers, clinicians, parents, and educators, it is important to examine its reliability as a measurement instrument. LENA's sensitivity has been shown to be high for AWC (82%) and CVC (76%; Xu et al, 2014; Zimmerman et al., 2009). However, it is currently unknown how LENA's CTC estimates compare to human transcription of adult-child turn taking. This is important, because LENA does not separate child-directed versus overheard speech (the algorithm simply detects adult and child speech in close temporal proximity). Therefore, it is possible that LENA's CTC estimates overestimate language interactions between adults and children (i.e. mom is speaking on the phone, infant is babbling to herself nearby). This study examines the correlation between LENA's CTC estimates and manual transcription of adult-infant turn-taking in a dataset of 70 English-speaking families with infants recorded over 2 days at -6, 10-, 14-, 18-, and 24-months of age. At each age for each infant, 100 30-second segments with the highest AWC that were at least three minutes apart were automatically extracted. Coders listened and identified all examples of adult speech followed by a response from the targeted child, or vice versa, and tallied the CTs they heard in each segment. Intercoder reliability was high (98%). LENA's CTC estimate for the same segments



was obtained through LENA's ADEX tool. Results show that the correlation between manual CT coding and LENA's CTC estimate is significant at 6-, 14-, 18-, and 24-mo (r s between .28 and .76, p s < .05), but not at 10mo ($r = .16$, $p = .20$). Importantly, agreement analyses (Figure 1) show that at each age, the average number of manually identified turns per child in 100 30-second segments is significantly lower than the LENA automatic estimate (all p s < .001), with the largest disagreement between the two methods obtained at younger ages. These results indicate that, in certain contexts, LENA's automatic CTC estimates differ substantially from human measurement of parent-infant turn-taking. Recent studies indicate that the proportion of overheard speech in infants' input declines with age (Bergelson et al., 2018), which could explain why the discrepancies between the two methods are largest for youngest infants. The results highlight potential problems with automatic measurement of parent-infant social interaction, and suggest that future studies should validate LENA's CTC estimates with manual coding.

P3-D-52: The impact of contextual, maternal and prenatal factors on receptive language in a Chilean cohort

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Introduction: The study of language predictors highlights the importance of considering as relevant factors the social environment, maternal characteristics and prenatal risk factors (Smith et al., 2018). Existing research has largely been undertaken in developed countries (Atilola, 2015). Subsequently, there is a dearth of literature on language development in other countries, including those in Latin America (Bravo-Valdivieso, Villalón, & Orellana, 2006). Research on language development in Chile has thus far indicated associations between language and several maternal and contextual factors. However, the generalisation of these results is limited by small sample sizes and restricted locations. **Aim:** Generate an explanatory model of Chilean infants' receptive language at 36 to 48 months considering resource access, maternal characteristics, prenatal risk factors, and perinatal social support variables. **Method:** A secondary analysis of data collected from the Longitudinal Survey of Early Infancy (ELPI) was used, which is a representative Chilean survey conducted between 2010 and 2012. The final subsample included children from 36 to 48 months old who lived with their biological mother ($n = 3,945$). Receptive language was assessed with the Spanish version of the Peabody Picture Vocabulary Test, and maternal intelligence with the digits and vocabulary subtest of the Wechsler Intelligence Adult Scale. The other variables were collected from the ELPI interview. For the analysis, a linear regression was conducted using the "hierarchical" method. **Results:** The final model included eight statistically significant predictors, which explained 13.3% of the variance in receptive language at this stage of life ($R^2 = .133$). Resource access, maternal characteristics, and perinatal social support variables were significant predictors for receptive language at this stage. However, most prenatal risk factors were not significant. **Conclusion:** When multiple factors are examined together, resource access, maternal characteristics, and perinatal social support factors are relevant predictors of receptive language in children between 36 to 48 months old. Therefore, when the social background is considered, prenatal risk factors seem to play a minimal role in receptive language. The current model explained only a limited amount of variance of receptive language at this stage.



Thus, further studies should consider other variables that could explain a larger part of the variance, such as the presence of other caregivers and previous language development. The current findings contribute to the existing body of literature on language predictors in a Latin American context. A key strength of this study is its use of a large representative Chilean sample to focus on the impact of variables that have previously been highlighted as significant in international research. These results could be used as a guideline to improve Chilean public policies targeting infancy. For instance, public health policies should promote the participation of mothers and significant relatives in health initiatives to increase maternal social support in crucial stages such as the perinatal period. Additionally, current Chilean programmes focusing on infancy should offer specialised programmes for promotion, prevention, and intervention, targeting mothers who did not finish secondary studies, have lower cognitive abilities, and families who lived in disadvantaged economic conditions.

P3-D-53: Tracking the development of shape sound symbolism in the first year of life

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Sound symbolism refers to the phenomenon by which individuals associate certain language sounds (i.e., phonemes) with certain properties. The most well-known example is the maluma/takete effect (Köhler, 1929): individuals tend to associate sonorants, voiced stops and back-rounded vowels with round shapes; and voiceless stops and front-unrounded vowels with jagged shapes (McCormick et al., 2015). This has been demonstrated in adults from a variety of cultures and language groups (see Styles & Gawne, 2017). However, the age at which this effect emerges is still unknown, with some studies suggesting it emerges at one year (Pejovic & Molnar, 2016) and others suggesting it emerges earlier (e.g., Ozturk, Krehm, & Vouloumanos, 2013). This is an important question, as it speaks to whether or not sensitivity to sound symbolism is an innate faculty of humans. If it emerges later in life, the age at which it emerges could suggest that certain developmental milestones or experiences are necessary. Here we report the first longitudinal experiment tracking the development of the maluma/takete effect. We tested 64 infants at 4, 8 and 12 months of age in a preferential looking paradigm (47 infants were tested at all three time points). On each trial, infants saw two objects on the screen, one with a round shape and the other with a spiky shape (see Figure 1) while listening to a nonword that contained round-associated phonemes (i.e., bobo or lulu) or sharp-associated phonemes (i.e., cheechee or kaykay). There were 8 trials per participant (12 seconds per trial); 4 were paired with a round-sounding nonword and 4 with a sharp-sounding nonword. The order of the objects on the screen and the order of the trials were pseudo-randomized. The data at each age were analyzed using linear mixed effects, with the percentage of looking time to the round object as the dependent variable. The predictor of interest was the type of nonword heard on each trial (i.e., round- vs. sharp-sounding). Models also included random subject and item intercepts, and slopes when appropriate (see Bates, Kliegl, Vasisth, & Baayen, 2015). Results indicated that there was no effect of nonword type on percentage looking time to the round object at 4 months ($p = .87$) nor at 8 months ($p = .93$). However, at 12 months there was a marginal effect of nonword type, such that infants looked longer at the round shape while hearing round- vs. sharp-sounding nonwords ($p = .089$). See



Figure 2. Our data suggest that sensitivity to sound symbolism is not innate. Indeed, it does not seem to be present up to and including 8 months of age. It seems that sensitivity to sound symbolism may begin to develop around 12 months of age. We are currently testing 14- and 16-month-olds to investigate development of sensitivity into the second year.

P3-D-54: Adult language affects infants' focal point before 36 months

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A series of studies by Ito (2015), Ito and Wang (2016), and Ito (2018) revealed that English-native speakers have a stronger tendency to put an agent into the subject position than Japanese-native speakers when describing an event or situation. In the studies, native speakers of Japanese and English are shown images involving two participants (figure 1), one of which is an agent (i.e., a bull chasing a person), and the other is a patient (i.e. a person being chased by a bull) and instructed to describe them. Figure 1. Example (1a) is a typical description by English natives who describe "the attacking bull" as the subject and (1b) is the one by Japanese natives whose subject is "the escaping man". This tendency shows that English and Japanese natives construe the same event/situation differently particularly as to the focus of the participant in the situation. (1) a. A bull is chasing a man. b. Otokonohito-ga togyu kara nigete-imasu. A man SUB a bull from escape-PROG (A man is escaping from a bull.) Based on the these results, the focus of the current study is on child language in order to see when the construal difference between Japanese natives and English natives starts to emerge. The subjects were English-native infants (18 of three-year-old children, 29 of four-year-old children, and one five-year-old children: total 48) and Japanese-native infants (50 three-year-old children, 50 four-year-old children, 50 five-year-old children: total 150). The procedure was the same used in Ito (2018), in which the subjects were shown the 12 images involving agent and patient and instructed to depict them. Their descriptions are recorded and transcribed for categorization into either an agent-focused description or a patient-focused one. The results are as follows: First, as shown in (2), both English and Japanese native three-year-old children tend to describe the situation with a one or two-word sentence (i.e., early sentence). However, even at this stage, they exhibit the same tendency as adults observed; English natives tend to focus on the agent, whilst Japanese natives focus on the patient. Second, this tendency becomes clearer in the descriptions of infants four years or older who are more likely to complete sentences with a subject and conjugated predicate like in (3). Typical description for figure 1 by three-year-old English / Japanese natives (2) a. Animal. Running b. Niget-eru. Escape-PROG Typical description of figure 1 by four- and five-year-old English / Japanese natives (3) a. A bull is chasing someone. b. ushi-ni kuware souni natte-ru. bull-by eaten looks become-PROG (someone) is about to be eaten by a bull. Even in the three-year old infants' language, around half of which seems to be in the stage of early sentences, a statistically significant difference between English and Japanese infants are observed. Furthermore, the difference becomes as clear as that of adults when they reach the age of four, by which time they can complete sentences with a subject and a conjugated predicate. These results suggest that adult language, particularly the way of describing an event/situation, affects infants' construal tendency onto which participant they focus on, and that this is acquired before the age of three (36 months) or younger, during the early sentence stage.



P3-D-55: Low statistical frequency of onset clusters in infant word segmentation

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In fluent speech, there are a variety of cues that signal word boundaries. Without the benefit of an established lexicon, infants must learn and rely upon these cues to parse words. Acquiring the appropriate skills to detect word boundaries is crucial to word learning. Phonotactics, which are language-specific restrictions on sound combinations, is such a cue. Sensitivity to phonotactics begins to emerge at around 9 months of age (Jusczyk et al. 1994) and is used in word segmentation (Mattys & Jusczyk 2001). Furthermore, English-learning 9-month-olds segment nonwords based on the statistical frequency of stop-liquid onsets in their language. That is, infants familiarized with high frequency onset (tr-) novel words embedded in passages are successful at segmentation, but infants familiarized to low frequency onsets (dr-) are not (Archer & Curtin, 2016). This suggests that 9-month-olds might not have enough experience with low frequency onsets to use them as cues to word boundaries. In this study, we focus on word initial complex onsets to determine how sensitive infants are to the occurrence of onsets in their language and whether they are capable of using low type frequency phonotactics to segment words within spoken passages. We pre-exposed infants to low-frequency (dr-) clusters to see whether this would support segmentation of novel forms. Using the headturn preference procedure, English-learning infants were pre-exposed to lists of unique tokens of nonwords that share the same onset. The low-frequency group (n = 24) was exposed to /dr/-words. We also included a zero-frequency group (n = 24) who were exposed to unattested /dl/-words so see whether pre-exposure was enough to enhance segmentation. Following exposure, infants were then familiarized with passages that include either low- or zero-frequency target nonwords ('drom' or 'dlom', respectively). At test, all infants were presented both target words ('drom', 'dlom') in isolation. Results showed a significant difference between the familiar (M = 7.42; SD = 2.50) and the novel (M = 8.29; SD = 2.20) trials, $t(23) = -2.213$, $p = .037$, $d = 0.452$ in the low-frequency condition. However, infants in the zero frequency 'dlom' condition did not demonstrate preferences for either test trial: familiar (M = 7.61; SD = 2.55) or novel (M = 7.82; SD = 2.54), $t(23) = -.484$, $p = .633$. The results of this study indicate that infants can access their representation of low-frequency wordforms. Even with equal pre-exposure to low- and zero-frequency onset clusters, those infants pre-exposed to /dl/-words and then familiarized with 'dlom' did not recognize the target word. This suggests that a lack of language experience impacts infants' segmentation of these forms from continuous speech. The current findings show that infants of 9-months may indeed have a latent representation of actual /dr/-words that is potentially boosted by pre-exposure. In this case, we have primed infants' recollection of low-frequency forms through pre-exposure, which helped with access to emerging representations.

P3-D-56: Parents' income and education do not impact Japanese infants' vocabulary at 20 months

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Measuring and understanding language skills at the early stage of life is important as it lays the foundation for later language development. Kuhl (2011) reported that language skills between 18 and 30 months predict language abilities and pre-literacy skills at the age of 5 years in children learning English. In the United States, the socioeconomic status (SES) of the family is considered one of the crucial factors that contribute to the variability of early language skills and vocabulary for 18-month-old infants (Fernald, Marchman & Weisleder, 2013). To date, however, studies that demonstrate the impact of SES on vocabulary are mostly based on English learning infants in the US, and whether it would have similar patterns in other languages and/or cultures remains unknown. In this study, we report the results of a large-scale research on Japanese infants that investigated whether the infants' family environment, such as household income and parental income, impact infants' vocabulary at 20 months. A total of 436 mothers or fathers completed the words and grammar of the Japanese MacArthur-Bates Communicative Development Inventories (JCDIs, Watanuki & Ogura 2004), when the infants were 20 months old (boys = 218, girls = 218). Prior to MCDI, participants also completed the questionnaire on home environment, which included items on household income, mother's occupation (working, maternal leave from their work, housewife, and other), parents' years of education, and parents' age when their child was 5 months old. The participants were recruited from Japanese-speaking homes in the Tokyo area. As shown in Figure 1, the numbers of words produced by the 436 Japanese infants were distributed normally. The average words produced was 101.90 (SD = 95.52), which was consistent with a previous Japanese study (Ogura, Watanuki & Inaba, 2015). This number is, however, significantly smaller than that of American infants learning English at the same age (Fenson, et al., 1988). Like American girls, Japanese girls were shown to have a wider vocabulary than boys ($t(428) = 4.36, p < 0.01$). We also confirmed that household income and parents' education of the 436 families are well distributed (Figure 2). To investigate the effects of the home environment on the vocabulary of 20-month-old infants, we conducted stepwise linear regression with vocabulary size as the dependent variable and home environment as a between subject factor. The results revealed that only mother's working status was significant ($F(4, 431) = 4.09, p < 0.01$). The vocabulary size of infants whose mothers worked or were on maternal leave was larger than infants whose mothers were non-workers ($t(428) = 2.09, p < 0.05$). In contrast, household income, age, and years of education of parents and interaction were not significant. These results suggest that Japanese infants' vocabulary at 20 months is not impacted by SES, which is a sharp contrast to the findings of American studies. Current findings indicate that the predictor of infants' vocabulary size based on home environment at 20 months was not universal, but culturally or linguistically different.

P3-D-58: The statistics of parent object talk: Implications for word-referent learning

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Statistical word-referent learning has emerged in recent years as an influential framework for understanding infant lexical development (Smith et al., 2014). Key to this framework is data from artificial learning experiments demonstrating that infants, children, and adults can



discover word-referent pairings from word-object scenes that are individually ambiguous but cross-situationally coherent (Smith & Yu, 2008; Yu & Smith, 2007). To test the scalability of these findings to infants' real-world learning, we compared the word-referent statistics in parent-infant interactions to the word-referent statistics in the prototypical artificial learning paradigm (Yu & Smith, 2007's 4x4 design; from here on YS07). These comparisons suggest that the statistical learning task faced by infants diverges in important ways from the task faced by participants. **METHODS** We analyzed audio-visual recordings of 37 parent-infant interactions (the 9-month-old Rollins Corpus; Rollins, 2003). We first transcribed parent speech and identified "referential utterances", defined as utterances when parents referred to an object by its conventional name (e.g., "look there's a car"), an alternate word (e.g., "you like that toy"), or a pronoun (e.g., "it goes beep beep"). Referential utterances were compiled into a corpus of 2,553 utterances directed to 15 objects (e.g., car, hat). To compare the infants' word-referent statistics to YS07's statistics, we randomly sampled six utterances per object from our corpus (YS07 had six trials per object). We analyzed: (1) the extent to which referential utterances referred to multiple objects (a feature of YS07), (2) instances of non-object names (or "competitor words"), (3) the frequency of object names, and (4) the frequency of competitor words. All analyses were repeated on 100 unique samples to ensure results were representative. **RESULTS & DISCUSSION** Word-referent statistics in parent-infant interactions differed from those in YS07 in several ways. First, very few utterances to infants referred to multiple objects ($M = .09$, $SD = .09$; Fig 2A), a hallmark of the YS07 paradigm. Second, infants heard more competitor words (token competitors per six utterances = 23.5; $SD = 3.1$; types per six utterances = 17.8; $SD = 2.5$; p 's < .001, Fig 2B-C). Third, unlike in YS07, object names were present in only a small portion of utterances ($M = .42$, $SD = .17$; $p < .001$; Fig 2D). Finally, on average, object names occurred less frequently ($M = 2.54$, $SD = 1.03$) than the most frequent competitor word ($M = 3.47$, $SD = .84$, $p < .05$; see Fig 2E-F). These findings have two implications for infants' real-world cross-situational learning. First, the learning problem faced by infants is likely better characterized as a "many-to-one" problem (i.e., which of many words go with the talked about object) rather than the "many-to-many" problem (i.e., which words go with which objects) prototypical of most cross-situational learning paradigms (cf. Mattock & Monaghan, 2012). Second, infants must overcome the challenge, underestimated by most experimental paradigms, that object names are infrequent in the input and that competitor words often eclipse object names in frequency. Current experimental research in our laboratory is investigating how learners overcome these problems and challenges.

P3-D-59: Infants' use of phonological detail (mispronunciations) in noisy listening conditions

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Much research suggests older infants are incredibly sensitive to subtle mispronunciations in words (e.g., Bailey & Plunkett, 2002; Ballem & Plunkett, 2005; Fennell & Werker, 2003; Swingley & Aslin, 2000, 2002). However, these studies took place in quiet listening environments, which may be unlike many of the real-world situations in which infants find themselves. Do these findings generalize to more challenging listening conditions? By 24



months, infants recognize words in the presence of noise at levels as low as -5 dB signal-to-noise ratio (SNR). When shown two familiar objects on a screen (with highly acoustically dissimilar labels, e.g., cow/pig; birdie/horsie) and hearing a voice (embedded in multitalker babble) telling them to look at one of the two objects, infants did so (Newman, 2011). The current study explores how noise impacts infants' ability to distinguish among familiar words, mispronunciations of those words, and novel words. Infants aged 18-24 months saw both a familiar and a novel object on the screen on each trial, and were instructed to find the item matching either a familiar word (e.g., apple), a novel acoustically dissimilar word (cheffin), or a novel mispronounced version of the familiar word (opple). In quiet listening conditions, infants look significantly more to the familiar object when hearing the familiar label ($M=67\%$, $t(20)=4.88$, $p<.0001$), but more to the novel object when hearing the novel label ($M=63\%$ to novel, i.e., 37% to familiar object, $t(20)=4.15$, $p<.0005$), replicating prior research (e.g., Swingley & Aslin, 2002). When hearing the familiar label mispronounced, infants looked to the familiar object marginally above chance ($M=55\%$, $t(20)=1.41$, $p<.10$) and significantly less than to the familiar object after a correctly pronounced label ($t(20)=2.72$, $p<.05$). However, in the presence of multitalker babble (9 female talkers superimposed over the labelling voice) presented at 0 dB SNR, results differed. The same infants performed at chance levels (50%) on the familiar ($M=50\%$), novel ($M=49\%$), and familiar mispronounced ($M=52\%$) trials ($t(20)<1.0$, $p>.20$). Thus, in 0 dB-SNR multitalker babble, 18- to 24-month-olds failed to demonstrate word recognition, even with a correctly and clearly labelled familiar object. These results contrast with previous studies showing success with a lower (more difficult) SNR (Newman, 2011). Why did infants fail in the current study, but succeed in Newman (2011)? Perhaps infants failed here because (1) they were slightly younger than those tested in the prior study, or (2) children may be unwilling to guess based on partial/noisy input when there is a novel object available (the combination of both noise and the novel object may make the task particularly difficult) or (3) infants may have viewed the speaker as unreliable because she produced both clear and mispronounced tokens. We are currently working to distinguish among these possibilities. However, our results thus far indicate that infants' success at speech-perception-in-noise may be task dependent, and that children's sensitivity to phonological specificity may be maximized in ideal listening environments. This raises questions about whether children can use the phonological detail in their representations when faced with more challenging listening conditions.

P3-D-60: Middle ear fluid: A common yet easily-missed condition that can affect children's performance on language-related tasks

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Otitis media with effusion (OME or middle ear fluid) is a common yet invisible condition in children. About 90% of children experience at least one episode of OME before the age of 5, and develop, on average, 4 episodes of OME every year (Rosenfeld et al., 2016). This can happen as a result of a past ear infection, allergies, a cold, or teething. OME is not the same as an ear infection, as the presence of fluid often occurs in the absence of a virus/bacteria and does not lead to the typical symptoms of infections (fever or severe pain). Instead, children might experience mild discomfort and trouble hearing, leaving caregivers unaware that their child has fluid in one or both ears. Previous research suggests that OME affects hearing



sensitivity and leads to poorer performance during phonetic discrimination (Polka & Rvachew, 2005). However, little is known regarding how OME might affect performance in other linguistic measures (e.g., word recognition). Furthermore, while language researchers typically ask about history of ear infections, the majority do not check for presence of fluid at the time of testing. The current project examines: (i) the frequency with which infants participating in a language study had OME on the day of testing, and (ii) whether having OME affected word recognition performance. We specifically focused on children who had fluid in both ears, since presumably that would have the greatest impact on hearing ability. Children between 20-29 months ($M=23.9$; $N=55$ to date) completed a Preferential Looking task. They were presented with paired images of familiar objects on a screen while a sentence instructed them to look at one of the objects. Children's eye movements were video-recorded and coded off-line to calculate the proportion of time they looked at the target object. Immediately after this task, participants were tested for presence of fluid in each ear using a portable middle-ear analyzer. This machine changes the air pressure in the ear canal to make the eardrum move back and forth while a sound is played. The test is quick (less than 2 minutes), only requires minimal training, and indicates when fluid is present as the eardrum's mobility is then restricted. Our data suggest that 20% of the study's participants had fluid bilaterally. Most importantly, as shown in Figure 1, accuracy during word recognition for children without OME was higher ($M=64\%$) compared to children with OME ($M=57\%$). This difference was marginally significant ($t(12.61) = -1.6163$, $p = .0653$; Cohen's $d = -.6705$). Additional data will be available by the time of the conference. Interestingly, based on our observations, children with OME did not show any kind of behavior during the task that would have indicated that the condition was present (e.g., excessive fussiness, or inattentiveness). Taken together, our preliminary data highlight the importance of checking for OME when conducting language-related research with young children. This work serves as a first step in understanding how this common (yet understudied) condition affects children's ability to complete tasks that rely on processing auditory information.

P3-D-61: Surprise! Violations of emotional expectancies facilitate infant word learning at 14 months

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Infants actively make use of their expectations about the world and violations of those expectations alter subsequent learning. For example, when 11-month-olds observed an object event that violated their expectations (e.g., an object floated in the air with no support), they explored the object more than in a non-violation condition and only successfully learned the association between the object and its sounds in the violation condition (Stahl & Feigenson, 2015). Further, children learned novel verbs better after experiencing violations of expectations about object behavior (Stahl & Feigenson, 2017). However, the above work focused on unexpected events involving object behavior. Could expectancy violations in other domains also promote children's learning? The present study aims to extend the above to another domain - emotional expectations. We investigated whether incongruent emotional face-voice pairings (i.e., violations of expectancies based on emotional knowledge) facilitate infants' word-object associations in the Switch task (Stager & Werker, 1997). In this task, infants are habituated to a word-object pairing and are subsequently presented two test trials:



one maintains the correct pairing (i.e., the 'same' trial) and the other involves a violation of that pairing (i.e., the 'switch' trial). In Experiment 1, we presented 14-month-olds ($N = 16$) with incongruent emotional face-vocalization pairings (e.g., an unhappy face and laughter) and then engaged them in the Switch task. Infants were habituated to a novel object paired with the word "bin". At test, infants looked longer at the object on the 'switch' trial that involved a mispronounced label ("din") than the 'same' trial with the correctly pronounced label ("bin") [$t(15) = 3.11, p = 0.007$]. This indicates that infants learned the object-word pairing in fine detail. However, an alternative explanation of infants' learning in the Switch task may be that salient emotional stimuli in general tend to boost infants' attention to the subsequent task. Thus, Experiment 2 was a control study in which we presented another group of 14-month-olds ($N = 16$) with four correct emotional pairings of human faces and vocalizations (e.g., an unhappy face and crying sounds) before presenting them with the same Switch task as in Experiment 1. We found that infants did not look longer at the object in the 'switch' trial than in the 'same' trial [$t(15) = 0.31, p = 0.763$]. Thus, the infants had greater difficulty with the association between the object and label presented in the emotionally congruent task than in the violation task. Our findings suggest that expectancy violations concerning emotional knowledge allowed infants to succeed in learning detailed associations between words with objects. So, why does violating infants' expectations facilitate subsequent learning? According to the Meaning Maintenance Model (Heine, Proulx & Vohs, 2006), expectancy violations may motivate infants to attempt to make sense of conflicting stimuli, thus heightening their attention and resulting in better learning in the subsequent task. This model also aligns with studies suggesting that learning may be proportional to the amount of surprise that the participant experiences (Grimmick, Gureckis, & Kachergis, 2019). Future work may investigate how varying the level of surprise arousal can affect children's learning to fully understand the role of expectancy violations in childhood learning.

P3-D-62: Word segmentation in French-learning infants: Acoustic and statistical cues

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Two types of information have been proposed as particularly relevant for bootstrapping infants' word segmentation abilities: statistical cues, such as transitional probabilities (TPs) between syllables (e.g. Aslin, Saffran & Newport, 1998), and prosodic cues. The latter involves language-specific prosodic regularities such as lexical stress (e.g. Jusczyk et al., 1993; Höhle, 2002), or language-general auditory mechanisms, such as the Iambic-Trochaic Law (ITL, Hayes, 1995). The ITL states that sequences of sounds that vary in intensity are grouped as trochaic strong-weak pairs, whereas sequences that vary in duration are grouped as iambic weak-strong pairs. Here, we explored how 6-to-7-month-old French-learning infants' exploit these cues for word segmentation. Based on previous literature that French-learning 8-month-olds are capable of using TPs for segmentation (Mersad & Nazzi, 2012), and acoustic cues to group speech sounds (Abboub et al., 2016), we constructed two languages pitting the cues against each other. Thirty-two infants participated in an HPP experiment similar to Thiessen & Saffran (2003) and were familiarized with a string of four disyllabic pseudo-words (see Figure 1). The TPs between syllables within the four pseudo-words were 1.0 (statistical words). The order of occurrence of the statistical words in the string was varied such that the TPs across the four



words ranged between 0.4 and 0.2. In one of the strings (duration condition), the first syllable of each statistical word was longer than the second, suggesting a weak-strong grouping across the boundaries of the statistical words according to the ITL. For constructing this string syllables from naturally produced iambs were used (recorded by a French-speaking trained phonetician). In the other string (pitch/intensity condition), the second syllable of each statistical word had a higher pitch and intensity than the first, suggesting a strong-weak grouping across the boundaries of the statistical words according to the ITL. In this string, all syllables came from naturally-produced trochees. In the test phase, bisyllabic sequences from the string were presented that either constituted units according to the acoustic information (acoustic words), units according to TPs (statistical words) or were a combination of two syllables that had never occurred together in the string (non-words). In the duration condition, looking times for statistical words were significantly shorter than for non-words ($p = .01$) (Figure 2, left). No effect was found in the pitch-intensity condition (Figure 2, right). This establishes that French-learning infants use duration information to segment word forms from the speech stream by 6-to-7 months even when statistical information works against it. The asymmetry between the two conditions (significant effect only in the duration but not in the pitch/intensity condition), further suggests that the prosodic system of French with its prominence of phrase final stress marked by duration has an impact on infants' segmentation. Further analyses and final findings will be discussed in relation to the early impact of language-specific properties on segmentation mechanisms.

P3-D-63: Toward consistency in English-Spanish vocabulary checklists for dual language learners

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Accurate and culturally sensitive measurement of dual-language-learners' (DLL's) vocabulary is imperative: 25% of all U.S. children are Hispanic, and 72% of Hispanics 5 years or older speak Spanish at home. The MacArthur Bates Communicative Development Inventories (MCDI) short forms are widely used, time-effective, valid, and standardized measures of vocabulary based on parent report. The MCDI: Words and Gestures (MCDI:WG) forms measure receptive and expressive vocabulary in infants 8 to 18 months, and the MCDI: Words and Sentences (MCDI:WS) forms measure expressive vocabulary in infants 16 to 30 months. MCDI short forms are available across multiple languages, including English and Spanish. However, English and Spanish MCDI's were created as standalone measures of monolingual language development, with little attention to the comparability of vocabulary items across languages. To what extent do items on English and Spanish forms overlap? How can researchers move closer to assessing a common set of vocabulary items? We compared Spanish and English MCDI short forms; identified common and unique items in each language; and generated supplemental checklists to allow item-level analyses across languages. Examination of words on English and Spanish short forms revealed little overlap. Of the 104 Spanish words and 88 English words on the MCDI:WG, only 23 were shared. Of the 100 Spanish words and 100 English words on the MCDI:WS, only 24 were shared. To address item-inconsistency, we translated words on English short forms, but not on the Spanish short forms, to create supplemental Spanish vocabulary lists, and vice versa. This resulted in 65 words for the Spanish supplemental checklist and 76 words for the English supplemental



checklist, building on the existing MCDI:WG short forms; and 76 words for the Spanish supplemental and 78 words building on the MCDI:WS short forms. Use of the English and Spanish supplements in conjunction with original short forms yields a total of 165 English words and 169 Spanish words for the 8-18 month vocabulary checklists and 178 English words and 176 Spanish words for the 18-24 month vocabulary checklists. Although supplements slightly increase time burden, they provide enormous benefits for researchers who seek to address questions around infant language development that extend beyond standardized scores. Prior mismatches in the English and Spanish MCDI short forms prevented item-level analyses of children's vocabulary across languages, which hindered interpretation of DLL language development. The current development of supplemental forms offers the possibility of asking about children's receptive and expressive vocabularies based on checklists tailored for cross-language comparisons and use with DLL's. Importantly, the newly developed English and Spanish short form supplements build on, but do not modify, the original short forms, providing researchers the option of using the original MCDI standardized short forms to assess the language status of children from Spanish and English-speaking homes following more traditional methods. A cross-national sample of 1000 infants (300 DLL's) ages 12, 18, and 24 months from the NICHD-funded Play and Learning Across a Year (PLAY) project will form the basis for assessing the psychometric properties of the English and Spanish vocabulary checklists supplements for DLL's.

P3-D-64: First word understanding in German babies started only around the 8-10 months and showed a quadratic trend

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Infants learning American English begin to understand first words uttered by their caregivers already around 6 months after birth (Bergelson & Swingley, At 6 to 9 months, human infants know the meanings of many common nouns. Proceedings of the National Academy of Sciences of the USA, 2012). Thereafter, they show a linear increase in this ability over their first year of life. At six months, infants learning American English also understand first words uttered by an unfamiliar talker (Bergelson & Swingley, Young infants' word comprehension given an unfamiliar talker or altered pronunciations. Child Development, 2017). For the later ability, however, there is a quadratic trend: 8-10 months old infants seemed to perform worse in understanding words than younger (6-7 months) and older (11-14 months) infants. Here we investigate at which age German infants learn their first word meaning associations and which trend their understanding of words spoken by an unfamiliar speaker follows. We tested 35 monolingual infants between 6 and 15 months old. Similar to Bergelson and Swingley (2012, 2017), we recorded eye movements during an intermodal preferential looking paradigm. Infants saw two different pictures on the screen (e.g., a cucumber and a baby) and heard a word matching the target picture (e.g., baby). Eye movement data revealed that only infants between 8-10 months old showed increased fixation to the targets; whereas infants 6-7 months old and 11-15 months old did not. Thus, infants learning German show robust word meaning associations later in development than infants learning American English. This is in line with slightly delayed development of word segmentation abilities shown for German learning infants compared to American English learning infants, which was related to cross-cultural differences in using infant-directed speech (Schreiner & Mani, Listen up! Developmental differences in the



impact of IDS on speech segmentation. *Cognition*, 2017). However, a quadratic trend in how infants deal with speech variation seems to reflect a cross-lingual genuine developmental pattern once first word forms are established. It appears that infants start with less specified phonological representations and acquire more detail later on.

P3-D-65: The role of speaker gender in infant lexical processing

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Adult and child language users utilize social category information to facilitate incremental language processing (Borovsky & Creel, 2008; Van Berkum, van den Brink, Tesink, Kos, & Hagoort, 2008). Gender is a particularly salient social category, given extensive preconceived notions and expectations about others based on their perceived and/or known gender (Messner & Bozada-Deas, 2009; Slepian, Weisbuch, Rule, & Ambady, 2010). To investigate the role of perceived gender in language processing, previous studies with adult participants manipulated gender-conforming vs. gender-conflicting information via stereotype-dependent inferences about the speaker, such as a male voice saying a phrase like "If only I looked like Britney Spears!" which is stereotypically related to female speakers (Van Berkum, et al., 2008). However, the age at which language users begin to draw these types of connections between language and the social world is unknown. The current experiment examined 22- to 24-month old infants (N=40) in a looking-while-listening paradigm. The question of interest was whether infants use gender cues to determine the intended referent of a speaker. On each trial, infants viewed two highly familiar objects, a target and distractor object. One object was prototypically male, and one was prototypically female (see Figure 1 for an example). While viewing these objects, they heard either a male or female speaker refer to the target object ("Can you find the sock? Check that out!"). The objects were selected to appear to be more feminine or masculine based on their colors and designs, and normed with both adults and pre-school children. Half of the trials were Consistent: the speaker's gender matched the target object's prototypical gender. The other half of the trials were Inconsistent: the speaker's gender mismatched the target object's prototypical gender. The experimental design, analytic plan, and predictions were preregistered on OSF. Data were collected using a Tobii eye-tracker; infants who could not be calibrated or who had more than 50% missing data were hand-coded (iCoder). The question of interest was whether the speaker's perceived gender would affect infants' looking behavior. Results indicate that on Consistent trials (in which the speaker's gender matched the prototypical gender of the target object), participants were significantly more accurate during the Target window (300-1800 ms after target word onset) compared to Inconsistent trials (in which the speaker's gender did not match the prototypical gender of the target object), $\beta = .06$, $F(1, 38) = 4.48$, $p = .04^*$. See Figure 2 for profile plot. These results indicate that the presence of a gender-matched voice facilitated infants' lexical processing. Planned analyses will use GCA to investigate time course and anticipatory looking, as well as other covariates. This research contributes the first investigation of the role of speaker gender in infant lexical processing, with implications for how social categories are encoded early in life.

P3-D-66: Audiovisual integration in 18-month-old toddlers: Examining the McGurk effect

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Introduction. A wide range of visual cues are available during face-to-face interactions and infants make use of visual information in speech perception (Yeung & Werker, 2013). Viewing lip movements can alter the perception of auditory speech, as shown by the McGurk effect (McGurk & MacDonald, 1976). In this effect, an auditory (A) syllable /ba/ is synchronously presented with a discrepant visual (V) syllable [ga], leading to the illusory perception of a third syllable 'da'. McGurk effects have been found in studies with adults and children from 3 years of age (McGurk & MacDonald, 1976). To date, only two studies have used this paradigm with young infants. Burnham & Dodd (2004) examined 4½ month-old infants but their results cannot be unequivocally interpreted. In turn, Kushnerenko et al. (2008) observed--using electroencephalography--that 5-month-old infants process incongruent audio-visual inputs that can lead to a McGurk effect (A /ba/ + V [ga]) similarly to congruent audio-visual input (A /ba/ + V [ba]). The developmental trajectory of this effect is therefore greatly understudied. In the present study we examine whether a McGurk effect is observed in 18-month-old toddlers. These infants are undergoing the so-called "vocabulary spurt". Recent studies have revealed a link between infants' early audiovisual speech processing abilities and their perceptive and productive lexical skills (Tenenbaum et al., 2014). However, infants' selective attention to audiovisual speech changes throughout development (Lewkowicz & Hansen-Tift, 2012), and 18-month-old infants seem to favor auditory over visual information while forming new lexical mappings (Havy et al., 2017). More research is thus needed in order to understand infants' audiovisual integration abilities at this point in development. Methodology. We used a visual habituation design to test whether 18-month-old French-learning infants exhibited a McGurk effect (Figure 1). We habituated two groups of infants (n = 24 each) with videos of a talking face producing congruent auditory and visual tokens of the pseudoword 'dilu'. Infants were subsequently presented with two types of test trials: (a) incongruent trials aimed to elicit a McGurk effect (x2): videos displaying auditory /bilu/ combined with visual [gilu] (henceforth McGurk trials), (b) non-McGurk trials (x2): Group 1 was presented with videos of congruent auditory and visual 'bilu', Group 2 with 'gilu'. Both trials of each type were presented consecutively, and their order of presentation was counterbalanced across infants. Results. We recorded and off-line coded infants' looking times to the videos during habituation and test. Analysis showed that both groups dishabituated upon seeing the McGurk test trials, suggesting that they noticed the discrepancy between the auditory and visual signals (Figure 2). Interestingly, infants in the first group looked significantly longer to McGurk than non-McGurk--'bilu'--test trials, while infants in the second group looked equally to the McGurk and non-McGurk--'gilu'--test trials. Together, these results show no evidence of a McGurk effect in 18-month-old toddlers. Instead, they suggest that infants might have resolved the conflict between auditory and visual information by relying on visual rather than auditory information.

P3-D-67: Convergence and divergence in prediction from vocabulary and speed of lexical access



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Early individual differences in vocabulary and speed of lexical access predict subsequent development (Friend et al., 2018; 2019; Marchman & Fernald, 2008). These constructs, though moderately associated (Fernald et al., 2006; DeAnda et al., 2018; Hendrickson et al., 2015), do not fully overlap. We conceptualize independent variance associated with each as long-term knowledge versus processing efficiency, respectively. We compare prediction to later language abilities from vocabulary and lexical access.

English- (N=49) and French-speaking monolingual children (N=58) completed the Computerized Comprehension Task (CCT; Friend & Keplinger, 2003; 2008) at age two. We estimated vocabulary size as number of correct touches and lexical access as mean latency to touch a target (as opposed to latency to fixate; Marchman & Fernald, 2008). Children returned at ages three, four, and five and completed the Peabody Picture Vocabulary Test (Dunn & Dunn, 1997), a measure of receptive vocabulary, and nonword repetition, a measure of phonological working memory.

If vocabulary and lexical access are dissociable, we expect vocabulary to predict later vocabulary more strongly than lexical access. Complementarily, lexical access should predict nonword repetition more strongly (working memory is highly associated with processing efficiency; Fry & Hale, 1996). We fit two-part linear spline structural equation models to growth from age three to four, and four to five. We entered vocabulary OR lexical access as a predictor then added language group and a language group X predictor interaction.

In the reduced models, age-two vocabulary and lexical access each significantly predicted vocabulary at age three (larger age-two vocabulary and faster lexical access was associated with larger age-three vocabulary). In the full vocabulary model, age-two vocabulary significantly predicted PPVT vocabulary at age three and growth from four to five (larger age-two vocabulary was associated with larger age-three vocabulary but more protracted growth). In the full lexical access model, there were no significant effects (see Table 1). Similarly, age-two vocabulary alone significantly predicted nonword repetition at age three and growth from four to five (larger age-two vocabulary is associated with better age-three nonword repetition but more protracted growth). In the full model, age-two vocabulary significantly predicted nonword repetition at age three but not growth. There were no significant effects of lexical access on nonword repetition (See Table 2).

Our hypothesis of differential prediction was not supported. Age-two vocabulary predicted both later vocabulary and nonword repetition. Lexical access predicted vocabulary in a reduced model only and did not predict nonword repetition. We discuss this finding in terms of McMurray et al.'s (2012) simulation showing that speed



of processing is an emergent property derived from multiple component processes. Along these lines, we consider that haptic responses are protracted relative to visual fixation: They require decision-making and voluntary motor execution, which involve executive control. Finally, our findings complement the late bloomer effect in expressive vocabulary in the receptive domain: typically developing children with lower receptive vocabularies at age two appear to catch up to their peers with a steeper slope from age four to five (Dollaghan, 2013).

P3-D-68: How brief exposure to varying phonetic contexts can enhance minimal pair word learning in 14-month-old children

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Between six and nine months, infants start to associate meanings to words (Bergelson & Swingley, 2012). However, at 14 months they still struggle to learn novel words that are phonologically highly similar (bih vs. dih) even though they are able to discriminate them (Stager & Werker, 1997). This apparent paradox has puzzled researchers and led to different explanations for successful minimal pair word learning. One of them assumes that sufficient acoustic variability in the input is needed for the infant to figure out the phonetic dimensions that are crucial for the lexical distinction (e.g. Rost & McMurray, 2009, 2010; Quam, Knight, & Gerken, 2017). Despite the evidence for a facilitatory effect of variable input, its cause and its detailed nature are not well understood. The current study focuses on the potential effects of variability in the phonemic contexts in which the sounds that distinguish the minimal pairs occur. An important cue for the consonantal place of articulation (/b/ vs. /d/) is the transition of the second formant (F2). As with many phonological distinctions there is no one-to-one mapping of a single acoustic feature to the sound category because the F2 transitions depend on the following vowel (Fig. 1). It might be precisely this (range of) variability that highlights the relevance of the F2 transitions for the categorisation of /b/ and /d/ in a word learning context. In a habituation study using the design of Thiessen (2011) we first exposed infants for 40s with variable CVC nonwords varying in either the initial consonant (Initial C: puk, tuk, fuk, luk, nuk, muk, buk, duk), the vowel (Vowel: bak, dak, bek, dek, bik, dik, bok, dok, buk, duk) or the final consonant (Final C: bup, dup, but, dut, bun, dun, bum, dum, buk, duk). In a subsequent habituation phase, which was identical for all children, they had to learn to associate the word buk (a single token) to an unknown object. In the test phase three kinds of trials were presented: three Same trials (buk), three Mismatch trials (duk with the buk-object) and a novel trial (loek with a novel object). All stimuli were recorded from a female native speaker of German in a mildly child-directed manner. We hypothesised that only children in the Vowel group would show successful learning whereas children in the Initial C or Final C group would not. We tested 42 monolingual German-learning infants (22 girls) with a mean age of 13.9 months (range: 12.8-15.0). 18 children were in each, the Initial C and the Vowel group. Testing for the final C group (N=6) is still ongoing. The results confirm the hypothesis (Fig. 2): Only children in the Vowel group show significantly longer looking times to Mismatch compared to Same trials ($p < .001$). For the Initial C and Final C there is no difference between Mismatch and Same (both p 's $> .13$). All children looked longer in Novel compared to Same trials (all p 's $< .01$).



This shows that a short exposure to relevant phonetic variability is beneficial when learning similar-sounding words. It is not variability in itself that is beneficial (as all exposure phases contained varying tokens). It is the variability in phonetic cues marking the relevant contrast that we take to be supportive in learning minimally distinct words. We are currently exploring the potential relation of these findings to a general consonantal bias in word learning which has not been shown for German yet.

P3-D-69: Mandarin infants' and adults' cue-weighting of English lexical stress

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Speech rhythm exists at different prosodic hierarchical levels (Geiser, Sandmann, Jäncke, & Meyer, 2010). For stress-timed languages, it is partly perceived through lexical stress at the word level (Jusczyk, Houston, & Newsome, 1999). Lexical stress is signalled by cues such as pitch, intensity and duration (Adams & Munro, 1978). While listeners use lexical stress to segment/group information, the extent to which they rely on these cues is dependent on the rhythmic nature of their native language(s) (e.g., stress- vs. syllable-timed, tone vs. non-tone language, Goyet et al., 2010; Houston, Santelmann, & Jusczyk, 2004). However, the mechanism underlying the perceptual weighting of these cues in speech, especially as perceived by tonal language-learners/speakers, is not yet fully understood. English-learning infants have been shown to be able to segment whole words with stress at the initial syllable by 7.5 months of age (Houston et al., 2004), and stress at the final syllable of whole words by 10.5 months (Jusczyk et al., 1999). We further explore the cross-linguistic influence of Mandarin on English lexical stress cue-weighting during infancy. Infants of 7.5 months, 10.5 months and adult listeners of English and Mandarin backgrounds will be tested (N = 16 per age group per language background) in an MMN multi-feature paradigm (Näätänen et al., 2004). Stress deviants are manipulated from a bisyllabic non-word (for both English and Mandarin) standard /dede/ (380ms) extended from a naturally produced single syllable /de/ to allow the same control of the acoustic features between the first and the second syllable, with pitch, intensity and duration changes at either initial or final syllable position (see Table 1). Preliminary EEG data for the perception of bisyllabic words from 7.5-month-old (N = 8), 10.5-month-old (N = 10) Mandarin-learning infants and Mandarin adults (N = 10) suggest that Mandarin participants across age do not have a preference to the stress at the initial syllable compared to the final syllable. This conforms with the classification of Mandarin as a syllable-timed language (Mok, 2009; Lin & Wang, 2007), and the fact that it doesn't differentiate meaning through lexical stress. Additionally, 10.5-month-old Mandarin-learning infants showed larger and stronger neural responses to all cues compared to the 7.5-month-olds, although some of their mismatch responses were still of positive polarity. In contrast, adults exhibit MMNs to all cues, despite their lack of syllabic positional preference. This indicates that, by 7.5 months, monolingual Mandarin-infants already formed the stress perceptual pattern that conforms to the rhythmic nature of their input language, and this perceptual pattern does not change across the developmental span.

P3-D-70: Speaker-specific representations of within-category variability in voicing cues in nine-month-olds



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Considering the vast phonetic variability in the input speech signal, infants learn relevant phonological contrasts remarkably quickly. One well-known example of a highly variable phonological distinction is the stop voicing contrast. Measured as the interval between burst and vowel onset (VOT; Lisker & Abramson 1964), it not only varies highly across languages, but also between speakers (Cho & Ladefoged 1999). Nevertheless, VOT variability contains demonstrable systematicities (Allen et al. 2002, Hullebus et al. 2018) that listeners can potentially use to differentiate speakers (Theodore & Miller 2010). Speaker-specific representations of phonetic parameters could structure and facilitate infants' perception of variability in the voicing contrast. The current experiment investigates infants' ability to associate properties of a VOT distribution with individual speaker representations. Experiment During a four-minute familiarisation phase, nine-month old infants saw two adjacent humanlike cartoon characters producing a total of 128 /ka/-syllables each, alternating in 32 blocks of eight. Items were sampled from a VOT continuum between 45 and 115 ms, recorded from a female native speaker of German in a production experiment (Tobin et al. 2018). Each face was associated with samples from a Gaussian VOT distribution with either a short or a long mean (65 or 95 ms respectively, SD=8), resulting in a bimodal distribution across the speakers as in Figure 1. Character positions and associated means were counterbalanced. Exposure to the full distribution was ensured as the start of each block was contingent on the infant's gaze to the talker as tracked by a Tobii T1750 eye-tracker. A subsequent test phase introduced novel /ka/-syllables in three VOT conditions corresponding to the familiarised means, 65 or 95 ms, and a control with intermediate VOT (80 ms). Each condition occurred eight times, totalling 24. At test, both characters' mouthed simultaneously. If infants can successfully disambiguate the two characters' speech based on their VOT distributions, we expect a higher proportion of looks to the face whose mean VOT matches the test item. Results and discussion So far, seven participants were tested from the 24 necessary for sufficient statistical power, which is expected to be reached this month. Two participants were excluded due to a lack of looking times at test. From the trials where at least 60% of the tracker samples contains gaze data, we compute the average proportion of looking times to the matching face as compared to the mismatching face per infant. Preliminary results show that, consistently, all infants tend to look longer to the mismatching face than the matching face. Estimates from a generalised linear mixed-effects model indicate approximately 72% of total looking times is directed to the mismatching face. Although the effect's direction is unexpected, it could be explained by infants habituating during the relatively long familiarisation, producing a preference for the novelty of the mismatching face. If these results remain robust with all participants and in a control experiment with another place of articulation, they suggest that infants are able to associate distributional properties of within-category phonetic variability to a specific speaker representation.

P3-D-71: Understanding the puzzle of vocabulary development in multilingual Singapore and its missing pieces

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Over the last two decades, literature on bilingual children has shown that children who grow up learning two languages do not typically differ in their total vocabulary size compared to their monolingual peers (Poulin-Dubois et al, 2012) though composition may be smaller compared to size with two word forms representing one lexical concept. However, these studies often sample children from minority bilingual communities (Bialystok et al, 2010) where the languages may be used in somewhat separate contexts. By contrast, in Singapore more than 90% of young people are bi-/multilingual, and dense inter-generational community-level multilingualism is the norm. The education system has an active policy of bilingualism and the majority of children grow up in households where they hear two or more languages/dialects (forthcoming). In recent years, English has become the most frequently reported main language at home for children between ages 5-10 (2010 Singapore Census) indicating rapid language change. This language environment provides a unique opportunity to investigate individual differences in vocabulary development in a non-WEIRD massively multilingual community. Using archival data from the longitudinal birth cohort 'Growing up in Singapore Towards Healthy Outcomes' (GUSTO), we investigated the size and linguistic composition of the expressive vocabularies of 140 24 month olds whose parents filled out local adaptations of the MacArthur-Bates CDI in Mandarin and English. In terms of composition, we find that the proportion of lexical concepts that a child can express in both their languages makes up 40% of their lexicon (Range: 5-537). The bias towards English language dominance is evident (Fig 1), but even the most extreme children are reported to have no more than 50% of their lexicon coming from only a single language. Regarding vocabulary size, pooled across languages, vocabulary size ranged from 8-760 (25th, 50th, 75th percentile: 67, 179, and 271 word forms respectively). These values are notably lower than reported vocabulary sizes for age-matched samples in OECD countries like the UK, North America and Australia (Oxford CDI, English (American), French (Quebecois) and English (Australian) versions of the Mac-Arthur Bates CDI, Wordbank, 2019). This mismatch is surprising given Singapore's rankings in standardized educational assessments such as the PISA (OECD, 2018), and suggests that the current assessment tools may be missing an important part of children's linguistic repertoire. In response to this finding, our multilingual team has identified an entire tier of child-directed words that is not captured in vocabulary inventories adapted from monolingual materials. Many of these local-words aren't easy to identify as belonging to one language or another (e.g., 'pom pom' for 'children's bathing') and likely arose from Singapore's dense contact language environment where language mixing and translanguaging are normative. Without any national dictionaries for Singapore, this special tier of child-directed words exist mainly in oral language, and have yet to be documented. In response to this finding, our current work includes collecting age of acquisition estimates for over 200 core local words, and developing a new vocabulary assessment to help discover how cheem (profound) the vocabularies of tiny Singaporeans really are.

P3-D-72: Neural oscillations and speech processing during the first months of life

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Neural oscillations correspond to the synchronous activity generated by neuronal assemblies, which can be naturally coupled, or coupled by a common stimulus (Arnal et al., 2015). It has been proposed that neural oscillations at certain frequency bands are involved in speech processing (Bastiaansen & Hagoort, 2006; Giraud & Poeppel, 2012). This is partly due to the close correspondence between the time scales of speech units and the frequencies at which these oscillations occur. More specifically low-gamma (25-35 Hz), theta (4-8 Hz) and delta (1-3 Hz) oscillations have been argued to aid in the processing of (sub)phonemic, syllabic and phrasal units in the speech signal, respectively (Giraud & Poeppel, 2012; Meyer, 2018). Currently it is unknown whether neural oscillations are already in place at birth, and if they are, whether they relate to speech processing. The aim of this study was to investigate neural oscillations and their relationship with speech processing at the very beginning of life. To do so, we assessed how neural oscillations operate in the newborn brain, when experience with the (extrauterine) speech signal is limited, and in the brain of 6-month-olds, once infants have gained (postnatal) experience with spoken language. We tested 47 newborns born to French monolingual mothers (within their first 5 days of life), and 23 French monolingual 6-month-old infants. We presented them with naturally spoken sentences in their native language (French), in an unfamiliar but rhythmically similar language (Spanish), and in an unfamiliar and rhythmically different language (English), while simultaneously recording their brain activity using electroencephalography (EEG). We assessed the effect of language familiarity on neural oscillations by performing time-frequency analysis on the EEG data (1-100 Hz) and by computing the differences across language conditions. Our results show that already at birth neural oscillations in the theta and low-gamma bands are modulated during speech processing, and that this modulation relates to language familiarity. We also found that neural oscillations change after the first 6 months of life, and we identified two main developmental differences: (1) changes in the lower frequency bands (delta, theta, alpha) are present for the three tested languages, so they do not derive from language familiarity, but likely reflect brain maturation, general experience with language, and/or more general cognitive development. (2) changes in the gamma bands (low and high) are mainly present for the native language (French) and the rhythmically similar unfamiliar language (Spanish), but not for the rhythmically different unfamiliar language (English), therefore likely reflecting language familiarity. Our findings suggest that neural oscillations play a role in speech processing from birth, and this role changes as infants attune to their native language.

P3-D-75: Morphological acquisition of diminutives and augmentatives in 30 and 36 month-old infants

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Diminutives have a noticeable prevalence in infant-directed-speech from a very early age in languages like Russian, Italian, Dutch and Spanish among others (Clark, 1993; Dressler 1994; Gillis 1997). According to Gillis (1997) the diminutives are the first grammatical morphemes used by infants. In Spanish diminutives appear in the infant's productive vocabulary when they



are as young as 16 months of age. This early onset of diminutives in the language of infants is explained by a high proportion of these lexical forms in the child directed speech uttered in languages like Spanish where virtually all concrete nouns are likely to take the diminutive form. The occurrence of diminutives in Mexican Spanish might be even more frequent than in other Spanish-speaking places. Several studies have documented the acquisition of diminutives. For example it is known that the use of diminutives in the infant directed speech has a facilitating factor in segmenting words in the speech stream and also in the acquisition of the grammatical gender of nouns (Kempe & Brooks, 2001; Kempe, Brooks & Pirrot, 2001; Kempe, Brooks & Gillis, 2005). Returning to Spanish, Falcón, Jasso and Alva-Canto (2016) have shown that infants understand the size-related meaning of diminutives (and augmentatives) as early as 30 months of age, despite the fact that diminutives have predominantly a pragmatic function (i.e., used to express kindness, warmth, tenderness, minimization of a petition, etc.) that may obscure their meaning. However Falcón et al., (2016) used only familiar words that were inflected with the morpheme for diminutives and augmentatives (e.g., *carrito*, *muñequita*, *carrote*, *muñecota*). Thus these results may reflect knowledge and understanding of the meaning of these particular words, but not necessarily knowledge based on a morphological rule (i.e., morphemes *ito* and *ita* carry the meaning of smallness). To test for infant's acquisition of the meaning of morphemes and understanding of their meaning related with size, an experiment with novel words was conducted. Using the Intermodal Preferential Look Paradigm, 30 and 36 month-old infants were presented to two instances of a novel object (i.e., a small and large version), children heard a novel word in the inflected form (e.g., *mabito* or *mabote*). Hence children were able to "recognize" the target novel object only by means of their knowledge of the morpheme and its meaning (and not by means of their experience with that word). Results showed significant effect of the morpheme in the preference to the target object only when words were inflected with the augmentative morpheme in 30 month-olds [$t = 2.645$ $p = .014$] but not with words inflected with diminutives or in 36 month-olds in any of the morphemes. These results may reflect the complexity of acquisition of the meaning of smallness in diminutives but also the some methodological difficulties related with the salience of relatively large objects

P3-D-76: Linguistic and temporal features of infants' early vocal interactions with mothers vs fathers and speech development at 12 months

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Speech development is a process starting in the earliest stages of life. It is known that infants' vocal participation in early interactions as well as the quality and quantity of speech parents direct to their babies during protoconversations facilitate speech and language acquisition in children. There is a need, however, to broaden the knowledge about the relationships between linguistic and temporal characteristics of both maternal and paternal Infant Directed Speech (IDS) and child speech development. The aim of this study was to analyze interrelations between: linguistic and temporal features of maternal as well as paternal IDS, temporal characteristics of 3-month old infants' vocalisations, and speech development at the age of 12 months. Method Thirty 3-month-old infants (14 girls) with both of their parents participated in the study. Mothers and fathers were visited at home and asked to play with their babies as they usually would. Parent-child protodialogues were recorded and one minute long episodes



were selected for the analysis. Parental IDS and child vocalisations (frequency and duration) were annotated with the application of the Praat 5356 software. Transcriptions of IDS were linguistically analysed on the basis of Roman Jakobson's theory of communication functions. Developmental assessment, including speech development assessment, was done at the age of 12 months. Results and conclusions Sample characteristics are presented in Table 1. There weren't any significant differences in the number and duration of infants' vocalizations in vocal interactions with mothers and fathers (all ps > .05). The frequency of parental IDS was significantly higher ($U = 117, p=0.0012$) and the total duration of parental utterances was significantly longer ($U=166, p< .05$) in mother-infant vocal interactions. Correlational analyses showed significant relationship between the frequency of infant vocalizations and the frequency of paternal ($\rho = .486, p<0.05$), but not maternal IDS. Additionally, total duration of child vocalization was correlated only with the frequency of paternal IDS ($\rho = .445, p<0.05$). Two main communicative orientations (CO) were identified in parental IDS: intersubjective (emotive and phatic) and educational (cognitive and conative). No significant differences were found in the CO of maternal and paternal IDS. No significant relationship was found between maternal communicative orientation and the frequency of infant vocalizations. However, infant vocalizations were more frequent ($U=25.5, p< .05$) and the total duration of child vocalizations was longer ($U=24, p < .05$) when fathers used intersubjective CO. High scores in speech developmental assessment at the age of 12 months were correlated with the frequency of paternal IDS ($\rho = .564, p<0.05$) as well as with the frequency ($\rho = .489, p < .05$) and total duration ($\rho = .501, p < .05$) of infant vocalizations during father-child vocal interactions at the age of 3 months. Both the quantity and the communicative orientation of paternal speech directed to three-month-old infants are beneficial for child speech development.

P3-D-77: Infants at risk for autism gradually exhibit abnormal social attention before age 2

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Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by social communication deficits and restricted and repetitive behaviors. Although ASD is considered as an infantile disorder, its onset of behavioral signs and early developmental trajectory before age 2 is still controversy: some research found that its phenotype emerges early, while recent evidence provides more support for a regressive pattern (Ozonoff et al., 2010). Associated with their social deficits, infants with high risk (HRI) for ASD showed deviances in social attention in the first year of life, such as lower attention to face (Chawarska, Macari, & Shic, 2013) and eye gaze (Elsabbagh et al., 2012), supporting the early-onset account. However, some studies also found that HRI for ASD might exhibit a normal or reduced trajectory of social attention at the beginning, but didn't show significant social deficits until their second year of life (Jones & Klin, 2013; Ozonoff & Iosif, 2019; Pierce, Conant, Hazin, Stoner, & Desmond, 2011), supporting the regressive account. In this study, we examined the early developmental trajectory of social attention in at-risk infants, as compared to typical infants. We recruited 23 siblings of children with ASD (HRI group, $M_{age}=16.62$ months, $SD_{age}=5.28$ months, range 5.98-24.00 months) and 40 age-matched typically developing infants (TD, $M_{age}=17.00$ months, $SD_{age}=4.48$ months, range 11.18-24.95 month). We simultaneously presented the infants with two types of stimuli: short videos of a woman playing different fingerplays, and



non-social stimuli, rotating objects (e.g., fan, windmill). We calculated the average proportional looking time on the social stimuli divided by the total looking time on both social and non-social stimuli (defined as social preference index, SPI), and the proportional face looking time against the social looking time (defined as face preference index, FPI). Also, we calculated an average temporal course analysis of the SPI and in all trials FPI to examine the developmental trends. Using linear mixed models, we found that SPI decreased faster at younger ages than older ages throughout the trial in HRI group, whereas TD showed no such trend across age. Second, we found smaller FPI in older than younger HRIs, whereas the TD group showed similar FPI across age. Last, SPI was correlated with autism symptoms in HRI group, especially in boys, suggesting that infants with more severe symptoms had a lower preference for social stimuli. Our results revealed that infants at high risk for ASD didn't exhibit abnormal social attention at an early age. Instead, this atypicality in social attention increases when infants grow older. These findings may support that HRI for ASD may present a regressive pattern in social attention development, rather than the early onset pattern. Future studies could explore this trend in a longitudinal design to delineate individual development characteristics, and explore whether SPI at young age can predict symptom severity at later age in HRI.

P3-D-171: Monolingual and bilingual infants' eyes-mouth preference at 4.5 months predicts their eyes-mouth preference at 8 months

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When looking at talking faces, infants' preference to look at eyes vs. the mouth undergoes a developmental shift during the first years of life (Lewkowicz & Hansen-Tift, 2012). It has been proposed that linguistic experience such as acquiring two languages from birth can modulate this shift. Four-month-old Spanish-Catalan-learning bilinguals already attend more to the mouth of a speaker, whereas their monolingual peers only do so by 8 months (e.g., Pons, Bosch & Lewkowicz, 2015). Recent studies suggest that bilingual infants' eyes-mouth preference may be modulated by the similarity in rhythm between the two languages the infants acquire. Bilingual infants and toddlers who acquire rhythmically more distant languages (such as English-French or Spanish-Russian) either do not differ from their monolingual peers in their eyes-mouth preference (Morin-Lessard et al., 2019), or they attend less to the mouth than bilinguals acquiring rhythmically overlapping languages, such as Spanish-Catalan (Birules, et al., 2019). To further understand the role of bilingual versus monolingual experience in infants' eyes-mouth preference, we longitudinally studied infants acquiring languages that, like Spanish and Catalan, are rhythmically similar. In addition, we used a stimuli set that are: (i) shared across the two target languages, hence familiar to both the monolingual and bilingual infants; (ii) do not require the processing of language rhythm, unlike in previous studies (e.g., Birules et al., 2019; Morin-Lessard et al., 2019; Tsang et al., 2018). Eye-gaze of 34 infants (18 monolingual and 16 bilingual [language pairs omitted for the blinded review]) was recorded at 4.5 and 8 months of age (longitudinally). Infants were presented with audiovisual vowels (/i/ and /u/) that are native to both language groups. We calculated the eyes-mouth preference score (i.e., the difference between the proportion of the looking times spent on the eyes and the mouth) for each infant at 4.5 and at 8 months. While 8-month olds on average spent less time looking at the eyes than the 4.5-month olds ($t(66)=3.0, p=.003$), we



observed no difference in mouth looking across monolinguals and bilinguals at 4 or at 8 months of age (all $p>.36$) To understand individual developmental patterns in our longitudinal data set, we conducted a regression analysis on infants' eyes-mouth preference at 8 months of age, where the predictors were eyes-mouth preference at 4.5 months and the type of language experience (monolingual and bilingual). The results demonstrate that eyes-mouth preference at 4.5 months predicts the eyes-mouth preference at 8 months ($\beta=.56$, $p=.03$, Intercept=-0.14). Specifically, if infants preferred the eyes/mouth at 4.5 months, they demonstrated the same preference at 8 months of age (Figure 1). Other effects did not reach significance (all $p>.6$). Overall, our longitudinal results demonstrate that infants' eyes-mouth preference at 8 months of age is predicted by their preference at 4.5 months (see also Tenebaum et al, 2013). Furthermore, when the stimuli are shared between monolinguals and bilinguals and the task requires no rhythm processing, monolingual versus bilingual experience did not modulate the eyes-mouth preference at either age. In sum, our results suggest that rhythmic differences across the bilinguals' languages alone does not modulate the development of the eye-mouth preference in bilingual infants during the first year of life.

E-Communication 2 (syntax, pragmatics, signed, nonverbal, disorders)

P3-E-78: Musical dynamics in early triadic interactions: A facilitator for infant development

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Research of the last decades have evidenced the importance of music for early psychological development. Music makes up a universal communicative medium that permeates our (inter)actions in the world and contributes to inform (that is, to give form) our daily experience (Cross, 2014). Research on communicative musicality (Malloch, 1999; Malloch & Trevarthen, 2009) refers to a neurobiological impulse that drives us to create and share music with others from birth. Thanks to this impulse, mother and child can communicate and co-regulate themselves psychologically through musically organized signs. While most studies carried out from the theory of communicative musicality described musical organizations in dyadic interactions (adult-baby), the proposal that children begin to communicate with others in a triadic fashion (adult-object-baby) only towards the end of the first year of life (Bates, Camaioni, & Volterra, 1975, Tomasello, 2004, 2008) has problems. For example, it has been pointed out, from the pragmatics of the object (Rodríguez, 2012), that the pure diadicity supposed by primary intersubjectivity does not exist: early social interactions take place, often, around materiality. Objects are part of interactions from the beginning. And this is so because, even when the child cannot blend in the same communicative act one object and another person, he is placed by others in meaning-loaded material scenarios (Moreno-Núñez, Rodríguez & Del Olmo, 2015, 2017). In the present study, we propose that early triadic interactions are present from the beginning of life, and they should be analysed in terms of their musical structure and dynamics. There is evidence that musical characteristics of early triadic interactions could contribute significantly to our understanding of different cognitive developmental processes involved on how infants build their relationship with others and the world. Following previous



research, early triadic interactions could have a rich and multilevel musical organization. For this study, we observed and videotaped a 2-months-old infant at home in interaction with his mother and an object (Table 1). We combined data provided by ELAN, Finale, and Matlab-MIRtoolbox for microgenetic quantitative and qualitative analysis to understand the structural and dynamic characteristics of its musical organization. The results show that the child participated in triadic interactions in which his mother communicate about and through objects using musical resources in increasingly complex ways (Figure 1). Musical structuring would happen within and between sequences of interaction (at the intersegment, intrasequence, and intersequence levels). It would involve as well different musical parameters (e.g. rhythmic-metric structure, temporal organisation). In other words, the adult constantly organised and adjusted her interaction with the baby, which was largely based on interrelated and musically structured actions. This could be an example of how adults involve infants as active participants in an interaction in which they are still unable to participate on their own initiative. We conclude that musical organization in early triadic interactions could follow a holographic structure in which each piece carries information about dynamic processes of different timescales.

P3-E-79: Cascading influences of infant gestures on communicative skills at age 5: Findings from a prospective pregnancy cohort study

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Background & Study Goals Before children reliably produce words, they communicate using gestures. Communicative gestures emerge during children's first year of life (Goldin-Meadow, Goodrich, Sauer, & Iverson, 2007; Goodwin & Acredolo, 1998) and are a useful tool for communicating wants and needs (Bates et al., 1979). Infant gestures may be one of the earliest indicators of later language skills (Rowe & Goldin-Meadow, 2009). For example, gesture use at 12 months (e.g., pointing) predicts word production at 24 months (Bavin et al., 2008) and in the preschool years (Rowe & Goldin-Meadow, 2009; Rowe, Özçalışkan, & Goldin-Meadow, 2008). This study used a developmental cascade approach (Masten & Cicchetti, 2010; Oakes & Rakison, 2019) to understand whether the development of children's communicative skills cascades from cumulative, interactive developmental changes in their paralinguistic skills (i.e., gesture use) and linguistic abilities (i.e., production vocabulary) over a long-range trajectory. Specifically, we sought to answer three questions: (1) Does gesture use at 12 months predict language development at age 5 years? (2) Does productive vocabulary at 24-months of age mediate this relation? And (3) does the relation vary by type of gesture (early vs. later)? Pathways between children's linguistic and paralinguistic skills would support the hypothesis that later communicative skills emerge from the interaction of developmental abilities from both the language and communicative domains. **Method & Procedure** Data for this study were obtained from mothers (Mage = 31.4, SD = 4.4) from a prospective, longitudinal pregnancy community-based cohort with mother-child dyads in a large city in Western Canada. This resulted in a sample of 1992 children (Females = 47.7%). Mother and child variables were obtained from questionnaires during the mother's pregnancy, and post-partum at 12 months, 24 months, and 5 years. Infant gestures data were obtained at 12 months via the MacArthur-Bates Communicative Development Inventory (MCDI) - Words and Gestures (Fenson et al., 2007). Children's vocabulary size data were obtained between 24 and 30 months via the MCDI



- Words and Sentences (Fenson et al., 2007). Finally, children's communicative skills at age 5 were assessed via the Children's Communication Checklist-2 (Bishop, 2013). Results & Discussion Analyses of predictive pathways were performed in SPSS Amos, controlling for English language exposure, child gender, child birthweight, family income and maternal education. There was a significant direct effect between total gestures at 12 months and general communicative skills at age 5 (Figure 1), and a direct effect from early gestures and later gestures on communicative skills (Figure 2). Follow-up mediational analyses, however, showed that vocabulary size at 24 months fully mediated these direct effects (see Figures 1 and 2). Our findings indicate that gestures in infancy indirectly impact communication skills during the transition to kindergarten via the effect of gestures on vocabulary size in early toddlerhood, suggesting a strong confluence of the linguistic and paralinguistic streams over the course of language and communicative development.

P3-E-80: 'Clap your hands' or 'take your hands'? One-year-olds distinguish between frequent and infrequent multiword phrases

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Traditionally, words are seen as the basic building blocks of language. However, there is growing evidence that multiword sequences also play an important role in language learning and use (e.g., Arnon & Christiansen, 2017). Both adults and young children are sensitive to the frequency of compositional multiword phrases. For example, two- and three-year-olds are faster and more accurate in repeating higher frequency four-word phrases (Bannard & Matthews, 2008), and four-year-olds show better production of irregular plurals in more frequent frames (Arnon & Clark, 2011). However, it is not clear when this type of sensitivity emerges in younger children: if larger sequences are an integral part of the acquisition process, then infants should also be sensitive to their frequency. Here, we conduct the first investigation of this question by assessing one-year-olds' ability to distinguish between three-word sequences that have similar lexical frequency but differ in their multiword frequency in infant-directed speech (e.g., high frequency: 'clap your hands' vs. low frequency: 'take your hands'). We used an infant-controlled sequential looking procedure to measure infants' gaze fixation to a visual stimulus while they listened to frequent and infrequent three-word combinations (hereon trigrams). Participants were 36 English-learning 11- to 12-month-olds (Range: 335 to 377 days; Mean: 359 days). Five additional infants were tested but not included in the analysis due to fussiness/crying (3) or non-completion (2). The material consisted of 12 pairs of trigrams that differed in only one word (e.g., 'clap.your.hands' - 'take.your.hands'). Items were constructed by extracting high frequency trigrams from a 363k-word corpus of caretaker speech addressed to 9- to 15-month-olds, and matching them with trigrams with similar lexical frequency but low trigram frequency. While both were grammatical sequences, the frequent variant was much more frequent than the infrequent variant (see Table 1). The items were read by a female speaker of Southern British English using infant-directed speech. The recorded stimuli for the frequent and infrequent trigrams were comparable in their acoustic characteristics (e.g., duration, pitch range, amplitude). Each participant heard 6 frequent trigram trials and 6 infrequent trigram trials, with each trial containing six trigrams of one type (i.e., six frequent or six infrequent items). If infants are sensitive to multiword frequency, they should show different listening times to the high and low frequency trigrams.



The results showed that the participants' fixation times were significantly longer for the frequent trigram trials (mean = 9.29s, sd = 3.00) than the infrequent trigram trials (mean = 8.39s, sd = 2.96) [paired-t(35) = 2.51, p = 0.017, Cohen's D = 0.299], suggesting infants are sensitive to frequency differences in multiword combinations. This is the first study that provides evidence for sensitivity to multiword frequency in children as young as 11 to 12 months. This finding demonstrates that before their first birthday children represent multiword units they hear in their linguistic environment, highlighting their role in early acquisition. More broadly, the findings support frequency-sensitive models of language acquisition.

P3-E-81: Social cues and word learning in 12-month-old infants

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Many studies have shown a positive association between the presence of social cues and language learning outcomes in infants (e.g. Tamis-LeMonda et al., 2001), highlighting contingent responsiveness as a potentially key social cue in the word learning process. In their study, Roseberry et al. (2014), demonstrated that young children learned words better from an on-screen interaction partner contingently responding to them than from a pre-recorded video of that person. However, these interactions were not only temporally contingent, but also enriched with socially meaningful elements such as affective responses or using the child's name. In our study, we investigated the extent to which temporal contingency could support word learning, in the absence of a human interaction partner and such socially meaningful responses. Previous studies suggest that 12 month-old infants can gaze-follow a contingently reacting physically present non-human agent, that is they exhibit a social-like behavior even in the absence of a rich social context (Johnson et al., 1998). Using a contingently reacting non-human bear-like agent with 12-13 month old French infants, we expanded this study in two ways. We first assessed whether this reaction could also be observed in an on-screen game-like scenario using gaze-contingent eye-tracking. Second, we tested whether this setting would also lead to the learning of novel word-object associations. Protocole (see Fig.1) : during Phase 1, our 35 French subjects experienced the contingency of the teaching agent as it was reacting, first to another on-screen animated human agent, second to the participants' own gaze. During Phase 2, we assessed gaze-following: the agent appeared between two novel objects, turned to look at one of them and asked the infant to look at it too. Only one of the objects, the target, was named. We assessed the learning of the novel label in Phase 3. Infants were presented with the same two objects as before, and heard the name of the target object (that they just had been taught), or a novel label. Above-chance looking towards the target object when it was being named was considered an indication of learning. Our results showed that 12-month-old infants gaze-followed the contingent teaching agent despite of it being presented on a screen and without further social enrichment ($p=0.002$, $se=0.03$, $b=0.09$). Importantly, they showed that they could also learn a novel word ($p=0.009$, $se=0.03$, $b=0.08$, see Fig.2). These results are important inasmuch as, to the best of our knowledge, no study showed word learning from a screen in 12 month-olds before, all the more from an animated non-human agent. This line of study could help diminish the video deficit precluding young children to easily learn from a screen. Truly understanding in which conditions contingency can support word learning from a screen could help us in creating educational content based

on naturally contingent technologies like touchscreens, while being best adapted to how children learn.

P3-E-82: Effects of internal state on infant learning and memory

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Although infants frequently fluctuate between different internal states such as sleep, calm attentiveness, wakeful activity, and crying (Clifton & Nelson, 1976), the potential implications of these changes for infant memory functioning are unexplored. This is surprising because research with adult populations has shown that memory processing does not occur in isolation (Bower, 1981). For example, being in the same mood at encoding and retrieval can facilitate memory performance compared to being in a different mood at encoding versus retrieval (state-dependent memory, e.g., Eich, Macaulay, & Ryan, 1994). One characteristic of early memories is their high degree of specificity. To access a particular memory, human infants require an almost perfect match between external cues present at encoding and external cues present at retrieval (Hayne, Boniface, & Barr, 2000). Given this profound reliance on matching external cues, infant memory might be highly susceptible to variations in internal state, too. We presented 9-month-old infants with a memory task and randomly assigned them to either receive induction of the same state ($n = 32$) or of diverging states ($n = 32$) immediately before encoding and immediately before retrieval. State induction occurred by evoking either calm or animated play with their caregivers for 5 min. Memory was assessed in a deferred imitation paradigm (Barr, Dowden, & Hayne, 1996). In a demonstration session, infants watched a model perform three target actions with a hand puppet. Imitation was assessed in a test session 15 minutes later. Infants in an additional age-matched baseline control condition ($n = 32$) did not see the stimuli prior to the test when their spontaneous production of any target actions was assessed. As expected, the state manipulation (play periods) led to variations in infant body movement (assessed by actigraphy) and behavior ratings between experimental conditions (Table 1). Production of target actions was significantly different between the three conditions (same state, different state, baseline), $F(2, 93) = 9.43$, $p < .001$, $\eta^2 = .169$ (Fig. 1). Only infants who were in the same state at encoding and retrieval produced a significantly higher number of target actions than infants in the baseline control condition, $p < .001$. Infants who were in the same state at encoding and retrieval produced a significantly higher number of target actions than infants who were in different states at encoding and retrieval, $p = .002$. The results show that relatively minor fluctuations in internal state can severely affect the accessibility of recent memories early in life. In terms of associative network theory, infants' memory networks can be expected to contain comparatively few nodes, and links between nodes, due to their limited knowledge and experience (Barr, Walker, Gross, & Hayne, 2014). Hence, activation of a particular node through association in a given situation is relatively less likely, compared to an adult who commands rich memory networks with myriad connections. Thus, using internal cues to retrieve recent memories is adaptive for infants. We are currently testing whether infant imitation is shaped by state-congruent learning as well.



P3-E-83: Spatial biases in infants' learning of serial order: Evidence for the role of cultural experience

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Recent evidence shows that, in preverbal infants raised in a Western culture by parents who read from left to right, directional spatial information (left-to-right versus right-to-left) modulates learning of serially order. Seven-month-old Italian infants represented increasing numerical order when numerical visual displays were presented from left to right, but not when presented from right to left (de Hevia et al., 2014), and a similar advantage for a left-to-right over a right-to-left spatial orientation was apparent when infants learnt rule-based visual sequences (Bulf et al., 2017). These findings are in line with evidence from adult studies showing bidirectional interactions between the coding and representation of serial order and spatial processing (e.g., Van Dijck et al., 2013), which are grounded in sensorimotor experience acquired through reading-writing habits (Van Dijck & Fias, 2011). Indeed, in adults the spatial attributes of the mental organization of serial order vary cross-culturally as function of reading-writing direction (Guida et al., 2018), and culture shapes directional biases in spatial attention in preliterate children (Gobel et al., 2018). Here we explored the developmental origins of the directional properties of the spatial mapping of order by testing implicit learning of spatio-temporal visual sequences in Japanese 7-month-old infants (N=128) and in infants growing up in Europe (N=128). While European cultures use a reading-writing system characterized by a unidimensional left-to-right oriented structure, the Japanese reading-writing system combines vertical and horizontal orientations, and both left-to-right and right-to-left directionalities. Infants were familiarized with 3-item sequences of shapes organized in ABB and ABA rule-like patterns presented in a left-to-right or right-to-left spatial orientation (Study 1) and a top-to-bottom or bottom-to-top orientation (Study 2). Familiarization was followed by six test trials with triplets of novel shapes depicting the familiar or a novel rule with the same spatial orientation as the familiarization trials. For Study 1, looking times during novel and familiar test trials were compared between spatial directions and cultures: the Japanese infants successfully transferred the familiarization rule to the familiar test sequences irrespective of the spatial direction of the sequences ($p < .001$). In contrast, the European infants failed in the condition in which the sequences were presented from right to left (Novelty \times Direction $p < .02$). For Study 2, results from the vertical top-to-bottom condition showed successful discrimination of the novel rule across both cultures ($p < .05$), while offline-coding of the looking time data from the bottom-to-top condition is still in progress. We interpreted European infants' failure under right-to-left presentation condition as the developmental outcome of implicit experience with a unidimensional and mono-oriented system to spatially organize external information and conceptual knowledge. To probe how adults spatially structure the visual environment for their babies within each culture, for both the Japanese and the European infants, we recorded 1-min sessions of joint book reading and toy construction; the scoring (in progress) of the directional behaviors produced by the caregiver will help us to clarify the role of cultural experience in driving infants' spatial biases.



F-Attention, Memory and Learning

P3-F-84: Characterizing multisensory attention in early development: Individual differences, trajectories, and relations with outcomes

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Multisensory attention skills (detecting audiovisual synchrony, shifting and maintaining attention to unitary audiovisual events) are cornerstones for language, social, and cognitive development (Bahrack & Lickliter, 2012, 2014; Bremner et al., 2012). Until recently there have been no measures appropriate for assessing individual differences in multisensory attention skills in young children. Thus, developmental trajectories of these skills and links with later outcomes have remained poorly understood. We developed the first individual difference measures appropriate for young children for assessing multisensory attention skills in the context of audiovisual social and nonsocial events. The Multisensory Attention Assessment Protocol (MAAP; Bahrack et al., 2018a) and the Intersensory Processing Efficiency Protocol (IPEP; Bahrack et al., 2018b) index intersensory processing (speed and accuracy of synchrony detection) and the ability to maintain and disengage attention to audiovisual events at a more fine-grained level than currently available. Together, they can characterize individual differences in multisensory attention skills, developmental trajectories of these skills, and relations between these foundational skills and developmental outcomes. The MAAP and IPEP were administered to a longitudinal cohort of typically-developing infants (N=106) and together assess individual differences in 5 multisensory attention skills. The MAAP assesses 1) duration of attention maintenance, 2) speed of shifting, and 3) accuracy of intersensory matching for audiovisual social and nonsocial events. The MAAP also assesses the cost of competing stimulation (from a central distractor event) on each of these measures. The IPEP is a more difficult test focusing on just intersensory processing 4) speed and 5) accuracy to selectively attend to audiovisual social and nonsocial events. Both protocols are appropriate for assessing individual differences: they are comprised of many short trials (MAAP: 24 15-s trials; IPEP: 48 8-s trials) and show very good reliability. Children received the MAAP and IPEP along with age-appropriate developmental outcome measures at 3, 6, 12, 18, 24, and 36 months. In a second study, 66 rising kindergarten and rising 1st-grade children received the IPEP and an assessment of pre-literacy skills (letter names and sounds knowledge). In our longitudinal sample, multisensory attention skills showed evidence of change across age, with improvements in intersensory matching, attention maintenance, and speed of shifting from 3-36 months. Individual differences in these skills at 6 and 12 months predict social, language, and cognitive outcomes 18, 24, and 36 months. In our sample of young children, greater accuracy on the IPEP predicted greater letter names and sounds knowledge ($p < .001$). Together, these findings demonstrate the multisensory attention skills assessed by the MAAP and IPEP show evidence of 1) meaningful individual differences, 2) improvement across age, and 3) relations with language, social, and cognitive outcomes in infancy, and 4) with pre-literacy skills in early childhood. The MAAP and the IPEP provide tools for characterizing individual differences in multisensory attention skills at a level of detail necessary for guiding interventions, and for characterizing developmental pathways from basic multisensory attention skills to more complex developmental outcomes.



P3-F-85: Infants' individual differences in perceiving the McGurk effect

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Infants are exceptional language learners, and this precocious ability is facilitated by a host of interactions across perceptual and cognitive development. One area of perceptual development pertinent to language is infants' sensitivity to audiovisual speech, which has been linked to later receptive and expressive language abilities (e.g., Bahrack et al., 2018; Young et al., 2009). A striking demonstration of infants' integration of auditory and visual speech information is their ability to perceive illusory McGurk fusions (Burnham & Dodd, 1996; 2004). In the canonical McGurk effect, when auditory /ba/ is temporally synced with visual /ga/, it is widely perceived as /da/ or /tha/. This illusory fusion effect is interesting but not unequivocal, some adults report perceiving the auditory stimulus (i.e., /ba/) or combinations (e.g., /bga/). In the current study, we examine individual differences in 25 (13 girls) 4.5-month-old's perceptions of fused /da/ and auditory /ba/ for McGurk stimuli using a stimulus alternating habituation task (Singh et al., 2016) designed to test two contrasts using a within-subjects design. All infants were habituated to the canonical McGurk effect (auditory /ba/, visual /ga/) and tested on two 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/. Fusers should dishabituate to the relatively novel /ba/ test trial. However, for non-fusers, the auditory /ba/ should be familiar and they should instead dishabituate to the /da/ test trial. Although as a group, performance on the two different block types did not differ ($p=0.162$), interesting individual differences emerged (Figure 1). Of the 25 infants tested, 6 infants dishabituated to the /da/ test trial but not to the /ba/ test trial, suggesting /da/ was novel and that /ba/ was familiar-these infants likely perceived auditory /ba/ during habituation. The opposite pattern emerged for 6 infants, suggesting these infants integrated the audiovisual information to perceive canonical fused /da/ during habituation. Of the remaining infants, 3 infants dishabituated to both /da/ and /ba/, potentially indicating alternate percepts (e.g., /tha/ or /bga/) during habituation, and 10 infants lacked stable preferences in either block. We are employing convergent computational modeling, neuroimaging, and longitudinal methods to further investigate these individual differences. Our dynamic neural field model simulates the infant habituation task (Figure 2) and replicates our behavioral data by simulating two different groups--fusers and non-fusers--and creates hemodynamic predictions. Consistent with adult data, our model predicts infants who perceive the fused /da/ should show larger hemodynamic responses in the posterior superior temporal sulcus than infants who perceive the auditory /ba/. We are currently testing these behavioral replications and hemodynamic predictions using fNIRS with 4.5-month-olds, and plan to follow these infants longitudinally as they participate in native and non-native phoneme discrimination tasks at 7 months. These follow-ups will allow us to measure how early audiovisual integration in speech perception across behavioral and neural levels may be related to important aspects of language development, notably native language phoneme attunement.

P3-F-86: Learning through interleaving and massing: Influence of memory development in infancy

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When children learn words, they are learning categories of things that can be labeled with the same word. Category examples for learning can be interleaved, as when two categories are interspersed between each other (e.g., seeing an apple, then an orange, then another apple, etc.), or massed, as when all the examples of one category are shown before the other (e.g., seeing all the apples before seeing all the oranges). In studies testing adults and infants, interleaving is often found to be more beneficial for learning categories than massing (Kang & Pashler, 2012; Kornell & Bjork, 2008; Vlach & Johnson, 2013), but its benefits depend on what is being learned (Carvalho & Goldstone, 2015). In contrast, Vlach and Johnson (2013) found that 16-month-olds could learn words when presented in a massed format, but not when presented in an interleaved format, perhaps due to limited memory for interleaved items over time. The current study examines memory for interleaved items in a word learning task. Words were presented in massed and interleaved formats as eye gaze data were collected. Infants were taught 12 novel words (e.g., "fep") for 12 novel shape categories, 6 in each of the two presentation formats. See Figure 1 for a trial example. In the massed format, there were three presentations of each category type in a row labeled with a novel label each time (e.g., "It's a fep!"). This sequence was repeated twice until all 6 instances were shown, followed by items from the other category. In the interleaved format, items were presented from the first and second categories in alternation, repeating until all 12 images were shown. For both presentation formats, a distractor object was shown for three seconds at the start and after every 3 category examples, and given a neutral labeling (i.e., "It's a toy!"). Following the learning trials there were four test trials, two for each of the learned categories. Each test trial paired one of the two learned categories with the other category, and one with the distractor object. Preliminary data (N = 11, Mage = 20.41mos) show above chance performance for interleaving trials ($t = 2.67$, $p = 0.02$), but not massed trials ($t = 0.31$, $p = 0.77$), suggesting that 20-month-olds' memory can support interleaving learning. A non-significant pattern suggests that with further data there may be a difference between interleaved and massed presentations ($t = 1.33$, $p = 0.21$). Study 2 will test 16-month-olds to investigate the possibility of memory for interleaved items in younger infants. The results of these studies will inform our knowledge of interleaving and massing items by showing effects of both the difficulty of the category and also the ability to integrate information into the category representation.

P3-F-87: Two-year-olds generalize from episodic memories to accomplish novel goals

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Memory-guided planning refers to the use of specific episodic memories to accomplish new goals (Blankenship & Kibbe, 2019). Being able to generalize from past experiences to solve new problems is critical for effective planning, since children rarely encounter situations that are completely identical to situations they have experienced in the past. Previous research suggests that 4-year-old can use memories from one event to plan and accomplish a goal in a novel context (Suddendorf et al., 2011). However, it is currently unknown whether the ability to generalize from episodic memories is available to children for whom episodic memory and planning abilities are undergoing significant development and are therefore still somewhat



fragile. In the current study, we investigated whether there is evidence for generalized memory-guided planning in toddlerhood. We tested 16 2-year-olds ($M = 30.6$ months, $SD = 2.9$; 10 girls) using a task that required children to acquire episodic memories in the context of the experiment, and to then generalize from these experiences to accomplish a novel goal. We first showed a blue "magic bead box" with a drawer embedded in its front and two objects: a "blick" (yellow cylinder) and a "dax" (wooden cube) (Figure 1). We showed children that placing the "blick" on top of the box caused purple beads to appear in the drawer, and placing the "dax" on top caused green beads to appear. Children were then invited to help the experimenter retrieve different colored beads for a monkey stuffed animal by indicating which object to place on top of the box when asked for a particular colored bead. We then asked whether children could generalize from this experience to accomplish goals in a new context. The experimenter told children that Monkey wanted more beads, but that her box was empty. She then removed the blue box, yellow cylinder, and wooden block from the table, and placed a new yellow box, a new pink cylinder, and a new blue cube on the table (Figure 1). The experimenter then asked children to help get colored beads for Monkey (e.g. "Can you get a purple/green bead for Monkey?") Children selected one of the two objects to place on top of the box (chance=50%). Critically, since children had no experience using the new box and objects, to succeed they had to generalize from their experience with the old box and objects. Children completed 8 generalization trials. We computed each child's mean percent correct across trials. We found that children selected the correct novel object significantly above chance ($M=65.7\%$, $SD=22\%$; $t(15)=2.91$, $p=.01$; Figure 2). Furthermore, children who succeeded at the first generalization trial performed significantly better across trials than children who did not ($F(1,15)=9.24$, $p=.009$), suggesting that better performance hinges on successful generalization from the outset. Finally, 13/16 children successfully extended the labels to at least one of the new objects when asked following the generalization trials. Our findings suggest that toddlers may flexibly use memories to accomplish novel goals, but that this ability may still be emerging in these children.

P3-F-88: Memory retention in word learning through overheard speech

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The majority of word learning research has focused on how children acquire words and how this information is retained over time through direct instruction- explicitly teaching children new words in a structured setting. However, it has been estimated that less than 25% of the time a child is interacting with a caregiver is spent in these direct instruction situations (Hoff & Naigles, 2002). Research has shown that children can learn words in less structured, indirect environments known as overhearing contexts; contexts in which children tune into conversations as a third-party observer and learn from these interactions (Akhtar, Jipson, & Callanan, 2001). Although children have been successful at acquiring novel words through overhearing, retention has yet to be investigated in these overhearing contexts. To study retention in word learning, researchers have tested the theory of desirable difficulties which states that introducing a challenge in a learning situation fosters retrieval processes that facilitate comprehension and retention of information (Bjork, 1994). In word learning, one form of a desirable difficulty arises when presentations of labeled objects are spaced out in time. For example, a child will be presented with spoons throughout the day rather than presented



with different spoons immediately after one another. Spacing these instances out in time allows forgetting of the label for the object and surface level features. As a result, when children are asked to recall the label after forgetting they undergo a deeper retrieval process, strengthening the mapping between the object and its label, and aiding in long-term retention (Vlach, Ankowski, & Sandhofer, 2013). The current study examines whether monolingual, 24- to 35-month-olds are able to learn and retain novel labels for novel object exemplars (shape categories) in an overhearing context. We hypothesize that children who overhear the objects and labels presented spaced out in time and tested after a delay will show better retention than children who overhear the objects and labels one after another. Children were randomized into two conditions: massed or spaced. In the massed condition, children were presented with novel labeled, object exemplars one at a time and then tested after a 2-minute delay. In the spaced condition, children were presented with labeled, novel object exemplars with 15-second intervals in between each presentation and then tested after a 2-minute delay. Children were tested in a forced choice task where they were asked to identify the novel object exemplar. Preliminary results (N = 12) suggest that children older than 30 months are learning better in the spaced condition. These results suggest that the combined effect of both the overhearing condition and the spaced presentation of objects are too difficult of a learning situation for younger children to successfully acquire and retain information but may prove beneficial for older children. Examining vocabulary development through overhearing is critical in order to obtain a holistic view of language development.

P3-F-89: Mirror image discrimination in 5-month-olds: Do they discriminate and is there a sex difference?

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Sex differences in visual processing and or/manipulation of visual objects in mind have repeatedly been reported. Studies show some such sex differences are already present in early infancy, at least by 5 months - including male superiority in mental rotation. However, mental rotation tests usually, including in the infant studies that found sex differences, rely on mirror image discrimination. Failure in such mental rotation tests may actually stem from a failure to retain the original object in mind, separately from its mirror image. Since an object is united with its mirror image in the late stages of ventral stream processing (e.g. Dilks et al., 2011), a visual processing strategy that favors ventral over dorsal stream processing, or a more developed ventral processing stream, may cause failure to discriminate between a familiarized object and its mirror image (see, e.g., Alexander, 2003, for a suggestion of a female bias for ventral processing). A previous study (Bornstein et al., 1978) found mirror image confusion in early infancy, by the age of 3-4 months. Since that study lacked analysis by sex, its results may have been driven by the females. Another study (Cronin, 1967) found males outperformed females in mirror image discrimination in kindergarten and first grade. If a similar sex difference in mirror image discrimination occurs at 5 months, this difference may drive both sex differences in infant mental rotation studies and mirror image confusion results in early infancy. Aim: Testing whether there is a sex difference in mirror image discrimination at 5 months, and if so, whether it is driving mirror image confusion results. We hypothesized 5-month-old males would outperform females in mirror image discrimination. Method: 5-month-old infants were familiarized with static images of Shepard-Metzler objects used, rotating, in



some infant studies which found sex differences in mental rotation. In familiarization, two identical copies of the object were presented side-by-side, and in the two test trials the familiarized object was presented alongside its mirror image (with the sides alternating). Results: Infants discriminated the object from its mirror image, showing a significant mirror image preference at test. Both sex groups significantly preferred the mirror image, with no significant difference between the sex groups. Conclusions: Unlike previous findings, infants did not display mirror image confusion. The difference in performance from the Bornstein et al. study may stem from different paradigms, different stimuli, and/or different age groups. Future studies should examine the contribution of such factors to the conflicting results. Contrary to the hypothesis, no sex difference was found. Uniting the object and mirror image occurs in late ventral stream processing. Possibly the female infants did not process the object fully, or did not process it as an object, thus did not unite the object and mirror image - unlike in studies using a rotating object or different orientations of the object in familiarization, which may lead to more complete ventral stream processing. Future studies should examine whether changing the familiarization method, without requiring mental rotation at test, reveals a sex difference in mirror image discrimination.

P3-F-90: Proactive interference disrupts toddlers' visual working memory

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Introduction: Proactive interference is a retrieval-based memory error where previous, irrelevant memories intrude during retrieval of currently relevant information (Keppel & Underwood, 1962; Kane & Engle, 2000). Although the effect was originally shown in verbal paradigms, recent studies have shown that it is also present in visual working memory (Hartshorne, 2008; Makovski & Jiang, 2008; Shipstead & Engle, 2013). Despite extensive literature investigating the effect in adults, little work has been done in young children (but see Oakes & Kovack-Lesh, 2013). The current study used Delayed Match Retrieval (Kaldy, Guillory & Blaser, 2016), adapted to a touchscreen tablet, to investigate the effect of proactive interference on visual working memory in 3-year-old children. IParticipants: Data was analyzed from 23 toddlers (13 boys, mean age = 35;24, range = 30;02-40;07). An additional 12 toddlers were tested but their data was not included, due to experimenter error (2), developmental concerns (2), failure to pass the training phase (4), or results were deemed outliers (3). IStimuli 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). First, training trials were presented to introduce the task rule: finding the card that matches the sample. Toddlers watched three face-up cards appear on a touchscreen in a triangular arrangement. The bottom two cards showed different target objects (match, and non-match) and the top card was always the sample. Toddlers had 10 seconds to choose the card from the bottom pair that matched the sample. Test trials started after the child completed three correct training trials in a row. Test trials were identical to training trials except that cards were introduced face-down. Then, the bottom pair of cards was exposed, then turned back face-down prior to the exposure of the sample (see Figure 1). The test consisted of two blocked conditions, each with 8 trials (with block order counterbalanced across participants): (1) Trial Non-unique: the same two objects were used in every trial, and (2) Trial Unique: a new pair of objects was used in every trial. IResults and Discussion: Toddlers' performance was



significantly higher in the Trial Unique condition (78.2 +/- 15.7%) than in the Trial Non-unique (61.4 +/- 17.5%) indicating that 3-year-old children are highly sensitive to the effect of proactive interference (paired t-test, $t(22) = 2.08$, $p < 0.0001$). The median difference in performance between the two conditions was 17.9%. The series of repetitions in the Trial Non-unique condition lead to a gradual accumulation of proactive interference effects; based on the observed trends, the effect reached nearly 30% by Trial 8, with PI reducing performance to chance level (see Figure 2). This finding provides important insight not only into the limitations of visual working memory in toddlers, but also provides the first quantitative estimate of an effect that has important methodological consequences for studies of visual working memory that typically reuse stimuli over multiple trials.

P3-F-91: Infants' curiosity is driven by the learning progress offered by environmental stimuli

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Infants learn from the complex environment around them at a fast pace, and one of the reasons for their learning success might be their insatiable curiosity. It has been argued that the mechanism underlying infant curiosity is an attentional bias towards stimuli that possess a specific level of surprise (Kidd, Piantadosi & Aslin, 2012) or unpredictability (Tummeltshammer & Kirkham, 2013). However, recently a more advanced mechanism has been proposed that entails the maximization of learning progress and predicts infants' attention to be pushed towards stimuli that offer an opportunity to learn (Gottlieb, Lopes & Oudeyer, 2016). In an eye-tracking study, we explored whether infants are sensitive to surprise, predictability and learning progress when allocating cognitive resources. We tested 90 8-month-old infants on a visual learning task that consisted of sequences of cue-target trials. The cue always appeared in the middle of the screen; the target could appear in one of four locations around the cue. The most likely target location varied across sequences, and infants could learn to make probabilistic predictions of where the target would appear. If infants looked away from the sequence for more than one second, a new sequence was played. We measured how fast infants predicted the target location (saccadic latency), how long they looked at the target (looking time) and at which trial of the sequence they looked away (look-away). We used an ideal learner model to estimate how surprising each trial was, how unpredictable the sequence was at each trial and how much learning progress each trial offered. We report three main results. First, we found that infants' saccadic latency was related to stimulus surprise and sequence predictability. This demonstrates that infants successfully learned the statistical structure of the task. Second, we found that infants' looking time to the target was related to the amount of learning progress that the target offered. This shows that infants are sensitive to the offered learning progress and take more time to process information that is more useful for learning. Finally, employing a generalized additive model, we showed that infants relied on the offered learning progress to decide whether to keep looking at a sequence or look away. Specifically, infants were more likely to keep looking at a sequence if the learning progress was higher. Hence, we conclude that infants' curiosity is driven towards the maximization of the learning progress, and this strategy allows them to shape their exploration of the environment optimally. In additional analyses, we will identify individual differences in infants'



visual exploration behavior and link them to indices of cognitive performance that were collected in a separate task.

P3-F-92: Mutual exclusivity: Using the referent selection task with monolingual and bilingual 2-year-olds

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When children are learning their native language, they tend to treat objects as if they only have one label—a principle known as mutual exclusivity. For example, when children are presented with the word “meewa,” they assume this label belongs to an unfamiliar object since familiar objects already have a label. This approach may not be an optimal strategy for bilinguals because there could be multiple words for each object. To test mutual exclusivity in monolinguals and bilinguals, the present study replicated Kucker, McMurray, and Samuelson’s (2018) referent selection (RS) task. Ninety-five monolingual and 49 bilingual 2-year-olds (24-27-month-olds) participated. The Language Exposure Assessment Tool (LEAT) was used to assess language exposure (DeAnda et al., 2016). In referent selection trials, 2-year-olds were presented with three objects: two known familiar objects (e.g., a cup and a duck) and one novel item (e.g., a slinky). In half of the 8 test trials, we asked children to choose the familiar object (familiar RS trials), and during the other trials (novel RS trials), we asked children to choose the novel object (e.g., “get the zylo?”). Retention of novel label-object pairings was assessed after a 5-minute delay. For these 3 trials, the experimenter presented the target novel object with two other novel objects previously shown. Replicating Kucker and colleagues (2018), when asked to choose the novel item on novel referent selection test trials (e.g., the slinky) when the novel word was introduced (e.g., “zylo?”), monolinguals successfully chose the novel item 89.01% of the time ($SD=34.69\%$) and bilingual children on 91.49% of the time ($SD=36.88\%$). Both groups performed above chance (33.33%). Five minutes later, only monolinguals retained the novel object-word mappings while bilinguals did not perform above chance. All children recognized the familiar items (duck, ball, or cup) significantly above chance ($M_{mono}= 84.63\%$, $M_{bil}= 77.21\%$) but there was a trend for a difference ($p = .15$) between monolinguals and bilinguals on their initial recognition. On the familiar RS trials, both monolingual and bilingual children chose the novel object well above chance ($M_{mono}= 58.59\%$, $M_{bil}= 64.25\%$). Our results (see graph) replicate and extend those of Kucker and colleagues (2018). Both groups recognized the familiar objects and both showed a strong novelty bias, consistent with the idea that novelty bias facilitates the acquisition of new labels in dynamic language learning situations. These findings also suggest that learning novel object-word mappings occurs at similar rates for both monolingual and bilingual infants. There was a difference between monolinguals and bilinguals in retention of novel labels. Retention is relatively poor in monolinguals, but worse in bilinguals at 24 months even after a short delay. Taken together, these findings suggest that the trajectory of language retention may be different between monolinguals and bilinguals. Furthermore, the level of familiarity with the original referents and general vocabulary level in each language may play into the retention of novel labels, but this is an open empirical question.



P3-F-94: Infant curiosity and effective learning: Insights from computational modelling

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Studies of curiosity demonstrate that infants tend to attend to stimuli that are neither too simple nor too complex, which is referred to as "Goldilocks effect" (Kidd, et al., 2012). Curiosity-driven behaviour also has been shown to enhance learning in adults (Gruber, 2017) and in artificial neural networks (ANNs) (Twomey and Westermann, 2018). It seems that, at least sometimes, it is beneficial to learn about easier events before learning about complex events. However, it remains unclear in which situations learning is facilitated by a simple-to-complex hierarchy. Here, we used ANNs to computationally model under which conditions a simple-to-complex hierarchy facilitates learning. In two modelling experiments, we trained an ANN to perform a visual category recognition task (Fig.1). The training set was constructed from handwritten digits from the MNIST dataset. Single digits were used as simple stimuli and double-digit combinations as the complex stimuli. In Experiment 1, we simulated incremental learning by training the network to perform a "simple" task of recognizing single-digit numbers, using supervised learning on a set of 10.000 examples, and then perform a "complex" task of recognizing double-digit numbers on a set of 10.000 examples. To simulate non-incremental learning, a new instance of the network was trained to perform the "complex" task from the start, using a set of 20.000 double-digit images. Both networks were then tested on a validation set of 10.000 unfamiliar double-digit stimuli (Fig.2). We observed no significant improvement in learning for the incremental training. In Experiment 2, the "simple" task was identical to the first experiment. The "complex" task used the same stimuli as Experiment 1 but required the network to discriminate whether the sum of digits on the picture was odd or even. We again trained one network incrementally on 10.000 examples of both the "simple" task and the "complex" task, and a second non-incrementally on 20.000 examples of "complex" task. After training, we tested both networks on the odd-even "complex" task with a validation set of 10.000 unfamiliar double-digits (Fig.2). In this experiment, the non-incrementally trained network performed at chance-level, while the incrementally trained network performed significantly better. The benefit of incremental learning might stem from the task's requirement for an intermediate level of representation. Specifically, it is difficult for the network to perform the odd-even task in Experiment 2 without it creating an intermediate representation of each of the individual digits. This individual digit representation is difficult to learn from the odd-even labels, as the tasks are orthogonal. In contrast, in Experiment 1, the network can recognise the double digits without the need for an intermediate single digit representation, and so there is no benefit from incremental learning. In conclusion, we have found that while under some circumstances, incremental or "Goldilocks" learning can facilitate learning in ANNs, in others it does not. We hypothesise that the same will be true of infant learning. Future work will work to probe how general these conclusions are and test the ensuing predictions in infants.

P3-F-95: Attention control flexibility underlies individual differences in temperament in the first year of life.



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From the very moment the baby is born there are individual differences in how babies react to the world. These constitutional differences in reactivity and the mechanisms controlling such reactivity comprise what has been called temperament (Rothbart and Bates, 2006). For example, some babies are prone to approach to novel objects with no sign of fear whereas others tend to be more cautious (surgency); others get more easily upset and are more difficult to be calmed (negative affectivity). It has been suggested that executive control skills contribute to explain individual differences in temperament from early on, being a building block for the effortful control temperament component. However, few studies have investigated the relationship between executive control skills and temperament in the first year of life. Some evidence indicate that executive control skills emerge during the first year of life and some rudimental forms of inhibitory control are already present by 6 months of age (Holmboe, Bonneville-Roussy, Csibra & Johnson, 2018). In our study, we investigated the association between individual differences in executive control of attention (particularly in attention flexibility) and individual differences in temperament in the first year of life. We measured executive control of attention of infants at 6 and 9 months of age with an eyetracking-based switching paradigm measuring visual attention flexibility adapted from Kovács & Mehler paradigm (2009). Perseverative anticipation in the location reinforced during the first block was used as an index of attention flexibility such that more perseverative anticipations indicate less flexibility of attention. Parents reported infants temperament at 6 and 9 months of age and we obtained the score for the three main factors of temperament: surgency, negative affectivity and regulation/orienting. Over a 100 infants participated in the study. Preliminary results show that proportion of perseverations in the switching paradigm at 6 months of age were positively related to surgency at 6 ($r=.27$, $p<.01$, $n=77$) and 9 months of age ($r=.27$, $p<.01$, $n=33$). No further associations between attention flexibility and temperament were found. Our results indicate that the attention flexibility paradigm is capturing the lack of inhibitory control underlying surgency temperament component. The absence of relationship between the regulation/orienting component and the performance of infants in the attention flexibility paradigm might be due to the fact that this temperamental component is measuring lower-level control mechanism relying in more simple attention mechanisms such orienting of attention.

P3-F-96: Associative learning modulates infants' attentional selection in a free-viewing task

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Attentional selection during free viewing of complex stimuli, such as videos, is thought to be driven by top-down (e.g., prior knowledge or current goals) and bottom-up (e.g., luminance or motion) factors. Whereas research in top-down attentional processes in adults explicitly manipulates knowledge or goals (e.g., Smith & Mital, 2013), prior work with infants has mainly studied top-down attention by using face looking as a proxy on the assumption that face looking is driven by knowledge. However, in complex video stimuli, faces are often visually



salient because they move (Wass & Smith, 2015). Thus, it is difficult to use face looking as a means of separating top-down from bottom-up influences on attention. Some recent work has studied infants' top-down attention by familiarizing infants with the spatial arrangement of targets: 6-month-olds used contextual knowledge to find targets faster and more efficiently in simple, static displays (Tummeltshammer & Amso, 2018). However, it is unknown whether manipulating infants' knowledge will affect their free viewing of complex video displays. In the current study, we devised a new way to study top-down attention in infants' video viewing by first manipulating infants' (8, 12, and 18 months; $N = 28$) knowledge about visual targets in a training phase, and then measuring infants' attention to those targets while watching videos in a free-viewing phase. Infants were presented with 8 gaze-contingent training trials in which two static cartoon objects were displayed on a black background (Figure 1). Once infants made a 200 ms fixation to the predetermined 'target' object, a 5 s video clip was triggered. In the subsequent free-viewing phase, infants watched 8 30 s Baby Einstein video clips. Both the trained and untrained objects were digitally inserted into each video at a counterbalanced, fixed location (Figure 1). Differential looking to the trained versus untrained object would indicate top-down attention modulation based on prior knowledge acquired from training. Infants fixated the trained object during $M = 3.57$ free-viewing trials ($SD = 1.62$), significantly more than the untrained object ($M = 2.57$, $SD = 1.77$), $F(1, 25) = 10.65$, $p = .003$ (Figure 2). However, there was no main effect of age for the total number of trials with fixations to each object. There was a marginal difference in the total amount of time spent looking to the trained object ($M = 3302$ ms, $SD = 2342$) compared to the untrained object ($M = 2462$ ms, $SD = 2804$), $F(1, 25) = 3.87$, $p = .06$, but there was no significant effect of age. These results indicate that infants as young as 8 months of age are able to adapt their gaze to look at targets that were made meaningful through prior association learning, even when those targets were embedded in a rich, complex video scene. The success of this manipulation provides further evidence for the burgeoning development of top-down attentional processing in the first year of life.

P3-F-97: The effect of social and non-social distractors on focused attention and distractibility in toddlers

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A central developmental challenge for infants and toddlers is allocating attention among various competing sources of information, focusing on some tasks and avoiding distraction from others. A number of studies (e.g., Kannass, Oakes, & Shaddy, 2009; Deák et al., 2008; Ruff & Capozzoli, 2003; Setliff & Courage, 2011) have shown longitudinal stability of measures of distractibility in free-play paradigms, as well as important links between measures of focused attention in early infancy (< 12 months) and later attention and cognition in the toddler years (age 2-3). Less is known, however, about how focused attention and distractibility develop during the toddler years, as well as how different types of distractors (social vs. non-social) may affect toddlers' ability to tune out distractors. The purpose of this study was to examine the development of focused attention and distractibility in toddlers age 1-3, specifically how non-social (TV) and social (experimenter) factors affect focused attention. To examine these questions, $N=70$ toddlers aged 16-, 24-, and 31-months old were tested cross-sectionally in a 2 (TV distractor vs. no TV distractor) by 2 (social vs. non-social) lab-based play task. Each child had approximately two minutes of free play per condition, with different experimenter-provided



toys. Free play was interrupted at scripted intervals by brief television clips (TV distraction conditions) and experimenter requests (social conditions). Videos were coded for various measures of attention and distractibility. To examine developmental changes in focused attention across different types of distraction, a 3 (Age) by 3 (Condition: TV distractor, social, and combined) ANOVA was conducted on proportion of time spent in focused attention. The only significant result of this analysis was a main effect of Age, $F(2,64) = 3.132$, $p = .05$; this result was driven by the 31-month-olds. While 16- (68.38%) and 24-month-olds (68.69%) were similar in focused attention across these conditions, 31-month-olds showed greater levels of focused attention compared to the other groups (77.73%). Next, we examined changes in distractibility with a 3 (Age) X 4 (Condition) ANOVA on a composite distractibility variable, composed of time spent looking at distractor TV clips and other non-focused attentional time. This analysis yielded a main effect for Condition, $F(1,65) = 9.244$, $p < .005$. This result is illustrated in Figure 1. Taken together, these results show important developmental changes in focused attention and distractibility, and offer new insights into the effects of different types of distractors on attention. Older toddlers showed more focused attention than did the two younger toddler age groups. Of additional interest is the comparison of distractibility in the various conditions. Toddlers were more distracted in the social-only condition than in the control condition, indicating that social demands interfered with focused attention. However, in the two conditions in which distractor TV clips played on a side TV, the presence of a social partner actually lessened distractibility (see TV + Social condition vs. TV only). Additional analyses are planned. We believe that these data will provide an important window into attentional development during a less studied window (the toddler years) of attentional and cognitive development.

P3-F-98: Detection of incongruent naming of occluded objects in 12-14-month-old infants

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Once infants learn their first words, they can potentially also notice when those words are used incorrectly. The N400 is an ERP component sensitive to semantic violations such as mislabeling, or incongruent ending of sentences (Kutas & Hillyard, 1980). In Parise and Csibra (2012) 9-month-old infants showed an N400 effect when a labelling was followed by the fall of an occluder, revealing an incongruent (familiar) object. Reversely, in studies by Friedrich and Friederici (2005) pictures were presented first, followed by labelling. In this context it was at 14 months of age that infants showed an N400 effect in response to incongruent labels. The present study aimed to probe infants' detection of semantic mismatch when this requires relying on working memory. Specifically, we tested whether (in)correct naming referring to a sustained object representation can elicit semantic mismatch. We measured whether infants would show an N400 effect when a previously seen, but currently occluded familiar object is labelled incongruently. We presented 12-, and 14-month-old Danish-speaking infants videos where a person first shows an object, then puts it in a box. This is followed by a hand pointing towards the box, and an auditory label (congruent or incongruent with the content of the box) presented concurrently with pointing. If infants detect a mismatch, a larger N400 is expected for the incongruent labels. Based on previous data suggesting that infants' receptive vocabulary undergoes a radical increase around 14 months of age (Bergelson & Swingley,



2015), we expect 14-, but potentially not 12-month-old infants to detect the mislabeling and therefore show an N400 effect. In addition to the ERPs, gamma-band oscillations will be analyzed, which have previously been found to accompany sustained object representations (Kaufman, Csibra, & Johnson, 2003). Higher gamma-band activity in the incongruent condition would indicate enhanced processing potentially due to the detection of a mismatch between the auditory label and the sustained representation of the object. The study is pre-registered with n=32 infants per age group to be included. Preliminary data (n=17) show no effect of semantic mismatch in the 12-month-old group at the N400 peak. Data collection is ongoing, expected to finish March 2019.

P3-F-99: Infant cognition theories' coming of age: Moving from qualitative to quantitative assessment

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At present, the most common form of theory development is through narration, and the most common form of theory evaluation is via qualitative reviews (or, as we familiarly call them, "story-telling"). This approach is lacking in rigor, as concepts and relationships are underspecified in narrative theories. Moreover, qualitative reviews can suffer from a host of biases in data selection, representation, and integration. Instead, we propose that the field of infancy moves towards quantitative theory evaluation on the basis of (community-augmented) meta-analyses. We illustrate this approach by attempting to adjudicate between top-down (lexicon first), bottom-up (phonology first), and joint-interactive/parallel theories of phonological acquisition in infancy, which predict distinct developmental profiles. We draw from MetaLab (metalab.stanford.edu), a repository for community-augmented meta-analyses that contains data on lexical and phonological development measured via laboratory tasks. This case study highlights the key questions one must answer when using statistical modeling of meta-analytic data, which saliently involve proposing clear definitions. Phonological development is often described as involving native attunement, whereby native sounds are perceived better, and non-native sounds worse. MetaLab data suggested that the predicted non-native decline was only significant when selecting studies where infants of multiple ages were tested with the same stimuli; and the predicted native increase was not significant in our analyses. Thus, we only retained the former. For lexicon-first theories to explain early phonological acquisition, infants must learn words before they start tuning out non-native vowels. This excludes any theory based on minimal pairs, leaving in the run theories based on infants learning some non-contrastive words. MetaLab contains several useful datasets, including two meta-analyses that record outcomes of word learning (preference for high frequency words; word-to-picture visual mapping) and three on processes (all three bearing on aspects of word segmentation). Visual comparison and a first attempt at statistical analyses lead us to the conclusion that the data are not compatible even with these weaker lexicon-first theories, because infants' (measurable) progress in phonology predates their (measurable) progress in the lexicon. For example, Figure 1 shows that the split between native and non-native vowel discrimination temporally precedes the point at which word segmentation results are reliably above zero; a similar conclusion ensues if we define non-native decline as effect sizes being significantly lower than those found in the first 4 months of age. Thus, these results



are not compatible with lexicon-first theories, but cannot shed light on whether phonology-first, interactive, or parallel theories are correct. In addition to showcasing the use of all available data to make theoretical decisions, our talk will lay out some outstanding weaknesses of our proposed approach, namely limited statistical power and unlimited theorist degrees of freedom, which can be curfewed by the use of power calculation and pre-registration. Limited statistical power and unlimited theorist degrees of freedom also afflict qualitative reviews, and there is no straightforward solution for them in a narrative framework. Therefore, we still strongly recommend the use of meta-analyses for theory evaluation (see Table 1).

G-Cognitive Development

P3-G-100: Go with what you know: A meta-analytical study of moderators on infants' preference for high frequency word forms

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Recognizing word forms is an important milestone towards learning word meanings. The standard task to assess the emergence of this ability tests infants' listening preference to lists of familiar versus unfamiliar word forms. Following the seminal study by Hallé & de Boysson-Bardies (1994), this ability has been considered to emerge around 11 months of age. Follow-up studies have questioned whether this effect can be generalized across ages and language backgrounds. The present meta-analysis integrates all studies on this topic, examining the evidence for a familiar word recognition effect and the factors structuring its variance. Our dataset contains 33 effect sizes from 15 studies including 606 monolingual infants from eight language backgrounds between 147-457 days of age, openly accessible on <http://metalab.stanford.edu/dataset/famWord.html>. All reported analyses are preregistered (<https://osf.io/pvkq4/>). We calculated Hedges' g effect sizes as the difference between infants' listening times to familiar and unfamiliar word lists, divided by their pooled standard deviation. We first examined the mean effect size in the absence of moderators and found a medium effect size of $g = 0.51$ ($z = 6.41$, $p < .001$). We then added the moderators age and native language, grouping languages from the same language families. Effect sizes significantly increased with infant age ($b = 0.0039$, $z = 2.39$, $p = .017$), and were significantly higher for infants with Romance native languages ($b = 0.258$, $z = 2.46$, $p = .014$; Fig.1). These results confirm the presence of a preference for familiar words across language backgrounds, which gets stronger with age and differs by language background. In addition, we took advantage of the unique possibilities that aggregation of larger datasets offers to examine evidence of a gradual effect of word familiarity. Each single experiment necessarily categorized word lists into "familiar" and "unfamiliar", but the effect of word familiarity on preferences can be conceived as gradual evidence accumulation. To assess whether the datasets would provide sufficient variability to examine such a gradual process, whenever possible we approximated word familiarity by examining parent-reported infant word knowledge on Wordbank (<http://wordbank.stanford.edu>), a database of child vocabulary development. Indeed, we found a large variation in the median percentage of infants reported to know the words in the familiar lists (range 19% - 69%). We ran an additional analysis with moderators age and median word knowledge, which again showed a significant effect of age ($b = 0.005$, $z = 3.012$, $p = .003$), as



well as a marginally significant increase in effect sizes with increasing word knowledge ($b = 0.908$, $z = 1.897$, $p = .058$; Fig.2), and a significant interaction between the two, indicating a decreasing effect of word knowledge with age ($b = -0.014$, $z = -2.07$, $p = .039$). These results provide preliminary evidence that word knowledge affects preferences in a gradual manner, providing an important link to mechanistic explanations of the emergence of such preferences. This analysis also showcases how using two sources of existing data can advance theory development beyond what any single study could offer.

P3-G-101: Infants' social reasoning about instrumental vs. non-instrumental actions

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Infants use social groups to learn about the world around them, generating expectations about how individuals will behave from the past behavior of their group members (e.g. Powell & Spelke, 2013; Liberman et al., 2016). Are there limits on the kinds of behaviors infants expect to generalize across social groups? If so, the nature of those limits would provide insight into the representations young infants use to reason about the social world. One dimension that may limit social generalization is the instrumental nature of a behavior. Infants may only expect inefficient or non-instrumental actions to generalize, either because they think the lack of a clear instrumental purpose makes a social purpose more likely (Liberman, Kinzler & Woodward, 2018), or because they use separate core systems of knowledge to reason about intentional agency versus social relations (Spelke & Kinzler, 2007). To test this prediction, we showed 8.5-month-old infants ($N=48$) and 12.5-month-old infants ($N=46$) events in which members of two different groups performed differing actions, either non-instrumental (sliding vs. jumping) or instrumental (sliding vs. jumping to contact a box, which changed color). We then tested if they expected a new group member to act alike via a violation-of-expectation looking measure. 12.5-month-old infants expected the action to generalize only when it was non-instrumental (interaction: $F(1,42)=9.87$, $p<0.005$). 8.5-month-old infants' behavior was less conclusive. They did not reliably expect the instrumental actions to generalize. However, their expectations for the two action types were not reliably different, and they showed an overall stronger expectation of instrumental generalization than the older infants ($F(1,42)=4.13$, $p<0.05$). To better characterize younger infants' reasoning, we first conducted a direct replication of the instrumental condition with higher power ($N=64$). 8.5-month-olds again did not generalize the instrumental behaviors to new group members ($F(1,60)=1.01$, $p>0.3$), but also trended toward a stronger expectation of generalization than the previously tested older infants ($F(1,82)=3.207$, $p=0.08$). Second, we investigated infants' causal understanding of the color change events. Previous studies suggest infants expect similar events in nonsocial contexts to involve contact causality (Muentener & Carey, 2010). Do they generate similar causal expectations in a social context? After being introduced to a social group, 8.5-month-old infants ($N=60$) saw one group member move behind an occluder, and a box protruding from the occluder change color. At test, the occluder was removed and infants saw the same events with and without contact between the agent and box. Numerically, infants looked longer to the non-contact events, but this difference was not reliable ($F(1,56)=1.67$, $p>0.2$). This suggests that social context may weaken younger infants' recognition of the causal nature of instrumental actions, which could account for their stronger social generalization of these



actions. Overall, we find that by 12.5 months of age, and potentially earlier, infants differentiate instrumental and non-instrumental behaviors when making inductive inferences in the social domain. In particular, they more strongly associate non-instrumental actions with social group membership. This sheds light on the structure of infants' social representations, and on their understanding of universal human behaviors like dance and ritual.

P3-G-102: Logical thought in infancy: Behavioral and neural evidence

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Two decades of research have attested infants' sophisticated abilities in interpreting situations and generating expectations. However, it is unclear whether preverbal infants also possess logical reasoning abilities. Recently, Cesana-Arlotti et al. (2018) showed that 12-month-olds may spontaneously draw elementary logical inferences witnessing simple visual scenes. Gaze inspection patterns and pupil dilation dynamics marked infants' behavior when the scenes required a logical inference to be understood. Building on this work, here we explore the stability of such markers as well as their neural correlates, and extend our investigation to how infants represent a situation with logical valence before drawing an inference. Our scenes presented two different objects identical in their top part. After an occluder hid them, one object entered the cup leaving only its top part visible (Fig 1A). This occurred either because the cup scooped it from behind the occluder (Fig 1A,i) or because the object entered the cup in full view (Fig.1A,ii). Then the object behind the occluder exited, allowing one to determine the identity of the object inside the cup. We focused on two crucial moments with potential logical valence: when participants represent the object without knowing its identity (it could be either object A or B), and when the scene licenses disjunctive syllogism (it cannot be A, so it is B). Both when something unknown had to be represented and when the identity of a non-visible object could be determined by inference we found higher pupil dilation with respect to control conditions in which the identity of the object was known, signaling processing of logical aspects of the scenes (Fig.1, B). The fact that we obtained the same effect as Cesana-Arlotti et al., despite the radical changes in our task, is a sign of the spontaneity and resilience of the dilation response in the inference phase. In order to investigate the neural basis of this ability, we collected near-infrared spectroscopy (NIRS) data from a different group of 12-month-olds with the same stimuli tested behaviorally. Currently no fNIRS investigation studying thinking and reasoning exists in preverbal infants. Preliminary results show greater hemodynamic response for scenes requiring to represent something unknown and to apply an inference, compared with control conditions (Fig.2). These differences appeared in the right superior frontal area and in the left middle-central gyrus. This neural activity converges with the pupil dilation effect found when infants see the same scenes. Importantly, the bilateral response contrasts with adults' brain activation profile in verbal reasoning tasks, which mostly emerges in frontal and parietal left regions. This shift from bilateral activations to lateralized responses may suggest that elementary reasoning processes initially exist preverbally and are not language-based, and may be influenced by language coding and structures with the development of language. Our work opens new ways to understand the development of logical abilities and their neural representation, allowing us to reveal how language acquisition potentially changes the brain circuits involved in higher level cognition.



P3-G-103: Infant visual attention style predicts change detection on a visual short-term memory task

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Visual learning is an important component of early cognitive development, and visual short-term memory (VSTM) critically supports much of this early learning. Although previous work demonstrates attention cueing can facilitate change detection for the cued locations (Ross-Sheehy, Oakes & Luck, 2011), it is unclear if general attention skill is related to overall VSTM performance. To examine this, infants were assessed using the Infant Orienting with Attention Task (IOWA; Ross-Sheehy et. al., 2015), and a Latent Class Analysis was performed on IOWA task scores to derive distinct attentional phenotypes. Three stable classes emerged from this analysis: High Reactive infants had strong spatial cueing effects, fast reaction and high error rates, Low Reactive infants had slow reaction times, low error rates, and weak spatial attention, and High Flexible infants had strong spatial cueing effects, moderate errors, and fast reactions times. If attentional style influences VSTM performance, we would expect distinct patterns of change detection as a function of attentional phenotype. 11-month-olds infants (N=98) were tested in the IOWA task and in a VSTM task, and visual gaze was assessed using a Tobii eyetracker sampled at 300Hz. The attentional classes were as follows: High Reactive (N=4), Low Reactive (N=42), and High Flexible (N=56). Due to low sample size, the High Reactive infants will be excluded from all analyses. The VSTM task was modeled after adult change detection tasks and consisted of arrays of 1-4 colored circles. Each trial began with a 1000ms sample array, followed by a 500ms retention interval, and finally a 3000ms test array that was either exactly the same as the sample array, or contained a single color change (Figure1). The set size and change status of each trial was randomly selected. A repeated measures ANOVA conducted on total look durations during test revealed several significant effects, including a main effect of Change Status $F(1,96)=4.627, p=.034$, Set Size $F(3,94)=3.054, p=.03$, and Class $F(1,96)=8.493, p=.004$ (Figure 2). Importantly, these effects were subsumed by a significant Set Size by Class interaction $F(1,96)=8.493, p=.004$. Follow-up simple effects tests revealed that High Flexible infants spent more time looking at the change trials than no-change trials in set size one ($p=.009$) and set size two ($p=.052$). These results demonstrate clear evidence of change detection for High Flexible infants when viewing 1-2 items, whereas Low Reactive infants showed no evidence of change detection at any set size. These results suggest attentional proficiency may be one critical component of VSTM performance, and suggest further research is needed to determine if these relations hold throughout development.

P3-G-104: Infants understand procedural fairness

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There is now a rich and rapidly growing literature on distributive fairness in children (e.g., LoBue, Nishida, Chiong, DeLoache, & Haidt, 2011; McCrink, Bloom, & Santos, 2010; Shaw, Montinari, Piovesan, Olson, Gino, & Norton, 2014; Warneken, Lohse, Melis, & Tomasello, 2011), infants (e.g., Geraci & Surian, 2011; Schmidt & Sommerville, 2011; Sloane, Baillargeon,



& Premack, 2012) and non-human apes (Brosnan & de Waal, 2014). By comparison, very little attention has been given so far to the development of knowledge about procedural fairness (e.g., Grocke, Rossano, & Tomasello, 2015; Qiu, Yu, Li, Cheng, & Zhu, 2017; Shaw & Olson, 2014). In four experiments (N = 64), we tested whether 20-month-old infants are sensitive to violations of procedural impartiality. In Experiment 1, participants were shown videos in which help was provided in two different ways. A main character provided help either impartially to two other agents, by helping them at the same time, or in a biased way, by helping one agent almost immediately and the other one only after a much longer delay. Infants looked reliably longer at the unfair than at the fair scenarios, despite the fact that in both scenarios help was provided to each helpee. In Experiment 2 we found evidence showing that infants do not simply reacted to the presence of balanced and unbalanced communicative interactions, but to the procedural fairness of the main character. Evidence from Experiments 3 and 4 helped us to assess whether the sensitivity to the unbiased and biased behaviour of the fair and unfair agent, respectively, was due to low-level factors rather than expectations of fairness. Moreover, the results of Experiments 3 and 4 provided a replication of the findings obtained in Experiment 1. Overall, on the basis of these results, we argue that, in their second year, human infants are already taking their first steps towards an understanding of procedural fairness.

P3-G-105: Infant expectations of instant or deferred gratification

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We regularly make decisions on instant or deferred gratification, especially in food intake. This is exactly the challenge faced by preschoolers in the delay-of-gratification paradigm (Mischel et al., 1989). After getting a marshmallow, 3- and 5-year-olds are told by an experimenter that they can eat the marshmallow immediately or wait until he returns to receive a second one. Many factors sway children's decisions, for example, self-control skills, which are influenced by social and environmental factors and also contribute to individuals' later life success (Casey et al., 2011; Lamm et al., 2018). Another direction of investigation is the trust children put in the experimenter's promise of the second marshmallow. After witnessing an experimenter lie or break her previous promise, children are more likely to eat the marshmallow before she comes back (Kidd et al., 2013; Michaelson & Munakata, 2016). The present study examines whether some early understanding about delay-of-gratification exists before individual differences can be observed in preschool years. That is, do infants hold expectations about others' choices of delayed or instant gratification, before children are old enough to participate in the marshmallow test? We tested infants in a violation-of-expectation looking-time task (Baillargeon et al., 2015) modeled after the marshmallow test. Infants at 22 months were assigned to an experimental or a control condition. In the experimental condition, infants watched two types of events alternately performed on an apparatus. To start, Agent1 had an empty plate in front of her. Next, Agent2 appeared, placed a marshmallow on the plate, and said to Agent1, "Here is a marshmallow. You can eat it now, or if you don't eat it and wait for me to come back, I will give you another one." Agent2 exited the apparatus. Agent1 either waited while tapping her fingers (wait event) or ate the marshmallow and then tapped her fingers (eat event). Infants looked reliably longer at the eat than at the wait event, suggesting that they expected Agent1 to wait. The control condition was identical except that Agent2 said "Here is a marshmallow. If you want, you can eat it now. Or, if you don't eat it, you can wait for



me to come back." Here, infants looked reliably longer at the wait than at the eat event, suggesting that they expected Agent1 to eat the marshmallow. Infants' language skills did not differ between the two conditions. Therefore, with a promise of a larger reward later, infants expect others to delay gratification. Their trust in the promise is consistent with prior suggestions of a default to trust others' testimony in infancy (Baier, 1986; Jaswal et al., 2010). Without this promise, by contrast, infants expect others to act on instant gratification. The present study suggests that infants, of a typical sample, hold expectations about instant or delayed gratification. It is still an open question how these early expectations translate to what infants do themselves (e.g., in self-control) and later preschooler's responses in the marshmallow test. Currently, we are testing a culturally, racially, and economically diverse sample of infants using this violation-of-expectation task, which will contribute to the recent conversations on the role of environmental factors, such as socioeconomic status and social-group membership, on children's self-control and trust (Doebel et al., in press; Watts et al., 2018).

P3-G-106: Children consider mental states in an interactive lying paradigm

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The past decade has suggested astonishing Theory-of-Mind (ToM) abilities in infancy, including understanding false beliefs. For example, in interactive tasks infants successfully take into account what an adult believes (whether or not there is a toy inside the box) when determining his goal in order to help (to get the toy or to open the box; Buttelmann, Carpenter & Tomasello, 2009) or warn him helpfully (Knudsen & Liszkowski, 2012). However, several of the infant false belief tasks have been found difficult to replicate (Poulin-Dubois et al., 2018). Further, infants might pass these tasks by simply tracking the adult's knowledge state and determining his goal (what is he trying to do?), rather than representing two conflicting perspectives at the same time (Tomasello, 2018). In contrast to helping paradigms, in which perspectives are aligned, lying appears to be a much clearer case of Theory of Mind use in action. When lying, one intends to provide a non-factual perspective and thus implant a false belief in a recipient in order to make him behave in an anticipated way. However, research to date has only revealed correlative evidence between lying and false belief understanding. In the current study, we pursued an experimental approach and manipulated a protagonist's mental state to test directly whether the protagonist's mental states would influence participants' lying behavior. The experiment tested for a causal link between lying and ToM *sensu* false belief understanding. In addition, we assessed ToM with a standard false belief test. We used a novel interaction-based lying paradigm we had previously established to work with 2- and 3-year-olds. Here, we tested children when they first begin to show explicit understanding of different perspectives (around 4 years), N=71 (full set will be 75; coded to date, 69). Children were randomly assigned to three between-subjects conditions. In a puppet play (xx4 trials?), a competitor was looking for a toy in order to steal it from the child. The toy was hidden in one of two boxes and we manipulated the competitor's mental state. He either did not know where the toy was (ignorance condition) or had a false belief (false belief condition) or a true belief (true belief condition) about its location. Thus, lying was more or less relevant depending on the competitor's level of knowledge. First analyses reveal that the majority of children lied (63%), and that lying correlated with passing the false belief test



($\phi(68)=.257$, $p=.034$). However, the number of lying children did not differ between conditions (pending final coding of data). The full set of analyses will be presented at the conference. Current findings, pending final analyses, support views that the implementation of differing perspectives within interaction is a challenging, and a late emerging ability relative to infants' early emerging sophisticated communication abilities. Findings are highly relevant to determining the emergence of false belief tracking and for interpreting infant studies on false belief understanding.

P3-G-107: A novel means-end problem solving assessment tool (MEPSAT): Evaluation of validity and reliability

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INTRODUCTION: Means-end problem-solving (MEPS) tasks are convenient early indicators of infants' cognitive development (Lobo & Galloway, 2013). Previous studies highlighted delays in performance and learning of MEPS in at-risk infants compared to typically developing infants (Clearfield et al., 2015; Cunha et al., 2018). However, real-time identification of delays in MEPS can be challenging since MEPS behaviors have traditionally been analyzed using time-intensive behavioral coding methods (Babik et al., 2018; Cunha et al., 2018). To provide an affordable and feasible assessment of MEPS for research and clinical settings, we developed a novel Means-End Problem-Solving Assessment Tool (MEPSAT). The goal of this study was to evaluate construct validity and reliability of the MEPSAT. **METHODS:** Twenty-two typically developing infants (Mean=5.9 months at the first visit; SD=0.2) and 30 infants with motor delays (Mean=10.4 months [prematurity-corrected] at the first visit; SD=2.4) were assessed longitudinally at 5 visits across 1-1.5-years in their homes. At each visit, infants engaged in a MEPS task: pulling a towel to retrieve a distant, supported toy. The MEPSAT was used to score from videos: 1) Means-end learning; and 2) level of performance (Figures 1A-B). In addition, infants were assessed using the Bayley Scales of Infant and Toddler Development (Bayley-III). MEPSAT scores were validated against cognitive and motor subscales of the Bayley-III by evaluating within-infant associations (whether variation within infants across time is similar across measures) and between-infant associations (whether average variation between infants is similar across measures). Intra- and inter-rater reliability of scores were evaluated via re-scoring of videos and calculating the intraclass correlation coefficients (ICC). **RESULTS:** Significant within-infant associations ($p<.05$) were observed between MEPSAT learning scores and level of performance and Bayley-III scores for both typically developing infants and those with motor delays; whereas significant between-infant effects ($p<.05$) were observed only for infants with motor delays. This indicates that infants with motor delays who had higher Bayley-III scores also showed greater MEPSAT learning scores and level of performance. Moreover, changes in the Bayley-III scores were related to changes in MEPSAT learning scores and level of performance across time for both groups. Strong reliability of MEPSAT scores was found for both typically developing infants (intra-rater: ICC=.998; inter-rater: ICC=.995) and infants with motor delays (intra-rater: ICC=.996; inter-rater: ICC=.997). **CONCLUSION:** The MEPSAT is supported by validity and reliability evidence and is thus a promising tool for screening to identify early problem-solving delays in infants with a range of motor abilities. It can be



performed in the home environment with minimal resources. It has a simple scoring system that can capture change in performance among infants with different levels of motor delays and change in performance across time, making it a potential method to assess the efficacy of interventions aimed at advancing problem-solving skills, motor ability, and cognitive outcomes in at-risk infants.

P3-G-108: Associations between joint attention and later verbal ability and executive function

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Background/ Objectives: Various studies have examined longitudinal associations between joint attention behaviors and later language ability, executive function, and overall development. The objective of this study was to analyze the predictive associations between individual differences in responding to joint attention (RJA) measured between 8 and 15 months of age and key developmental outcomes (verbal development and executive function) measured at 24 and 33 months. The Dimensional Joint Attention Assessment (DJAA; Elison et al., 2013) was used to characterize individual differences in RJA. The DJAA is a naturalistic, play-based interaction between an administrator and infant participants. It includes four series of four presses, presses that include progressively less subtle (more redundant sensory information) bids for joint attention with the infant. Verbal development was assessed with the Mullen Scales of Early Learning (MSEL; Mullen, 1995), and executive function was assessed with the Minnesota Executive Function Scales (MEFS; Carlson & Zelazo, 2014) a tablet-based assessment standardized for children 2 years of age and older. These analyses also extend analyses of DJAA and social reciprocity relationships in a portion of this sample previously presented at ICIS 2017. **Method:** Between 9 and 15 months ($m=12.5$ months, $sd=1.67$), 144 infants (75 females) completed the MSEL and DJAA as part of a larger study. At 23-25 months (mean=24.6 months, $sd=0.49$) 128 infants (66 females) completed the MSEL, with 76 (40 females) also completing the MEFS. At 29-36 months (mean=32.1 months, $sd=1.39$), 50 infants (24 female) completed the MSEL, with 41 infants (20 females) completing the MEFS. Forty-nine infants (24 females) had MSEL scores at both time points, and 22 infants (11 females) had MEFS scores at both time points. Associations between DJAA scores at 9-15 months and later MSEL Verbal and MEFS scores were assessed via regression after controlling for participant sex and other relevant variables. **Results:** DJAA scores at 12 months were associated with MSEL Verbal scores at 24 months after controlling for sex and MSEL Verbal scores at DJAA measurement, $t(1,124)=2.27$, $\beta=0.187$, $p=.025$, and the overall model was significant, $F(3,124)=9.36$, $R^2=.185$, $p<.001$. DJAA scores also associated with MSEL Verbal scores at 32 months, $t(1,46)=2.12$, $\beta=0.294$, $p=.040$. The overall model was also significant at 32 months, $F(3,46)=3.34$, $R^2=.179$, $p=.027$. This pattern did not arise when DJAA was used to predict MSEL Nonverbal scores (see Table 1). DJAA scores were not correlated with MEFS scores at 24 months, $r(77)=.02$, $p=.86$. However, DJAA scores were marginally correlated with MEFS scores at 32 months, $r(51)=.25$, $p=.07$. After controlling for sex, DJAA scores were marginally associated with 32 month MEFS scores, $t(1, 50)=1.98$, $\beta=.265$, $p=.054$. The overall model was not predictive, $F(2,50)=2.91$, $R^2=.104$, $p=.064$. **Conclusion:** DJAA mean score is longitudinally associated with verbal development at 24 and 32 months, and is marginally associated with executive function at 32, but not 24 months. These results underlie the



important developmental sequelae associated with the early-emerging social cognitive skill of responding to joint attention, and are relevant into toddlerhood and early childhood.

P3-G-109: A training study of children's early theory of mind abilities

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Already between the ages of 3 and 4, children start to comprehend the mental states seeing and knowing (Wimmer et al., 1988; Ruffman & Olson, 1989). Children at this age, for instance, understand that seeing the content of a container leads to knowing the content. Thus, already at this young age, children show signs of mental state reasoning abilities. In the past years, a number of studies have aimed at training and thereby fostering children's early mental state reasoning competencies (Hofmann et al., 2016). Though, most of these studies have focused on children in their fourth year of life and have almost exclusively measured and trained the comprehension of false beliefs. Furthermore, while a beneficial influence of language on ToM is well-known (Milligan et al., 2007), different linguistic trainings have proven at least partially successful in eliciting better mental state reasoning abilities. Some authors argue that the acquisition of the syntax of complementation is especially beneficial for children's Theory of Mind development (deVilliers & deVilliers, 2000). On the other hand, there is evidence that comprehension and production of mental state language is facilitating for the development of mental state reasoning abilities (Brooks & Meltzoff, 2015; Olson, 1988). The aim of the present study was, thus, to foster mental state reasoning abilities in children shortly before their third birthday and to compare the effectiveness of two different types of training on later comprehension of the mental states seeing and knowing. In our training study, children were tested several times throughout their third year of life. Some of the children received an intense training either on mental state language (N = 28) or on complement syntax (N = 22) in the two months before their third birthday. The remaining children (N = 72) participated in the control group and did not undergo any training. Performance in a near-transfer pre- and post-test was compared between mental state language training children, syntax children and control children. A two-way repeated-measures ANOVA revealed a significant effect of group ($F(1,99) = 14.21, p < .001$) and a significant interaction between group and measurement point ($F(1,99) = 11.51, p = .001$) on a near-transfer seeing-knowing task. Post-hoc independent-samples t-tests found significant differences at post-test between the mental state language group and the control group ($t(95) = 5.23, p < .001$) and between the mental state language and the syntax group ($t(46) = 4.06, p < .001$) but not between the control and the syntax group ($p > .05$). There were no group differences at pre-test. By the time of the conference, data from additional children will be available. The results of the study indicate that it is possible to foster comprehension of the mental states seeing and knowing already in 2- to 3-year-old children and to elicit comprehension of these mental states earlier than in regular development.

P3-G-110: Early environmental experiences, frontal EEG activity and self-regulation in young children: Two meta-analyses

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Self-regulation, which is defined as the ability to automatically or purposely control thoughts, feelings and behavior, is predictive for development in many domains in life (Raver et al., 2012). For instance, competent self-regulation is associated with higher academic competence and lower levels of externalizing and internalizing problems (Eisenberg et al., 2000; Murray & Kochanska, 2002; Rodriguez et al., 2005). The concept self-regulation is widely studied, including many studies examining the influence of environmental experiences during the first years of life (e.g., Karreman, Van Tuijl, van Aken, & Deković, 2006). Self-regulation also received attention within neuroimaging studies, showing that the development of self-regulation is related to individual differences in brain activity (e.g., connectivity and power). For instance, individual differences in frontal electroencephalogram (EEG) activity are related to aspects of self-regulation, including effortful control (Xie, Mallin, & Richards, 2018), executive functioning (Perone & Carlson, 2018) and emotion regulation (Perry, Swingler, Calkins, & Bell, 2016). Results of previous studies also show that individual differences in brain activity are associated with early environmental experiences, such as parenting behaviors (Bernier, Calkins, & Bell, 2016), characteristics of parents (St. John et al., 2017), family relationships (Marshall et al., 2008) and demographics (Evans & Kim 2013). Therefore, it might be the case that the influences of early environmental experiences on self-regulation are, at least partly, mediated by frontal EEG activity. Unlike the studies that examine the association between early environmental experiences and self-regulation, the number of studies examining the association between early environmental experiences and frontal EEG activity and between frontal EEG activity and self-regulation is limited. Consequently, as a first step, it is important to establish the robustness of these associations. Therefore, two multi-level meta-analyses will be performed to examine whether individual differences in frontal EEG activity are indeed associated with (1) early environmental experiences and (2) the development of self-regulation. Studies with samples of infants and pre-school aged children have been included, but the first three postnatal years will be the focus for the current presentation. Four databases have been searched without publication date restrictions: PsycINFO, Web of Science, MEDLINE and PubMed. A total of 2.397 studies have been screened and around 30-40 studies for each meta-analysis are meeting the inclusion criteria. Studies meeting the inclusion criteria are currently coded in SPSS for information concerning the study, the sample, research design and effect sizes. A quantitative synthesis of the data will be performed to examine the associations between (1) frontal EEG activity and early environmental experiences and (2) frontal EEG activity and self-regulation. Subgroup analyses will be conducted to examine whether differences within the samples (e.g., age, gender) and differences within the designs (brain region, EEG measurement moment, type of task to assess self-regulation or early environmental experiences) are related to the effect sizes.

P3-G-111: Ten-month-olds' representations of utility in goal selection

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The naïve utility calculus theory (Jara-Ettinger et al., 2016) argues that from an early age humans view agents as utility-maximizers, who act in a way that minimizes action costs and maximizes rewards. While a wealth of research shows that infants in their first year of life expect agents to realize outcomes in the most cost-efficient way possible (Gergely & Csibra, 2003; Liu & Spelke, 2017), and can infer the value of goals from the amount of effort an agent



invests to approach them (Liu et al., 2017), not much work has examined whether they expect agents to select the highest-utility outcome among those available. In three violation-of-expectation studies, we tested whether 10-month-olds expect an agent to maximize her utility by (a) bringing about the outcome which would yield higher rewards (operationalized as larger number of goal objects) than another, given identical action costs (Study 1: $n = 24$), and (b) bringing about the outcome which would require less effort than another, given identical rewards (Study 2a: $n = 24$; Study 2b: replication with slightly modified stimuli, $n = 24$). In Study 1, after being familiarized with an agent approaching object A over B, infants looked longer at test when the agent approached three tokens of object A over one, compared to when she approached a single token as in familiarization ($M_{\text{appr3}} = 19.31$ s, $M_{\text{appr1}} = 14.98$ s, $t(23) = 1.99$, $p = 0.058$, $\log_{10}\text{BF} = 1.87$). In Study 2, after being familiarized with an agent approaching an object by jumping a wall of variable height, infants did not look longer at test when the agent, facing a choice between two identical goal objects respectively located behind a high or low wall, selected the former (Study 2a: $M_{\text{high}} = 29.93$ s, $M_{\text{low}} = 27.13$ s, $t(23) = 1.27$, $p = 0.216$, $\log_{10}\text{BF} = 0.73$; Study 2b: $M_{\text{high}} = 21.01$ s, $M_{\text{low}} = 25.64$ s, $t(23) = 1.09$, $p = 0.287$, $\log_{10}\text{BF} = 0.44$). These results suggest that young infants may not use common assumptions about reward computation ("more is better" or "identical objects are of identical value") in the domain of action understanding. One possibility is that infants fail to use a naïve utility calculus productively to reason about agents' behavior in situations when novel goal options become available, or that they generally do not compare the relative utility of different alternative goals. We are currently preparing follow-up studies that will address these hypotheses.

P3-G-112: Toddler inhibitory control: Links with breastfeeding history and current diet?

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Introduction. Low levels of inhibitory control are often associated with psychopathology, such as attention deficit hyperactivity disorder, and child externalizing behavior problems. Nutrition, including early life nutrition, has been associated with inhibitory control, though its exact role is still unclear. After birth, breast milk is often the first source of nutrition for an infant. Since early life (the time spanning roughly between conception and the infant's second birthday) is a crucial phase for development, breastfeeding plays an important role in early development and health. Breastfeeding history is associated with a healthy dietary pattern in children. Additionally, both breastfeeding history and healthy dietary patterns have been associated with better executive functions, of which inhibitory control is part. As stated in our preregistration in the Open Science Framework (<https://osf.io/5mgmf> and amendment: <https://osf.io/35tg6>), we investigated the associations between breastfeeding history and inhibitory control at preschool age, with current diet quality as a potential mediating factor. **Methods.** Seventy-two families from the BINGO study (Dutch acronym for Biological Influences on Baby's Health and Development) participated at child age three. Six inhibitory control tasks were performed during a home visit: Snack Delay, Flanker, Whisper task, Bear Dragon task, Gift Wrap, and Gift Delay. Furthermore, the Behavior Rating Index of Executive Functions questionnaire for preschool children was filled in by both parents to assess child inhibitory control. In addition,



questionnaires about breastfeeding were administered at previous measurement rounds at age two, six, and 12 weeks and at 12 months, and now again at 36 months. Finally, the child's diet quality at age three was assessed via three 24-hour recalls, in which the mother had to report all that the child had eaten the previous day. Results. Preliminary results showed that the behavioral tasks did not correlate with parental reports, showing the value of collecting both behavioral data and reported data. Furthermore, the behavioral tasks did not correlate with each other. This indicates that the tasks measured different aspects of inhibitory control. Finally, reported inhibitory control behavior was correlated between father and mother ($r=0.585$, $p<0.001$). At the moment, the main analyses, by use of a mediation analysis, are being carried out. Conclusions. Parental reports of inhibitory control behavior were correlated, which makes it possible to combine both into one robust variable for the main analyses. The fact that the behavioral tasks did not correlate with parental reports, shows the value of collecting both behavioral data and reported data to obtain a more complete picture of a child's inhibitory control capacities. Further conclusions will depend on the forthcoming results of the main analyses.

P3-G-113: How do infants represent the relation same?

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Adults have a word "same" that expresses the relation of identity between two or more entities (e.g., "Sue's grade is the same as Luca's"; "The students' grades are all the same"). There is now substantial evidence that young infants are able to represent the relation same between two entities (e.g., Hochmann, Carey & Mehler, 2018). Here, we investigate the format of that representation. We consider the hypothesis that, rather than a symbol for the relation same, infants only represent symbols for the individuals involved in the relation. The relation would be implicitly carried by the computation that relates those symbols. Such a format of representation consists in representing variables for individuals, which can be repeated. If X is a variable for an object, two same objects can be represented as X X. To test whether infants rely on such a format of representation, we considered one straightforward prediction. As working memory is limited, the number of same elements that can be represented should be limited. In a modified oddball paradigm, we presented sequences of syllables to 11-month-old infants. In each experiment, one group (N=16) heard sequences corresponding either to a standard (75%) structure built on identity relations or a deviant (25%) structure ending with a different syllable; the other group (N=16) heard 50% of each structure (Table 1). In Experiment 1, the standard structure consisted in 4 identical syllables (e.g., AAAA: ba-ba-ba-ba; di-di-di-di; fu-fu-fu-fu; etc), while the deviant structure ended with a different syllable (e.g., AAAB: ke-ke-ke-lo). In Experiments 2-3, sequences were made of 6 syllables, exceeding working memory. In Experiment 2, the standard structure was AAAAAA and the deviant AAAAAB. In Experiment 3, the standard was again AAAAAA and the deviant AAABAA. In Experiment 4, the number of syllables varied between 3 and 5. The standard structure consisted in syllables that were all the same (AAA, AAAA, or AAAAA), while the deviant corresponded to the AAAB structure. We measure pupil dilation (Hochmann & Papeo, 2014) in deviant (different) trials with respect to standard (same) trials. Results (Table 1) suggest that infants represented the AAAA structure (Experiment 1) but not the AAAAAA structure (Experiment 2). They could however represent the first 4 syllables of the AAAAAA sequences (Experiment 3). As 6



exceeds working memory limits even in adults, the only way to represent 6 same syllables would be to represent all the same, an ability apparently beyond the reach of 11-month-olds. Experiment 4 confirms this interpretation as infants failed to consider that AAA, AAAA and AAAAA had a common structure. In sum, our results confirm that infants are able to process the relation of identity between entities, but only when the number of entities remains below 4. This suggests that infants do not possess a unitary mental symbol for same that could combine with a universal quantifier. Instead, the representation of same is built upon representations of individuals.

P3-G-114: Visual object categorization in infancy

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How do infants see the world? The object is the unit of human visual attention and perception. In the mature visual cortex, object representations show a spatial organization by categories, where a broader distinction between inanimate and animate objects further breaks up into finer-grained distinctions between human vs. nonhuman faces and bodies, and natural vs. artificial (big vs. small) inanimate objects. This organization is a hallmark of the visual system in primates. While cortical precursors of the adult-like organization, especially areas dedicated to face perception, may already be in place at birth, it remains unknown when this organization becomes functional so to drive, and account for, infants' looking behavior. To study this issue, we measured with eye-tracking the differential looking time (DLT) as 4- (N=24) and 19-month-old (N=24) infants looked at two exemplars belonging to two of eight animate and inanimate categories (human/nonhuman faces/bodies and big/small natural/artificial objects). Based on DLTs, we built a representational dissimilarity matrix (RDM) for each group, which evaluates infants' perceived similarity/dissimilarity of each pair of stimuli. High DLTs indicate that infants judged the two pictures to be different and spent more time looking at one or the other picture, while low DLTs indicate that infants judged the two pictures to be similar. Using representational similarity analysis, we tested the correlation between each RDM and a set of synthetic RDMs modeling the organization by categories, characteristic of the mature visual cortex (1 for between-category comparisons; 0 for within-category comparisons). This organization matched the RDM of 19-month-old infants (Figure 1A), highlighting the animate/inanimate, human/nonhuman, face/body and big/small categorical distinctions. None of these categorical distinctions were apparent in 4-month-olds, who instead exhibited a general preference for human faces. In addition, object discrimination in the younger (but not the older) group was driven by a low-level visual feature: the number of pixels (Figure 1B); i.e. 4-month-olds looked longer at the bigger figure. These results were replicated using the AlexNet Deep Neural Network (DNN), which was previously trained to categorize pictures at the basic category level (e.g., cups, cats, trees, etc.). This DNN provides a fine-grained model of visual object perception in adults. None of the RDMs obtained from the various layers of the DNN correlated with the RDM of 4-month-olds. In contrast, layers 6 to 8 (out of 8) correlated with the RDM of 19-month-olds. Consistent with the above results, this analysis showed that the adult organization by categories, characteristic of the mature visual cortex, is in place at 19 months of age. In a second study, we assessed whether categorical distinctions could emerge also in 4-month-olds' (N=24) looking behavior, when controlling for the number of pixels. Under this condition, the broadest animate-inanimate categorical distinction emerged



(Figure 1C). In summary, we showed that the adult-like organization of visual-object representation is largely functional by the 19th month of life. In contrast, low-level visual features mainly drive the visual behavior of 4-month-old infants; even though the most general animate/inanimate distinction is already in place.

P3-G-115: Accumulated experience trumps explicit assessment in 3-year-olds' distrusting repeated false testimony

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Three-year-olds show a strong bias to trust even a deceptive speaker (Jaswal et al., 2010). However, if given opportunities to observe the person deceiving another as a bystander, three-year-olds could overcome their bias to trust the adult's testimony (Ko et al., 2014). But the observation was only effective after watching the deception 4 times, suggesting that accumulating sufficient experience may be important to children at this age. Recently, Krogh-Jespersen & Echols (2018) demonstrated that explicit assessment of the informant can also help 3-year-olds successfully avoid learning from a previously inaccurate speaker. The assessment was done by asking children to verbally evaluate the speaker's prior accuracy. This suggested that explicit evaluation of their knowledge influences 3-year-olds' decision making in situations, such as learning a new label. Expanding this finding to a domain of judging the truthfulness of an informant, we examined whether making knowledge explicit by verbally assessing the speaker's truthfulness is more effective than observing the deception as a bystander. Twenty-three 3-year-olds were asked to play a sticker-finding game (Jaswal et al., 2010) with an adult after an observation period, during which the child watched two adults play the same game. One of the players hid the sticker in one of two boxes and told the other player the wrong location of the sticker, winning the game as a result. After showing the act of deception three times, the child was asked to explicitly assess the deceiver by answering the question, "Is she doing a good job at telling the other person where the stickers are?" After answering the question, the deceiving player played the same game with the child (3 trials). Additional 26 3-year-olds played the game after 3 observations of deception without explicit assessment. When we compared the two conditions, no significant difference was found. Children in both conditions still trusted the adult player, being able to win less than 40% of the time (Figure 1). We further compared this performance with that of 3-year-olds who were not given observation opportunities (control, n=23) and those who were given four observation opportunities (4 observation, n=18) (from Ko et al., 2014). Children were only successful in disregarding the adult's false testimony after they have observed the deception 4 times. Neither observing the deception three times nor 3 observation with the explicit assessment of the deceptive informant was helpful in 3-year-olds' overcoming the bias of trust in other's testimony. However, majority of 3-year-olds (21) answered positively to the assessment question and only 3 correctly answered. The minority 3 found stickers 55.6% of the time, better than those who said yes (28.3%), leaving the possibility that incorrect assessment might have been another source of influence. Currently, further data collection is underway until we have a balanced response group. Still, the results here highlight the effectiveness of bystander observation and the role of experience frequency. While 3-observation with assessment was not enough to alter 3-year-olds' judgment, just one more observation was effective in turning 3-year-olds not to trust the adult's testimony.



P3-G-116: High pre-schooler users of touchscreen devices show reduced cognitive flexibility

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The rapid increase in accessibility and usability of mobile touchscreen devices (i.e. smartphones and tablets) has led to widespread changes in the family media environment, leading concerned parents, policy-makers and scientists, to question the impact on infant and toddler development. However, rigorous scientific research investigating the impact on the developing mind lags behind the widespread usage. Studies with conventional media like television have linked screen media viewing in pre-school with impaired executive function (EF; Barr, Lauricella, Zack, & Calvert, 2010; Lillard, Drell, Richey, Boguszewski, & Smith, 2015; Kostyrka-Allchorne, Cooper, & Simpson, 2017), but specific evidence of associations with modern touchscreen media platforms use is sparse and shows mixed effects of immediate and long-term touchscreen media use associations with pre-school EF (Huber, Yeates, Meyer, Fleckhammer, & Kaufman, 2018; McNeill, Howard, Vella, & Cliff, 2019). In this study, forty-six children (23 girls) with different levels of touchscreen use (high, ≥ 15 min/day; and low use, < 15 min/day, duration of use reported by the parent) were tested on EF performance (cognitive flexibility, working memory, and inhibitory control) at 3.5 years (mean age = 41.29 months, standard deviation = 0.53 months) to investigate group-level differences. Preliminary results suggest that high users of touchscreen devices show reduced cognitive flexibility, as indexed by a marginally significant higher proportion of high users not switching between mental sets on the Dimensional Card Sorting Test (DCCS), $\chi^2(1) = 3.675$, $p = 0.055$. Inhibitory control measured by delay of gratification tasks was not significantly related to touchscreen use, i.e. performance on a Snack Delay, $U = 271.5$, $z = 0.339$, $p = 0.734$, and a Prohibition Task, $\chi^2(1) = 0.008$, $p = 0.928$, did not differ between groups. Problems with perseveration on the DCCS have been explained by a number of factors, including perceptual conflict between switch sets (Doebel & Zelazo, 2015) and conflict with the latent stimuli-response representation formed during the pre-switch phase (Morton & Munakata, 2002). While the results presented are preliminary, they point to an influence of touchscreen use on cognitive flexibility, in a way that experience of salient and contingent digital content might lead to stronger representations of latent perceptual features and bottom-up stimulus-response pairings. The next steps are to explore the shared variance between this and additional measures of EF (e.g. working memory) as a way of triangulating dimensions of emerging EF and better understand its associations with media use. Contrary to popular concerns, delayed gratification did not differ between groups. The next steps are to look at pre-potent motor response inhibitory control (e.g. in Go/No-go tasks), which is distinct from inhibition required for delayed gratification and has been previously found to be associated with touchscreen applications active playing (McNeill et al., 2019). Future studies are needed to replicate findings, to demonstrate causality, to understand trajectories and bi-directional associations, and to investigate the interplay between bottom-up and top-down processes over time.

P3-G-117: Coordinative processes underlying the emergence of infant agency



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How does the perception of self as a causal agent develop in early infancy? Mobile conjugate reinforcement (MCR) experiments show that infants greatly increase their kicking rate when one of their feet is tethered to a mobile hanging overhead. Infants do not kick more simply because the mobile moves. Rather, increase in kicking rate depends on the contingency between infant and mobile motion (Rovee & Rovee, 1969) and may reflect the infants' realization that they can control the mobile's movement (Adolph & Kretch, 2015; but see Kelso, 2016 for an explanation based on self-organizing coordination dynamics). What mechanisms underlie the formation of agency? Kelso and Fuchs (2016) proposed an autocatalytic process as a key mechanism involved in emergence of the agentive self. Once connected to the mobile, the infant's initially spontaneous movement causes the mobile to move, stimulating more infant kicking. The more the infant kicks, the more the mobile moves in response, stimulating further infant movement. Positive feedback amplifies the coordination between infant kicking and mobile response. At some critical level of coupling, the infant suddenly discovers its own agency: it transitions from spontaneous movement to making something happen in the world. Kelso and Fuchs (2016) hypothesized that the moment of realization will be marked behaviorally by an increase in coordination between mobile and movement as well as an abrupt increase in kicking rate. However, despite many studies using the MCR paradigm, neither mobile motion nor the coordination between mobile and baby movement have been measured. Here, three-dimensional movement of both infants and mobile was recorded at 100 Hz using a Vicon motion capture system. The mobile consisted of two colorful blocks mounted on the ends of a wooden arm which rotated when a string was pulled. Fifteen full-term 8-13-week-old infants completed an experiment consisting of four experimental stages: baseline (mobile stationary and disconnected), active baseline (experimenter moves mobile), coupled (infant tethered to mobile) and decoupled (mobile disconnected and stationary). The Kelso-Fuchs (2016) model reframes MCR by representing the coordination between infant and mobile as a dynamical system consisting of nonlinearly coupled oscillators. Synchronization is the degree of similarity in phase of multiple oscillators over time. Hilbert transforms were applied to 3D infant foot velocity and 2D mobile velocity to derive their respective phase time series. The Kuramoto order parameter, a measure of synchrony ranging from 0 to 1, was calculated for phase of mobile and toe movement. Preliminary results show a sudden increase in velocity of the tethered foot after 90 sec. of the coupled stage relative to the toe's activity during 2 min. of both baseline stages (Figure 1, Figure 2 d-f). At this same time point, synchrony between toe and mobile also begins to increase dramatically (Figure 2c). These results support the Kelso-Fuchs (2016) model, demonstrating that a marked increase in coordination between infant and mobile undergirds the sudden rise in infant kicking observed during the coupled stage. Agency emerges as a kind of phase transition in which infant and mobile mutually synchronize.

P3-G-118: Will it fall? Is it on? Children and adults use physical knowledge to inform linguistic expressions of support relations

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Support relations are a central concept in early spatial knowledge (Baillargeon, 2002). By 13 months, children understand that an object with 50% or more of its volume on a surface will not fall (Baillargeon, 1995). This type of relation--an object supported from below by a solid surface--is often encoded by adults and 4-year-olds with the linguistic construction BE on (e.g. "X is on Y", Landau et al., 2016). While there appears to be a privileged relationship between BE on and understanding of gravitational support, little is known about the mapping between the two, or its development. We asked whether the non-linguistic understanding of support has a one-to-one mapping with the expression BE on. We studied 32 adults and 18 children between 3- and 4-years-old (mean 4;3; range 3;8-4;11). Participants were divided evenly into two conditions: Physics or Language. In both conditions, participants watched a video, in which an object (a cube or L-shaped block) was held on a table. In the Physics condition, a character asked "Will it fall after I let go?" and two other characters provided contrasting answers (i.e. yes/no). Participants indicated which character "knew more" about the object. The Language condition had the same design, but the character instead asked "Will it be on the table after I let go?" In each condition, objects were displayed at different percentages of volume supported by the table, ranging from 10% to 100% supported. Physics dictates that objects with 50% or more of their volume supported do not fall. Participants saw both shapes at each percentage of volume supported once, for a total of 20 trials. Data are shown in Figure 1. Age was a significant predictor for response ($\beta=-0.468$, $SE=0.215$, $p=0.030$), with adults having more categorical responses than children across both conditions. Condition, however, was not a significant predictor for either adults' or children's responses ($\beta=0.128$, $SE=0.211$, $p=0.544$); responses over condition largely overlapped for both groups. Stimuli that received a "no fall" response in the Physics condition also received a "yes on" response in the Language condition. For adults, these judgments predominated at 60% and greater volumes of support. Children required larger volumes of support than adults (roughly 90%) for both "no fall" and "yes on" judgments. Judgments were also affected by shape for both children and adults across both conditions ($\beta=-0.662$, $SE=0.136$, $p < 0.001$), with the L-shape eliciting more conservative judgments than the cube. That is, children and adults required the L-shape to be more supported than the cube to make "no fall" or "yes on" judgments. These results provide evidence for two important conclusions. First, although prior evidence suggests children as young as 13 months can make accurate predictions about support relations, our results suggest children's explicit judgements of physical support are more conservative than one might expect. Second, both children and adults show a close mapping between their physical knowledge of support and their linguistic labeling, suggesting that the former serves as a foundation for the latter.

P3-G-119: Probabilistic reasoning triggered by verifiability in preschoolers

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Numerous foraging situations require taking into account distributions. Reliance on distributional cues however may manifest in a surprising form of ecological rationality. In situations where observers have to formulate a prediction on the basis of observed possible outcomes (e.g., picking a ball from a bag of 10 green and 5 yellow balls), instead of always formulating a preference for the group making up the majority of the observations (expected utility maximization), the ratio of their guesses will match to the ratio of the possible outcomes



(probability matching). Probability matching is not only attested in the case of human adults and infants (Vulkan, 2000; Davis, Newport and Aslin, 2011), but also in that of various non-human species (e.g., Greggers and Menzel, 1992, Behrend and Bitterman, 1961, a.o.) which might hint that the strategy is robust enough not to be interrupted by developmental factors. In this contribution we explored whether in a similar guessing task children also deploy strategies motivated by extra probabilistic factors. Specifically, we propose that preschool age children express a higher propensity to commit to a probability matching strategy if they have a chance to verify their prediction. In our experiment 4- and 5-year-olds were introduced to a set of items consisting of two types of tokens with different cardinalities (e.g., 10 houses and 5 flowers). After these items were hidden in a bag, participants had to draw one item without looking and guess what is inside their hand. Participants were exposed to a series of trials such that at certain pre-established trials, we revealed that they will have a chance to verify their response by checking whether their guess was correct. Contrary to the documented cases of probability matching in the literature with this age group (e.g., Denison et al., 2010), our data suggests that children do not always commit to a probability matching strategy when they have a chance to formulate a prediction. Instead, we found that participants were more likely to match their predictions to the dominant partition of the sample on those trials where we notified them in advance that they will have a chance to check their prediction. This raises the possibility that children at this age invoke probabilistic inferences selectively, giving advantage to cases where they have a chance to verify and thus attune their predictions.

P3-G-120: Infants' understanding of overarching goals as constraints on action

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Many of our everyday actions are driven by overarching goals, such as reaching for a pen to write down a phone number. Infants tend to interpret reaching actions as goal-directed, expecting an actor who selects one object over another to pursue the same object goal later on (Woodward, 1998). Can infants interpret a selective reach as a sub-goal of an overarching goal? Research has shown that contextual factors can influence infants' goal attribution, for instance: information about the agent's perceptual access (Luo & Baillargeon, 2007), the environment (Sommerville & Crane, 2009), and the action sequence in which the reach is embedded (Sommerville & Woodward, 2005). Here, we investigate whether infants consider the context of a possible overarching goal when interpreting an actor's selective reach for an object. In Study 1, we replicated the finding that infants attribute an object goal when an actor selectively reaches for one object over another (Woodward, 1998), using functional objects. Sixteen 11-month-old infants were habituated to an actor reaching for a cup or spoon. When the objects switched locations in test, infants looked longer in the first pair of test trials when the actor reached for the new object than the old object ($p=.025$). In Study 2, we asked whether contextual information suggesting an overarching goal would influence infants' interpretation of the actor's selective reaching. Infants first saw familiarization events in which the actor used each object with a corresponding context object (i.e., the spoon with a bowl to eat, the cup with a teapot to drink). Habituation was identical to Study 1 except that the actor reached for the cup or spoon in the presence of its corresponding context object. In test, the context object was removed. Infants looked equally whether the actor reached for the new or old object



($p=.516$). Thus, infants did not attribute an object goal to the actor following the change in context. In Study 3, we investigated whether infants consider the actor's construal of the scene when making goal attributions. The procedure was identical to Study 2, except that in habituation the corresponding context object was hidden from the actor (but visible to infants). In test, infants looked longer when the actor reached for the new object than the old object, ($p=.032$), as in Study 1. Thus, infants do not cancel their goal attributions whenever there is a change in context; rather, they recognize that the actor must have visual access to contextual information for it to influence her behaviour. Our studies show that although 11-month-olds can attribute object goals to an actor based on her selective reaching, they no longer do so when contextual information visible to the actor is removed from the scene. Infants may have inferred an overarching goal (e.g., eating) which constrains the actor's reaching (e.g., to the spoon). In ongoing research, we are examining whether infants attribute a person-specific overarching goal, or whether they use their own prior experience and an understanding of object affordances, to interpret the actor's behaviour.

P3-G-121: The effect of mother on infant engagement with toys during play

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An increasing literature has revealed the role of parents in directing infants' attention and facilitating their learning. Much of the existing work has focused on parent-child interaction during late infancy and toddlerhood, with a goal of understanding early language learning (Yu & Smith, 2012). Here we examined the effect of parent on play in 6-month-old infants ($N = 87$) to understand the origins of these effects. Infants were recorded as they played with four toys for two 90-s sessions, separated by about 15 min and unrelated tasks. Infants could receive "solo play" sessions (in which parents were instructed to refrain from interacting) or "parental play" sessions (in which parents were encouraged to play with their infants), and were randomly assigned to receive two solo sessions, two parent sessions, first a solo and then a parent session, or first a parent and then a solo session. Parent and infant toy-specific touching durations were coded using Datavyu, allowing us to test the hypothesis that parental behavior impacts infants' toy interaction. Recently, Wass et al. (2018) highlighted the role of parental scaffolding in exogenous attentional control between solo and joint play in 11-month-old infants, showing, for example, that parental scaffolding mitigated the role of attentional inertia in infant behavior during joint play sessions. We coded duration of touching each of the four toys (because infants could touch more than one toy at a time, the total touch duration could be greater than 90 s). During parental play sessions, we also coded the duration of maternal touch to each toy. Infants' toy preferences differed during solo and parental play (see Figure 1). Specifically, when infants played alone, they touched the "box" toy more than when they played with their mother. This was consistent with the observation that mothers had different preferences than did infants (i.e., they touched the "worm" more than the other toys). If maternal preferences influence infants' attention, we should see differences in how infants distribute their attention (i.e., touching) during solo and parental play. Comparison of initial solo versus initial parental play sessions revealed that 6-month-old infants touched the toys less during parental play than during solo play, $t(85) = 2.22$, $p < .03$, $d = .48$, likely due to the structuring nature of caregivers in developing infant's sustained attention. More importantly, maternal influence on attention was sustained even when the infants played alone in a



subsequent session. Comparison of the two groups of infants who played alone in the second session (half whose session 1 was solo play, and half whose session 1 was parental play) showed that infants played more with the ring toy in their second session if they first experienced parental play if they first experienced solo play, $t(45) = 2.53$, $p = 0.01$, $d = .74$ (see Figure 2). Thus, parental direction shapes child preferences. In summary, the kind of maternal scaffolding observed in older infants and toddlers in previous studies has its origins by 6 months.

P3-G-122: Infants prefer novel to familiar musical experiences

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Musical preference is influenced by many factors. Social psychologists have found that music listeners tend to prefer music with prior exposure (Meyer, 1903). Mechanism driving infants' preference, however, might be different from the one behind adults' decision because of their still developing processing skills in understanding music. To investigate this question, we tested infants whose experience with music is still relatively limited. Using the Headturn Preference Procedure, we tested infants' preference for German and Korean traditional songs played by cello and haegeum. 38 Korean infants between the age of 9 and 30 months participated in the study. Mothers of participating infants answered questions designed to gauge infants' exposure to music. A cellist and a haegeum player each played 5 German and 5 Korean songs. Four types of 20-second stimuli were generated by combining the ethnicities and instruments. Infants were first presented with two practice trials containing a 350Hz sine wave. They were then presented with the test stimuli containing one of the four types of musical pieces. An experimenter outside the experiment recorded the child's looking time online. We constructed mixed-effects regression models. The dependent variable was infant's looking time. We first ran a model with instrument, origin, trial number, and age as fixed factors, and participant and the song as random factors (formula: $l_t \sim \text{instrumentC} * \text{originC} \text{trialnumC} \text{DayC} (1 | \text{NewID}) (1 | \text{song})$). We found a significant main effect of all fixed factors except the ethnic origin of the music. The significant effect of instrument indicates that infants listened longer to haegeum than cello. In a subsequent analysis where we included additional factors such as exposure to music or instrument, however, it turned out that the effect of exposure has a significant effect in explaining infants' preference for music. There was a significant effect of exposure to Korean music such that ones with more exposure had lower looking times. There was also a marginal interaction of exposure and instrument such that those with low exposure had longer looking times to the haegeum. Exposure to Western music was also significant in a 3-way interaction. The interaction was such for those with no exposure to Western instruments, looking times for Korean music was the same for each type of instrument but for Western music there was sig. more looking time to the haegeum. For those with exposure to Western instruments, looking time for Korean music was significant such that there were longer looks to the haegeum, but looking time for the two instruments for Western music did not differ. Overall our results point to the novelty bias for infants' music preference, which is somewhat different from the familiarity preference claimed for adult's music preference. We could find the answer in the changing developmental needs for learning and appreciation of music. Even musically untrained Western adults have implicit knowledge of Western musical pitch structure. However, 6-8 month old infants do not (Lynch, et al., 1990).



Therefore, any emotional reactions infants experience when listening to music cannot be based on musical-system specific pitch structure. What seems like infants' preference for own ethnic music is due to less amount of exposure to own music rather than engrained culture-specific bias.

P3-G-123: From motivation to action: The role of social-cognitive competencies in early helping behaviors

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A variety of recent evidence suggests that infants are prolific helpers: they appear to be eager to assist others in meeting their instrumental goals. However, the motivation underlying infants' helping behavior is not yet fully understood. Some evidence supports the notion that infants detect and utilize others' needs to guide their helping behavior but other work suggests this ability may be somewhat fragile early in life. In the current experiments, we investigated infants' ability to detect others' subjective needs. We asked whether infants could select items to help others on the basis of others' internal states. The majority of research on infants' helping behavior has focused on infants' ability to help others meet their instrumental goals. Determining the degree to which infants can help others to meet their internal needs or goals is an interesting area of investigation as internal goals are more abstract than instrumental goals. We tested 24-month-old infants in two experiments designed to investigate their ability to identify others' subjective needs and use others' subjective needs to guide their helping behavior. In Experiment 1 (N = 30), an actor was playing a shape sorting game with an infant when she became either thirsty or cold. The actor asked the infant for help while reaching ambiguously toward a drink and a blanket. Infants brought the needed item at rates above chance, 22 of 30 infants, $p = 0.02$, binomial test. These findings suggest that infants were able to help with the needed item in situations under which subjective needs were quite distinct. In Experiment 2 (N = 33), an actor was playing the same game, when she became either hungry or thirsty. The actor asked the infant for help while reaching ambiguously toward a snack, a drink, and a shoe. Only 14 of 33 helped with the needed item, $p = 0.272$, binomial test (see Figure 2), suggesting that infants' selection of items was not influenced by the actor's particular subjective need. However, follow-up analyses revealed that infants never brought the distractor item (0/33), raising the possibility that infants' helping may have been driven by the thematic relationship between the items and the actor's need, and suggesting that the mere presence of a third response item did not diminish infants' performance. These findings suggest that at two years of age, infants may be able to help individuals by bringing objects that meet their subjective need, but only when subjective needs are quite distinct from one another. When subjective needs are closely related, infants appear to struggle with bringing an individual the correct item. Together with prior findings, our results suggest that infants' ability to identify others' needs, and use these needs to guide their helping behavior, may hinge on the type of need that the recipient possesses. In ongoing work, we are investigating the scope of needs that infants are sensitive to, and how infants weigh the needs of others against the personal costs to the self.



P3-G-124: Novel predictors of women's social cognition about infant crying: Sleep, working memory, and inhibitory control

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Prior research has demonstrated that maternal social cognition about infant crying is a unique predictor of sensitive responding to infant distress, and that such social cognition is rooted in part in maternal emotional and personality traits (Leerkes et al., 2015, 2016). Others have demonstrated the importance of sleep (Bai et al., 2019) and executive function skills such as working memory and inhibitory control in relation to parenting outcomes (Deater-Deckard et al., 2010; Sturge-Apple et al., 2017). The goal of this study is to integrate these lines of work to determine if women's sleep, working memory, and inhibitory control predict their social cognition about infant crying over and above demographics, emotional risk, and personality characteristics in a convenience sample of female college students. 109 female college students completed questionnaires via Qualtrics including demographics, the Difficulties with Emotion Regulation Questionnaire ($\alpha = .83$), and the agreeableness and conscientiousness subscales of the NEO which were averaged to yield a measure of positive personality ($\alpha = .83$). Then, they visited the lab. Upon arrival, women completed a form including how they long they slept the night before versus on a typical night to construct an index of current sleep deprivation. Next, they completed computer-administered working memory and inhibitory control tasks. Later, they viewed four 1-minute long video clips of crying infants. After each video, participants rated their emotional reactions, noted the specific emotions expressed by the infant, and rated how much they agreed with various causal attributions about why the infant was crying. Two factors were created from these measures: infant-oriented cry processing reflecting high empathy, sympathy, accurate cry detection, and causal attributions focused on the difficult nature of the situation ($\alpha = .83$) and self-oriented cry processing reflecting high self-focused anxiety and frustration and causal attributions that were negative or minimized the emotional nature of crying ($\alpha = .83$). Results from two multiple regressions are summarized in Table 1. Consistent with prior research, age and positive personality predicted higher infant-oriented cry processing; and less prior experience with infants and more emotion regulation difficulties predicted higher self-oriented cry processing. Notably, working memory was a significant predictor of higher infant-oriented cry processing over and above demographic covariates and emotional/personality characteristics. In contrast, sleep deprivation and inhibitory control were unique predictors of self-oriented cry processing such that self-oriented cry processing was higher among women who were more sleep deprived and lower among women with better inhibitory control. These results suggest that sleep and executive function may play an important role in parenting outcomes by virtue of the impact they have on social cognition. It may be that the ability to hold more knowledge in mind facilitates the perspective taking necessary to support infant-oriented cry processing. Being well-rested and able to inhibit prepotent responses may reduce the likelihood of experiencing negative emotions and making negative causal attributions when faced with crying. An important next step is replicating this work with parents and testing direct and indirect effects in relation to observed parenting.



H-Social Development

P3-H-125: Maternal perception of infant cry when living in an armed conflict zone

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Infant cry (an auditory signal) is instinctive infant communication that evokes parental care. However, crying may also evoke a sense of panic and urgency, increase parental stress levels, and sometimes affect the way parents behave toward their infants. With this in mind, we questioned how parents who live in an armed conflict zone would perceive infant cry. For example, people that live in the Gaza vicinity of Israel are exposed to missile alarms (an auditory signal of danger) that inform them of a danger requiring immediate action (e.g., getting their children to a shelter within 15 seconds). As a result, the auditory modality of people living in this area is heightened, and people are cued to any sound that is reminiscent of an alarm. Because infant cry is like a "human alarm," would mothers living in the Gaza vicinity be more susceptible to infant cry and would they interpret it differently than mothers living in safer places? We hypothesize that (1) mothers living in this area would have greater difficulty hearing their infants cry compared to mothers living in less stressful areas and (2) maternal perception of infant cry would be linked to maternal reaction to that cry. Ninety-nine mothers were recruited from two different areas in the southern district of Israel (high and low exposure to missile alarms). The high exposure group included families living in the Gaza vicinity. In the low exposure group, people lived in an area exposed to substantially lower numbers of missile alarms and had 60 minutes to get to shelter once the alarm was heard. Data were collected in home visits in which mothers completed a computer-administered task (RICAS) assessing maternal perception of infant cry. Mothers listened to five 30-second audio recordings of infants crying in varying intensities and tones followed by different statements regarding the cry. For each statement, mothers rated how much they agreed/disagreed with the statement (e.g., "It was difficult to tolerate the sound of this cry"). Two factors were found: 1) Difficulty hearing the infant cry and 2) attribution of distress level to infant cry. Next, maternal reaction to infant cry was assessed by asking mothers to watch a video of an infant crying and indicating when they would intervene (IDICV task). Results showed that mothers from the high- (vs. low-) exposure group reported higher sensitivity to infant cry, as reflected by reporting greater difficulty listening to infant cry, [$t(97) = -2.41, p < .05$]. Additionally, for the entire sample, a significant negative correlation existed between maternal attribution of distress level to infant cry and time taken until intervention in the video task, [$r = -0.289, p < .01$]. These results suggest that mothers who are highly exposed to auditory signals of danger (e.g., missile alarms) develop an oversensitivity to auditory signs, such as infant cry. Furthermore, a mother's perception of the urgency of the cry seems to affect her behavior toward the child. Implications of this link will be discussed, focusing on possible risks for child self-regulation and behavioral problems.

P3-H-126: Gotta gotta get up, to get down: Parents dynamically upregulate their own arousal to help their child downregulate their arousal



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When we see someone experiencing an emotion, and when we experience it ourselves, common neurophysiological activity occurs. But although inter-dyadic synchrony, concurrent and sequential, has been identified, its functional significance remains inadequately understood. Specifically, how do the influences of partner A on partner B reciprocally influence partner A? For example, if I am experiencing an affective state and someone matches their physiological state to mine, what influence does this have on me - the person experiencing the emotion? Here, we investigated this using infant-parent dyads. We developed miniaturised microphones to record spontaneous vocalisations and wireless autonomic monitors to record heart rate, heart rate variability, and movement in a cohort of 84 12-month-old infants and their parents. Day-long recordings were obtained 'in the wild' in naturalistic settings, without an experimenter being present. Overall, our results from cross-correlation analyses suggested that infant-parent autonomic activity did not significantly co-fluctuate across the day ($p=.15$). However, when we examined the 'high points' of infant arousal - as defined either by identifying the times within the day when infants showed the highest arousal, or by identifying infants' most intense naturally occurring positive or negative affect vocalisations - we found that parents did show significant responsivity to 'peak' infant arousal moments. Bootstrapping analyses suggested that parents showed significant responsivity to peaks both in infant positive and negative affect ($ps<.001$), but stronger reactivity to infant negative affect. Linear mixed-effects model analyses suggested that instances, where the adult showed greater autonomic responsivity, were associated with faster infant quieting ($p<.001$). Our results also suggested that how parents respond to their child's 'peak' arousal moment varies contingent on context. When the initial arousal level of the parent is low, the parent increases their own arousal in response to their child's arousal - matching their own arousal state to their child's; but when the arousal level of the parent is high, the parents respond to increases in the child's arousal in the opposite way - by decreasing their own arousal. This suggests that adults employ diverse tactics to maintain allostasis within the dyad - dynamically connecting, or disconnecting, their own level of arousal from their child's. Our findings suggest that autonomic state matching has a direct effect on the person experiencing the affective state and that parental co-regulation may involve both connecting, and disconnecting, their own arousal state from that of the child contingent on context.

P3-H-127: Anxious parents show higher physiological synchrony with their infants

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Parental anxiety is a risk factor for a number of outcomes, including child anxiety, in offspring, but research into the intergenerational transmission of anxiety has not historically focused on infant populations. Furthermore, virtually all previous research has involved either questionnaires, or small doses of 'best behaviour' interactions observed in the lab. Here, we



examined how affective and physiological states covary between infants and parents in naturalistic settings. We used miniaturised microphones and cameras, and wearable physiological monitors, to record vocalisations and day-long physiological fluctuations in 82 12-month-old infants and their parents. Participating parents completed a clinical self-rating of anxiety (the GAD-7). Our results suggested that parents with lower self-rated anxiety scores ('low GAD-7') showed reactive autonomic changes to moments of 'peak' arousal from their child, but did not show autonomic responsivity to their infant apart from that. In low GAD-7 parents, negative time-lagged associations were observed between parent and infant autonomic activity, suggesting disconnections between the parent's and the infant's autonomic arousal. When comparing how parents reacted to moments of 'peak' arousal from their child, no difference was observed between 'low GAD-7' and 'high GAD-7' parents. But when comparing how parents reacted to more small-scale, minor fluctuations in their child, a significant difference was observed: 'high GAD-7' parents showed greater reactivity to small-scale changes in their child. Consistent with this, we found that, for 'high GAD-7' parents, infants' levels of autonomic arousal more strongly predicted parental levels of autonomic arousal throughout the day. Our findings have implications for understanding the differential processes of physiological regulation in anxious and non-anxious partnerships. They may help us in the process of informing intervention strategies for dyads needing support for elevated levels of anxiety. Preliminary data from a new study replicating the above protocol within inpatient and outpatient perinatal mental health services in the UK National Health Service is presented to extend discussion of the clinical applications of this research.

P3-H-129: Parental guidance and toddlers' object learning

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Children learn about objects in their environment early in development, and much of this learning occurs via informal caregiver instruction. However, little is known about the features of instruction that support learning or how caregiver instruction at home affects children's learning from other teachers. Caregivers may structure teaching or provide particular kinds of guidance that enhances their instruction, including offering praise. However, praise might have conflicting effects on children's learning. Praise enhances motivation in the classroom (e.g., nongeneric praise; Zentall & Morris, 2010). Yet, praise can also decrease task persistence (e.g., mothers' person praise; Pomerantz et al, 2013). Caregiver praise can then affect children's performance within a task but also carry over to other learning situations, perhaps in ways similar to the overjustification effect -- that is, if children are motivated to reach an extrinsic goal (such as receiving praise), their intrinsic motivation can be reduced (Lepper et al, 1973). The present study sought to understand how different elements of parental naturalistic teaching, including praise, affect children's object learning. Here, we examined how different aspects of parental teaching affected 22-26-month-olds' object learning. 48 toddlers were taught to build one novel, multi-step toy by a caregiver for up to five minutes, and were then taught to build two toys by an experimenter. Children were then tested on their learning of all toys. Parent guidance during teaching was coded by transcribing and categorizing parent utterances, and parent and child actions were also coded to assess the extent to which the child "drove" the interaction (measured as the proportion of steps completed by the child relative to the parent). A separate measure of child skill (Bayley



Cognitive Scale) was used as a control in analyses. Initial results (N = 42) showed that more praise was associated with marginally more proportional child steps during teaching (B = 0.011, SE = 0.006, p = 0.065), demonstrating that parents who praise children have children who "drive" the interaction to a greater extent. However, more parent praise during teaching was also related to lower test scores on the experimenter-taught toys (B = -0.017, SE = 0.007, p = 0.022), suggesting that parent who offer praise when they teach may have children less able to learn when taught by another teacher. Since there was minimal assistance and no praise during test, these results could be due to "praise seeking" -- parental praise acting as an extrinsic reward, reducing children's intrinsic motivation to perform the task without praise at test. Praise, while locally useful in promoting child action, could thus be harmful globally in situations where praise is absent. Additional coding is underway to examine other elements of parent teaching including categorizing types of praise as well as coding parent gesture, physical assistance, and other utterance categories. Results from this study have implications for understanding the conditions under which successful and motivated learning occurs, both experimentally and in everyday interactions with caregivers.

P3-H-130: Developmental origins of human unique rhythmic coordination: Examination in 18- to 42-month-old children

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Musical behavior, such as singing a song or dance, is one among the human unique features. Comparative studies on chimpanzees and humans demonstrated that there are both similarity and difference on a fundamental ability for the musical behavior, referred to as rhythmic coordination: The ability to adjust one's own tempo of the movement to match with those of others is shared between chimpanzees and humans, while the adjustment is more rapid and complete in humans in comparison with the chimpanzees (Yu et al., 2018). In the current study, we aimed to examine a developmental process of this human unique ability on rhythmic coordination in children. Three age groups were targeted: 18 months of age (n = 17, mean = 18.25 months), 30 months of age (n = 17, mean = 30.14 months) and 42 months of age (n = 17, mean = 42.44 months). We introduced a joint drumming task from Kirschner & Tomasello (2009) to produce repetitive and rhythmic movement from the children. Vibration sensor attached inside the drum and video camera recorded the children's drumming responses and other musical behaviors, respectively. All the children drummed under four conditions: Two Partner (social or non-social) × Two Music Speed (400 or 600ms ISI) condition. In the social partner condition, the children drummed with their mom who was trained to drum along with the designated music speed. On the other hand, in the non-social partner condition, the children drummed with an arm-robot. Among the two speed conditions, 600ms ISI was a test condition, and 400ms ISI was a baseline condition because it was close to the children's spontaneous motor tempo. In line with the previous study, our results suggest that the human unique ability on rhythmic coordination develops between 18 and 30 months of age and the adjustment accuracy was higher when the children drum with their mother. On the poster presentation, I would like to discuss about possible developmental process of the rhythmic coordination with concerning joint attention behavior and other musical behaviors shown by the children during the drumming task.



P3-H-131: Neural and behavioral correlates of ostensive cues in naturalistic mother-infant interactions

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To engage in Joint Attention (JA), that is attending to the same object together with another person while being mutually aware of it, is a crucial ability helping infants to focus on socially relevant information in the environment. JA develops at around 6-9 months of age. In a controlled laboratory experiment JA, operationalized as an interaction including mutual gaze, enhanced 7-month-olds' object encoding (Cleveland, Schug, & Striano, 2007). However, it remains unclear if this promoting effect also occurs during natural parent-child interactions, which specific aspects of an interaction account for it and what is the neural foundation. The Natural Pedagogy account states that besides mutual gaze, other ostensive cues like infant-directed speech promote social learning (Csibra & Gergely, 2006). One promising neural correlate of this state of facilitated information encoding is theta power which is measured via the electroencephalogram (Begus, Southgate, & Gliga, 2015). Here, we investigated effects of ostensive cues on 9-month-olds' object encoding and its neural underpinnings (N=16, 9 female, mean age: 9 months 18 days). During a familiarization phase, mothers presented novel objects to their infants in two different ways: during the JA condition, mothers were asked to act as naturally as possible including infant-directed speech, mutual gaze and calling infant's name. During the No Joint Attention (NOJA) condition, mothers were asked to use adult-directed speech, not to mention their infant's name or look at their infants. Each familiarization lasted until the infant looked at the object for 20s. We subsequently measured infants' object encoding in an object recognition test (see Figure 1 for the paradigm). We hypothesized: (a) Infants show enhanced sustained object-directed attention and (b) look more often to their mothers during JA-familiarization. (c) Theta power (4-6Hz; F3, F4, Fz) during the encoding of objects in the JA-familiarization phase is enhanced. (d) Object encoding is enhanced during JA-familiarization, leading to a preference for a novel object in the object recognition test. Sustained attention was defined as infants' looking time to the object divided by the sum of infants' looking time to the object and the environment. Figure 2 shows the results for hypothesis a to d: As expected, compared to the NOJA (mean=0.77, SD=0.11) condition, infants' object-directed sustained attention was increased in the JA condition (mean=0.84, SD=0.09), $t(15)=2.58$, $p=.021$. Infants spent more time looking at their mothers during JA (mean=4.28s, SD=3.10s) as compared to the NOJA condition (mean=2.45s, SD=2.26s), $t(15)=2.15$, $p=.048$. Unexpectedly, there was no difference in theta power between conditions while infants looked at the object, $t(15)=-1.24$, $p=.233$ and infants' object encoding performance did not differ between conditions, $t(15)=-.55$, $p>.25$. Behaviorally, ostensive cues focused infants' gaze to the object and their mothers. This is in line with results by Wass et al. (2018), who found that jointly playing with their mothers increased object-related attention in infants. We did not find any neural evidence that ostensive cues increase infants' attention. JA did not enhance object encoding. Further analyses will investigate whether specific aspects of the social interaction (e.g. mutual gaze) are related to infants' object processing.



P3-H-132: Investigating developmental trajectories of infants' preference for social interactions

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In a previous study, we found that 9.5- to 11-month-old infants ($n = 20$), but not 7- to 8.5-month-olds ($n = 20$) are attentive to third-party social interactions and that this preference parallels changes in their active social behavior. Our findings were in line with the "9-month-shift", suggesting that the age around 9 months marks a critical period in infants' social cognitive and motivational development (e.g., Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998; Tomasello, 1995). To gain a more comprehensive insight into developmental trajectories of infants' preference for social interactions, we ran a follow-up study in which we extended the initial age groups to a broader and continuous range between 7 and 13.5 months of age ($N = 50$; $n = 19$ female; $M = 316.9$ days, $SD = 58.42$ days). Infants went through the same two experimental phases as in our initial study. First, we presented infants with a preferential-looking task to investigate their preference for third-party interactions. Two videos were presented at the same time: One video showed two adults engaging in social interaction (playing a clapping game, touching their hands, leaning towards one another), whereas the second video showed the same two people performing identical movements while standing back-to-back (non-interactive control). We measured infants' proportional looking time at the social interaction video during 12 randomized trials. Second, we assessed infants' active social engagement while playing with their parent. Based on video recordings of a 5-minute free play session, we coded four infant behaviors (general interest in parent, look at the parent's face, eye contact, joint attention looks). For analyses we integrated the four behaviors in one social engagement score. We hypothesized that if infants' preference for third-party social interactions increases continuously from 7 to 13 months of age, then the proportional looking time to the social interaction videos should increase with age (continuous predictor). Correspondingly, if infants' active social behavior increases throughout the second half of the first year of life, the social engagement score should increase with age. Lastly, we hypothesized that if infants' attentional preference for third person interactions relates to their own active social behavior at the individual level, the two measures should be correlated with one another. Our findings revealed that both infants' preference for others' interactions increased with age ($Beta = .04 \pm SE = .01$, $t(1,49) = 3.73$, $p = .00$), as well as their active social engagement ($Beta = .08 \pm SE = .03$, $t(1,48) = 2.94$, $p = .01$). At the individual level, the two measures were not correlated ($N = 50$; $r(48) = .23$, $p = .11$). We could replicate the finding from our first study that infants' social engagement and orienting increases towards the end of the first year of life. Moreover, in extending our earlier findings, the current results suggest that this increase follows a continuous pattern rather than an abrupt change.

P3-H-133: Is joint attention uniquely human? The need for fair cross-species comparisons

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Human infants start to develop joint attention skills (e.g. point and gaze following) from as early as 6 months old, and from 9 months of age infants engage in joint attention events with caregivers, where attention about an object or event is shared. It has been argued that joint attention is vital for the evolutionary and ontogenetic emergence of complex cooperation and linguistic communication, and indeed the emergence of joint attention may have been the 'small change that made a big difference', having profound downstream effects on human cognition and its uniqueness (Tomasello et al., 2005). The empirical pillars on which such theories rest are, however, surprisingly weak: we know remarkably little about joint attention across species and cultures and the evolutionary origins of joint attention remain obscure. The extent to which engagement in joint attention events is uniquely human remains uncertain, largely due to methodological and definitional differences across species. Definitions of joint attention used in the literature are diverse. Whilst some operational definitions focus on coordination of attention via gaze patterns alone, there is a growing acknowledgement that in order for individuals to share attention about an external entity, they have to engage in some sort of communication with their partner whilst coordinating their attention (e.g. Sipošova & Carpenter, 2019): it is this communication that makes the interaction truly joint. It is claimed that looks of different qualities between two individuals can communicate the presence or absence of sharing intentions in humans (Hobson & Hobson, 2007), but it is not possible to operationally implement such a measure in non-human species, creating a problem for fair cross-species comparisons. We conducted a rigorous test of the idea that humans can reliably distinguish 'sharing looks' from 'checking looks', by asking 32 female raters to categorise looks of pre-linguistic infants towards their mothers filmed during free play as sharing, checking or orienting looks. Overall, we found very low agreement between raters, indicating that humans cannot reliably distinguish checking from sharing looks in infants. We therefore argue that as the quality of look cannot be reliably judged by third party observers, it should not be used as a measure of communication between mothers and infants to distinguish coordinated attention from joint attention. Instead, definitions of joint attention events need to rely on the exchange of facial expressions, gestures or vocalisations as communication that makes sharing attention about an object or event manifest. We take this definition and apply it to our large-scale cross-species and cross-cultural investigation of joint attention development. We will outline the methods we are using in this project, which we hope will allow fair cross-species comparisons and ultimately provide insight into the extent to which joint attention events are unique to humans.

P3-H-134: The moderating and mediating roles of mothers' parenting stress and social support in predicting infant emotional availability

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Biological birth status, and in particular premature birth, has long been considered of great consequence by developmental and health researchers and demonstrated to be a consequential risk factor for healthy development. Those infants, not only born preterm but very preterm (<32 weeks gestation) and/or with a very low birth weight (VLBW; <1500g), are considered at even higher risk for adverse and multiple short and long term developmental



and behavioral outcomes (Delonis et al., 2017; Scott et al., 2018). While abundant research attention has been devoted to cognitive-related processes and intellectual outcomes, few studies have examined the longitudinal impact of birth status on infants' relationships with their mothers and their socio-emotional development. Yet mother-infant relationships form the foundation for children's socio-emotional development and their future relationships. These positive relationships often foster resiliency and protect against adversities throughout children's development (Luthar, 2006). However, the stress of a VLBW birth can bring with it other strains and tensions that may affect the developing relationship. We investigated developmental patterns of such relationships (via Emotional Availability (EA) Scales; Biringen et al., 1988) in fullterm and Very Low Birth Weight Preterm (VLBW/PT) children from infancy to emerging school age in a 4-wave longitudinal design. We previously found that VLBW/PT infants tended to lag behind fullterm infants on levels of responsiveness and involvement with mothers. In the current study we focus on the contributing factors of maternal stress (via moderation) and social network support (via mediation) on such effects. Infant-mother dyads (n=109) were observed in home-based interactions (face-to-face and free play) when infants were 6, 12, 18 and 48-months-old in fullterm (37-41 weeks, >2500g; n=48) and healthy VLBW/PT (26-32 weeks gestation, birth weight 800-1500g, corrected for gestational age; n=61) infants. At each time point, 25% of the sample was double-coded (coefficient range = .82 to .99). At all waves, mothers completed the Social Support Satisfaction (SSS-II; Telleen, 1985) and Parenting Stress Index (PSI; Abidin, 1990). Moderation analyses revealed that mothers who were initially high in distress and low in sensitivity tended to have children who were consistently underinvolved over the course of the study (Fig 1). Results did not differ between fullterm and VLBW infants. Separate mediation analyses revealed that two different stable aspects of mothers' support network mediated the effect of VLBW/PT status on child EA (Fig 2). Mothers of VLBW/PT infants consistently had smaller networks and received less help from others. Both deficiencies then anticipated lower maternal sensitivity when infants were 4 years old. Lower sensitivity was then associated with lower child responsiveness. In a longitudinal study measuring relationship variables in infancy, maternal support and stress served to partially explain how the effect of VLBW/PT birth status on infants' socio-emotional development persisted. Mothers with less distress and more support and who are higher in sensitivity and structuring may counteract the socio-emotional costs to children of being VLBW/PT. Our results have implications for VLBW/PT infants' development, the parent-infant relationship, and integrating family and contextual-environment level factors into early prevention and intervention programs.

P3-H-135: Do infants use synchrony rather than looks as a signal for third-party affiliation?

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Interpersonal synchronous/asynchronous movement has been suggested as a useful signal for infants in evaluating relationships between third-parties. But it is not clear whether both synchronous and asynchronous movement or only (a)synchronous movement is related to inference of affiliation. Some studies have shown infants assume synchronous partners to be affiliated, but not asynchronous characters (Fawcett, & Tunçgenç, 2017). Others suggest that



infants expect asynchronous partners to be non-affiliates but have no significant expectation for synchronous partners (Cirelli, Wan, Johannis, & Trainor, 2018). Importantly, these previous studies used synchronous/asynchronous characters of similar appearance. It is not known whether synchronous movement is more important than the similarity of synchronous/non-synchronous characters' appearance in determining 'in-group' and 'out-group' boundaries. This study investigates whether infants aged 15 months use synchronous/asynchronous movement to infer affiliation of third-parties which are different-looking characters. Thirty 15-month infants were tested by eye-tracking, using a Violation of Expectations (VoE) and social preference paradigm. In the habituation phase, two types of videos were shown twice, each depicting three hand-puppet characters, a duck in the centre and a rabbit on each side. In one, one rabbit sways in synchrony with the duck while the other rabbit sways asynchronously. In the other video, the synchronous/asynchronous action of the rabbits is reversed. The following test session then had two segments. In the 'Pre-approaching' segment, the three hand-puppets first stand still next to each other. The duck then says, "You are my best friend", and approaches and cuddles one of the two rabbits ('Approaching segment'). The infant's looking times at the whole screen and each character were measured during each segment in this test phase. In the VoE situation, the duck cuddles the asynchronous character, while in the expectation (E) situation, the duck cuddles the synchronous rabbit. In the Approaching segment, the results show that 15-month-old infants looked marginally significantly longer at the VoE situation [$t(29)=1.60$, one-tailed $p=.061$, Fig 1]. However, as Fig 2 shows, in the VoE situation, the difference in looking time at each rabbit (Non-synchronous - synchronous characters) was significantly larger than in the E situation [$t(29)=2.22$, one-tailed $p=.017$]. Also, only in the VoE situation, the difference was larger than the chance level [$t(29)=2.24$, one-tailed $p=.019$]. This suggests that infants expect asynchronous partners to be non-affiliates, but with violation of expectation they looked at the VoE situation, and especially at the non-synchronous character cuddling the duck. In the Pre-approaching segment, there was no significant difference between time of looking at synchronous and asynchronous characters (Fig. 1 & 2), suggesting that infants have no significant preference for synchronous characters. This is a different result from the previous study (Fawcett, & Tunçgenç, 2017), which showed the synchronous character was preferred when the same animal soft toys were used. We conclude that synchrony, in particular asynchronous movement can be used to infer third-party affiliation, even when the characters have different looks. Our results suggest asynchrony could be a more important cue than appearance when infants make inference about third party affiliation.

P3-H-137: Exploring emotion discrimination in 5-month-olds: The relation with quality of parent-child interaction and spatial frequencies

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It is unclear whether infants can discriminate emotions at five months of age. Previous research suggested that individual differences in emotion discrimination relate to the quality of parental behaviour as observed during parent-child interaction or as reported by questionnaires (Bornstein, 2011; de Haan et al., 2004; Taylor-Colls et al., 2015). However, these studies focussed mostly on parental behaviour and did not investigate effects of infant behaviour nor the effects of dyadic quality of interaction. In addition, for those infants that can discriminate



between facial emotional expressions, the spatial frequencies used can inform about the neural pathways involved in this ability (Johnson, 2015). At 10 months of age, infants show differential responses to emotions when a face contains higher (HSF; related to processing of detailed information), but not only lower frequencies (LSF; related to processing of global configuration of a face) (van den Boomen et al., 2019). It is unknown whether 5-month-old infants show differential responses to emotions when specific spatial frequencies are available. The current study investigated whether at five months of age infants (N = 43) show differential brain activity between emotions. Brain activity was measured using electroencephalography (EEG) while infants viewed faces with fearful or neutral expressions. Furthermore, we explored whether the spatial frequency content of the face affected neural responses. Therefore, faces were filtered to contain either LSF or HSF information (figure 1). Analyses were conducted on mean activity of Event Related Potential (ERP) components that are typically associated with emotional face processing in infants: N290, P400 and Nc. Finally, we explored the relation between emotional face processing and parent, child, and dyadic qualities of interaction. Parent-child interaction were assessed with the Manchester Assessment of Caregiver Infant Interaction (MACI; Wan et al., 2016). The results show that at the group level none of the ERP components differed between emotional expressions and there were no interactions between emotion and spatial frequency (all $p > .05$). However, when splitting the group based on median MACI scores, infants who showed high quality of interaction (i.e. more attentiveness to caregiver, positive and negative affect, and liveliness) showed differential responses between emotions at the N290 ($p = .009$), whereas infants who showed low quality did not ($p = .169$). The same pattern was observed at the P400, although the results were not significant (interaction between infant score and emotion: $p = .096$). There were no other interactions of the PCI scores with emotion or emotion and spatial frequency at the N290, P400, or Nc (all $p > .1$). These findings indicate that a subgroup of infants show differential brain activity between emotional faces at five months of age, which seem to relate to quality of their behaviour during the parent-child interaction. That is, only those infants with high quality of interaction seem to show differential brain activity evoked by fearful versus neutral faces. These findings have important consequences for early detection of infants with suboptimal quality of interaction, who might be at risk for development of reduced social skills.

P3-H-138: Infant attention, movement, and socio-emotional responses to live musical performances in a group context

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Musical interactions between parents and infants are widespread and have demonstrable effects on infant affect, behavior, and physiology. However, music is often experienced collectively, and little is known about how infants respond to musical performances in a group context. In the present study, a large group of parent/infant dyads watched a "Baby Opera" composed for infants and performed by professional musicians while their attention, behavior, and affective responses were recorded. Fifty infants (6 months to walking) watched a live performance including a lullaby and a playsong. All dyads watched passively (parents asked to avoid interacting musically with their infant) and actively (parents asked to interact with their infant musically), with order of presentation counter-balanced for song type (lullaby or play song) and social context (passive or interactive). Results suggest that play songs captured



infant attention to the show ($p < .001$), while lullabies encouraged infants to direct attention to their parent ($p = .014$) and others around them ($p = .004$) regardless of the social context. Play songs elicited more positive affect than lullabies ($p = .003$), particularly in the interactive condition. Infants and parents moved together more in the interactive than passive condition ($p = .015$), indicating that parents followed the experimenter instructions. Surprisingly, however, infants initiated movement by themselves most often in the passive condition ($p = .001$). Overall, results suggest that song type affects infants' attention and affect in group settings, and that the interactive context additionally modulated their affect and their interest in initiating movements. These studies provide the first investigations of group dynamics in infants' attention to live music in social contexts with high ecological validity.

P3-H-139: Parenting beliefs and behaviours in Canadian mothers of diverse backgrounds

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Examining parents' own beliefs about their parenting is important since beliefs affect parents' sense of self and their interactions with their children. Research indicates that parents who perceive themselves to be efficacious caregivers tend to have a warmer parenting style and to be more sensitive to their infants (de Haan, Prinzie, & Dekovic', 2009). Conversely, engaging in unrealistic and/or negative attributions about their child and holding the child responsible for challenging behaviours (i.e., child causal attributions; CCA) has been related to overly reactive parenting behaviours and negative parent emotions (Shai & Belsky, 2011). Despite the documented role that parental attributions (PA) and parenting self-efficacy (PSE) play in influencing quality of parenting, the relationship between these parent characteristics, and how these characteristics interact to impact parenting, has seldom been studied in parents of infants. Furthermore, even less is known about the interactions of PSE and PA across cultures, for example individualistic vs. collectivist cultures (Kulich & Zhang, 2010). In Canada, Chinese Canadians (CC), one of the most prominent groups of immigrants, are characterized as endorsing collectivist values: Chinese cultural norms are generally based on interdependence, with members endorsing in-group harmony and cohesion over individuality, and this is reflected in parenting beliefs and practices. In contrast, the parenting style used by European Canadians (EC) may be more focused on self-development and fostering autonomy (Keller, 2007). The current study compared the relationship between parenting beliefs and behaviours in CC and EC mothers from Toronto, Canada. 175 culturally diverse mother and infant dyads were recruited from community agencies and immigration and settlement centres. Through correlations and regression analyses, this study examined the relationships between parent attributions regarding child behaviour and PSE in a sub-sample of mother-infant dyads from two distinct cultural groups: CC ($n = 37$) and EC ($n = 50$). Findings reported in Table 1 showed that: 1) CC mothers make more CCA for misbehaviour; 2) CC mothers showed lower PSE; 3) cultural background was found to moderate the relationship between PSE and CCA (i.e., lower PSE predicted higher CCA more strongly among CC mothers than EC mothers). Exploratory analyses of the entire (multi-cultural) sample reported in Table 2 further examined the influence of child and maternal age on maternal sensitivity and PSE for the overall diverse Canadian sample and for the two cultural groups: 4) higher child age predicted higher maternal



sensitivity for the diverse Canadian sample and for the CC group, and higher maternal age predicted higher maternal sensitivity for the diverse Canadian and the EC sample approached significance; 5) higher maternal age predicted lower PSE for the diverse Canadian and the EC sample. The current findings further our understanding of the relationship between parental beliefs and behaviours, the influence of child/maternal age on each of these factors, and suggest that cultural norms and conventions may affect parents' perceptions of infant behaviour and evaluations of their own parenting capabilities. There are potential implications for the delivery of culturally sensitive mental health services for infants and mothers.

P3-H-140: Beyond the dichotomy: A new self-report instrument to quantify gender as a continuous construct

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Gender can be expressed in different ways. On the one hand, a person's gender identity is defined by perceptions regarding their own gender. On the other hand, gender identity is defined as how a person expresses their own gender. These two aspects of gender may or may not be correlated each other. Indeed, people with the same gender identity may vary vastly in degree of their expressed masculinity or femininity. Despite this fluidity in gender expression, gender is commonly used as a binary factor psychological research. Indeed, research shows important gender-related differences. For example, differences exist between mothers (female) and fathers (male) with regard to their communication and socialization behaviors when interacting with their own children (e.g., Rowe, Coker, & Pan, 2004). However, it is possible that a dichotomous gender factor may miss more nuanced differences that could explain behaviors of females and males better. Therefore, there is a need to quantify gender in a more continuous fashion and to move beyond a simple dichotomy. The current study introduces the Experiences, Perceptions, and Interests Questionnaire (EPIQ) to address these issues. The EPIQ was created to quantify individual differences in gender-related domains. Specifically, the EPIQ assesses experiences with caring for children, perceptions toward gender stereotypes and roles, and interests in gendered activities. In this initial study, 167 adult undergraduate students (70 female) were assessed using the EPIQ. An exploratory factor analysis (EFA) confirms the theoretically motivated three-factor structure of the EPIQ (Experiences, Perception, Interests). Further, SEM analysis testing for an overall dichotomous structure of the EPIQ (male vs. female) reveals a poor fit of the data ($\chi^2=1553.26$, $p=.000$). This indicates that that the EPIQ is quantifying a gender as a continuous construct rather than assessing an underlying dichotomous structure of gender. In summary, the EPIQ is an appropriate measure of gender expression in young adults, and may have predictive utility above and beyond dichotomous, male/female gender. Future research studies on the effects of gender in various settings, including but not limited to developmental science, may benefit from using the EPIQ in addition to the traditionally used dichotomous gender classifications. Examples of applications for the EPIQ in developmental research will be provided.

P3-H-141: Sharing food with infants

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In this poster we would like to explore the question how food is shared with infants among the Hadza in Tanzania, a cultural community that traditionally lived off hunting and gathering. The Hadza have previously been characterized as "central place provisioners" (Marlowe, 2006), that is they go out to hunt or gather and return with (some of (Berbesque et al., 2016)) the food to share it with other members of their group. The sharing among the adults is not strictly speaking voluntary (e. g. Marlowe, 2006): - persons try to hide food from others so they don't have to share - sometimes significant amounts of the food are eaten before they reach the camp - food is shared on demand or by tolerated theft. Arguably, it might be difficult for small infants to receive sufficient amounts of food if others do not provide them with it (although Hadza children are extraordinary in the amount of food they manage to supply for themselves; Crittenden, 2016). In this study we analyzed situations in which infants were eating to determine 1. how active they are in receiving and eating food 2. how their interactional partners react to their bids for food and independent eating 3. how they share and whether sharing is encouraged Participants were 20 Hadza infants between the ages of app. 6 and 27 months who were video-recorded in at least one eating situation with their interactional partners. The videos were analyzed qualitatively. 1. Preliminary results suggest that whether or not a child is active in obtaining food depends on the desirability of the food and the interactional partners that they are with. For instance the same child may be completely uninterested in eating the main meal but cry to receive salt. Or a child who eats independently with her main caregiver seems passive and hardly able to eat on her own when hand fed by another caregiver. 2. It seems that particularly the infants' primary caregivers are unobtrusive in their reactions. At first sight, they do not seem to be very responsive (and actually sometimes are not, such as when a dog comes and steals a child's food while the mother does not notice) but at a closer look some are very involved and responsive while at the same time providing the child with room to develop their independence. Independent eating is fostered through placing food in their hands instead of their mouths, providing infants with their own dish but also by waiting and letting them struggle or play with food. 3. Sharing comes in different flavors. There is active sharing when one interactional partner offers or gives another food. There is also passive sharing or tolerated theft in which one partner takes food from another without being admonished for it. Sometimes infants are also aided in, pressured to or tricked into sharing. At other times they are blocked off from the food or reproached for trying to take it, particularly when they are feared to spoil the food. Implications for the infants' development of independence and food sharing will be discussed.

P3-H-142: Relations between parental mental-state language and early false-belief understanding among toddlers from low-income homes

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While children fail traditional elicited-response false-belief tasks until ~age 4 (Wellman et al., 2001), considerable evidence suggests that they can succeed on alternative false-belief tasks as early as the firsts years of life (Onishi & Baillargeon, 2005). Children from low-income homes



show disparities in their performance on elicited-response false-belief tasks when compared to their more advantaged counterparts (Devine & Hughes, 2018). However, studies have yet to examine low-income children's performance on alternative false-belief tasks, making it unclear whether children from low-income homes have difficulty representing others' beliefs, or whether their difficulties are specific to elicited-response tasks. A second question is whether socialization practices that have been shown to support children's false-belief understanding in higher-income samples, such as parental use of mental-state language (Ruffman et al., 2002), also relate to false-belief understanding in low-income groups. We addressed these questions in the current study by examining whether low-income 2.5-year-olds could succeed in an alternative false-belief task and whether parental use of mental-state language was associated with their performance. Parents described images to their toddler (Taumeopeau & Ruffman, 2008), with the percentage of their utterances that contained mental-state terms assessed. Children completed an adapted version of the alternative false-belief task devised by Roby and Scott (2018). Children heard a change-of-location false-belief story accompanied by a picture book. In the story, Lucas and Jacob played hide-and-seek. Lucas peeked and saw Jacob hide in a tent (location counterbalanced). When Lucas closed his eyes, Jacob snuck under a table. Children then received two 6-s test trials. In the anticipatory-looking trial, children saw Lucas between the two locations and heard, "Ready or not! Here I come!"; we measured where children looked in anticipation of Lucas's search. In the preferential-looking trial, children saw two images, Lucas approaching the tent (belief-consistent image) and Lucas approaching the table (belief-inconsistent image), and heard, "Lucas is looking for Jacob."; we measured how long children looked at each image (Fig-1). As a group, children looked equally to the two locations during the anticipatory-looking trial, $t < 1$, suggesting they failed to anticipate the mistaken agent's actions. However, children looked significantly longer at the belief-consistent than the belief-inconsistent image during the preferential-looking trial, $t(36) = 2.00$, $p = .05$, indicating they identified which action was consistent with the agent's false belief. Parents' use of mental-state terms was correlated with children's performance during the anticipatory looking trial, $r(36) = .35$, $p = .04$, but not the preferential-looking trial, $r(36) = -.09$, $p = .60$. The positive results in the preferential-looking trial suggest that low-income toddlers can represent false beliefs and can succeed in alternative false-belief tasks. In addition, while children did not succeed as a group in the anticipatory-looking trial, children who heard higher levels of mental-state language were more successful at predicting the mistaken agent's behavior than those who heard lower levels of such talk. These findings begin to clarify the nature of low-income children's false-belief understanding and factors that support their false-belief performance.

P3-H-143: Spontaneous help-seeking in 18-month-olds in an instrumental problem-solving task

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An adaptive strategy when confronted with a challenging problem is to seek help from others. While there is extensive developmental research on means-end or instrumental problem-solving behavior, very little is known about when and how toddlers request help on these problems as well as what social or cognitive factors might influence their help-seeking



behavior. First evidence suggests that toddlers spontaneously request help, especially in instrumental problem-solving contexts (e.g. De Cooke & Brownell, 1995; Goubet, Rochat, Maire-Leblond, & Poss, 2006), yet under which conditions and on the basis of which social-cognitive abilities remains unclear. That is particularly surprising given that it has been argued that help-seeking is a critical component of problem-solving - one that has been understudied in younger children and that is used spontaneously and frequently across development (Nelson Le-Gall, 1981). As part of a larger study with 18-month-old toddlers, we investigated how social and cognitive factors (including language skills, joint attention, and executive functioning) relate to instrumental problem-solving. The problem-solving task involved three sets of items which increased in difficulty (see Figure 1). Because this task was originally set up to test problem-solving ability in isolation, no assistance was provided; nevertheless, many toddlers spontaneously produced help-seeking behaviors. In order to explore this strategy and how it might relate to our previous factors of interest (problem-solving, executive functioning, language skills, and joint attention), we coded for a number of help-seeking behaviors intended to attract an adult's attention to the toddlers' problem, including pointing, "gimme" gestures, vocalizing, and reaching while shifting gaze between the problem array and an adult (as in Goubet et al., 2006). We found that most infants (44/46; 96%) produced a help-seeking behavior at least once, and children on average produced 10.02 help-seeking behaviors across the problem-solving task. Further, while 18-month-olds' help-seeking behaviors did not significantly differ between the two easier categories of the problem-solving task ($t = -0.40$, $p < .69$), significantly more help-seeking occurred during the hardest category of items ("no-contact") than did in the easier "full contact" ($t = -7.76$, $p < .00001$) or "intermediate contact" ($t = -5.74$, $p < .00001$) categories (see Figure 1). Additionally, we found that help-seeking did not relate to problem-solving ability or to executive functioning - perhaps unsurprisingly, as no help was provided. However, help-seeking was significantly related to three independent predictors: gender ($t = 1.71$, $p = .048$), language skills ($t = 5.04$, $p < .0001$), and time spent in active joint attention with a parent in a free-play task ($t = 3.12$, $p = .004$) (see Figure 2). Children with better language abilities (as assessed by productive vocabulary), those who spent more time actively engaged with their parent, and, unexpectedly, girls produced significantly more help-seeking behaviors. While evidence has been found that girls are quicker to seek help than boys by 36 months (Benenson & Koulkazarian, 2008), we did not expect to find gender differences as early as 18 months. These results begin to shed some light on early help-seeking behavior and the factors that influence it.

P3-H-144: Cognitive dissonance from 2 years of age? Toddlers prefer what they previously chose over options they didn't choose

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As adults, our choices have an impact on our values and preferences. We do not only choose what we prefer, but we also tend to adapt our preferences in accordance with our previous choices. This is thought to result from cognitive dissonance as an effort to reconcile our choices with our values (Festinger, 1957). Here, we asked when this phenomenon develops. We reasoned that inconsistent choices and values would only cause dissonance if children already have a concept of the self that holds these values. Therefore, we hypothesized that this phenomenon might emerge between the second and the third year of life when children



have been argued to develop an explicit concept of the self (e.g., Rochat, 2010). To test this, in a preregistered study, we offered children between 16 and 54 months the choice between two equivalent hidden objects. After their initial blind choice, they were given a second choice between a new object and either the object they had initially chosen or the object they had previously not chosen. Importantly, the actual objects of choice remained hidden so that a previous preference could not have influenced the child's choice, but could only result as a consequence of their own initial choice. In line with our hypothesis, a preliminary sample of $N = 115$ children showed a significant age-related change towards choices in line with cognitive dissonance in the studied age range. While 16- to 24-month-olds still preferred the new object in both conditions, 2-year-olds and older children showed choices consistent with cognitive dissonance. That is, from 2 years of age, children preferred their initial choice over the new object, but the new object over the initially unchosen object. This indicates that cognitive dissonance indeed emerges around 2 years of age, and we hypothesize that this development may be linked to the development of self-concept.

P3-H-145: Mother touch patterns in face-to-face interactions and object-oriented tasks: A micro-analytic study at seven months

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Social touch is a primary form of social exchange in infancy (Herrera et al., 2004; Mantis et al., 2014). Several studies have showed the relation between touch provided by a caregiver and positive developmental outcomes (Field, 1998; Field et al., 2010; Field, 2016; Dieter, Field, Hernandez-Reif, Emory, & Redzepi, 2003; Boundy et al., 2016). Nonetheless, studies of maternal touch in infancy and how mother's touch behavior adapts to a specific interactive task are still limited. Our objective was to explore maternal social touch patterns, when they interact with their 7-months-old infants, in dyadic and triadic object play tasks. Mother-infant dyads (infants aged 7 months), were observed in a structured social interaction design with three play tasks ($N = 51$ dyads, $n = 35$ coded): (1) free play with toys, (2) free play without toys, and (3) object play with a challenging toy (above the infant's developmental level). Each task lasted approximately 3 minutes. Social touch in mother-child interactions was coded using an adapted version of the Mother Touch Scale (Stepakoff, 1999; Stepakoff et al., 2007). The onset/offset of every maternal touch was coded and categorized in twenty-one types of touch behaviors; each touch was further ordinalized in eight categories from affectionate touch to intrusive touch. This dataset was part of a larger longitudinal study of touch in infants aged 7-18 months. In the main analysis we examined if the type of play task had an effect on the mother's use of different touch categories. We fitted the proportion of time mothers spent touching the infant with a 3 (Play Task) x 8 (Touch Category) ANOVA where Play Task and Touch Category were within-subjects factors. Both main-effects and the two-way interaction were significant ($p < .001$): Touch Category, $F(1.16, 39.54) = 47.11$; Play Task, $F(2.00, 68) = 21.44$, 2-way interaction, $F(3.51, 119.19) = 18.73$. We found that mother's touched significantly more often in the free play without toys task ($M = 69\%$) than in the two triadic object-oriented tasks ($M = 38\%$ vs $M = 41\%$). The 2-way interaction was explained in great part by the use of static touch in the dyadic task and object-mediated touch in the triadic object play tasks. Maternal touch behavior changed as a function of different play tasks. Our results showed that



mothers touched their infants more frequently and used more diversified touch types in dyad play task. Moreover, mothers also applied similar amounts of touch and categories of touch in both, triadic object play tasks. To conclude, our results indicate that the frequency and categories of touch used by the mothers, when interacting with their 7-month-olds infants, adapt to the infant's developmental needs and the demands of different play tasks (dyadic play task vs object play tasks).

P3-H-146: Infants' inferences about social affiliation based on infant directed communication

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Infants prefer infant-directed speech (IDS) (Cooper & Aslin, 1990; ManyBabies Consortium, in press) as well as individuals who address them using IDS (Schachner & Hannon, 2011). This study explores infants' social inferences in a third-party context and ask whether infants would anticipate an adult who communicate with a baby using IDS to be preferred by the baby over another adult using ADS. Turkish learning monolingual infants (12-17 months, N = 19) were first familiarized with three animated figures that differed in size, representing two adults and a baby (e.g., Spokes & Spelke, 2017). For each of the two familiarization trials, infants observed the baby crying, and subsequently, one of the adults communicating with the baby in Turkish IDS and the other one in Turkish ADS. During test, infants saw two types of events in alternation: congruent events (i.e., the baby approached the adult who previously used IDS) and incongruent events (i.e., the baby approached the adult who previously used ADS). Infants were presented with each event type for three times. We predicted that if infants form expectations regarding the affiliative preference of the baby character, they would look longer to the incongruent events compared to the congruent events. We submitted the log transformed fixation times to a mixed ANOVA with Block and Congruency as the within-subjects variables. Given the wide age range, infants were divided into a younger (< 14 months) and an older (> 14 months) group with a median split procedure and Age was added to the analyses as a between-subjects variable. The results revealed a significant Block effect ($F(2, 17) = 12.03, p < .001$) and a marginal interaction between Age and Congruency ($F(2, 17) = 3.76, p = .069$). Planned contrasts also revealed a significant linear interaction between Block, Congruency and Age ($F(1, 17) = 4.84, p = .042$). Younger infants' looking times at congruent and incongruent events did not differ across blocks ($p_s > .1$). In contrast, older infants showed an increasing trend in their looking to incongruent compared to congruent events: Their looking times did not differ during the first two blocks ($p_s > .2$), however they attended more to incongruent compared to congruent events during the third block ($t(9) = 2.33; p = .045$) (See Figure). Given the small sample size, our results are not conclusive, however, they suggest that infants form expectations about others' affiliative choices based on the speech register individuals use to address them. Further, these expectations seem to become evident around 14 months of age. On the other hand, the fact that older infants' preferences become evident only during the last block suggests that the lack of such expectations in younger infants might be driven by task-related processing difficulties. Overall, these preliminary findings might suggest that different communicative cues such as IDS not only guide infants' attention but also their social expectations. These and other possibilities will be discussed in light of more data.

P3-H-147: Reassessing parent mental-state talk in low-income populations

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Parents' use of mental-state talk with their children predicts a variety of developmental outcomes, including children's mental-state vocabulary, emotion understanding, and understanding of others' beliefs (Devine & Hughes, 2018; Taumoepeau & Ruffman, 2016). Research suggests that parents initially talk more about desires and emotions, and gradually use more cognition words (think, know) as their children get older. This pattern is thought to scaffold early socio-cognitive development. However, because this research has focused largely on higher income samples, little is known about whether socioeconomic status (SES) impacts parent mental-state talk. Moreover, the standard approach to measuring mental-state talk (i.e., counting the number mental-state labels) might not fully capture how parents convey mental states, especially in lower SES populations. Research on parents' co-narrating stories with their children suggests that lower SES families often use other rhetorical devices such as dramatic language and reported speech to convey mental-state information (Miller, Cho, & Bracey, 2005). The present study sought to clarify the nature of mental-state in lower SES populations and determine whether the standard coding approach in the literature adequately captured mental-state talk in these families. To test these questions, we recruited a socioeconomically diverse sample of 42 parents and children (16-31 months, $M = 22.1$ months). Household income ranged from $< \$25,000$ to $> \$150,000$, with 20% reporting $< \$25,000$. Parent-child dyads viewed a picture-book that was meant to evoke mental-state talk from the parent. Parents were instructed to talk about the pictures like they normally would at home. Parent-child interactions were transcribed and then coded in two passes. The first pass used the standard approach in the literature, coding the percentage of utterances containing emotion, desire, or cognition terms. A second pass then captured additional ways parents could convey mental states: words that strongly implied a mental state without labeling it directly (i.e. yucky), words that described actions driven by mental states ("Is she hiding from the dog?"), and reported speech (That boy says, "I am so tired"), which can convey others' thoughts and feelings. The first-pass coding revealed a main effect of SES on parents' use of cognition terms, $F(3, 33) = 3.30, p = .03$. Higher SES parents used more cognition terms than lower SES parents. There was also an SES x Age interaction for cognition terms, $F(3, 33) = 3.85, p = .018$. Replicating previous literature, higher SES parents used more cognition terms with older children. However, this age-related pattern was not evident in lower SES families. Preliminary results indicate that our second-pass coding results in a significant increase in the amount of mental-state talk captured, $t(22) = 8.66, p < .001$, but this increase is marginally greater for lower SES parents than higher SES parents, $t(22) = 3.87, p = .06$. Together, these findings suggest that mental-state talk might be both quantitatively and qualitatively different in lower SES families, indicating a need for further research in this population. Implications for the relationship between mental-state talk and socio-cognitive development will be discussed.

P3-H-148: How can I help you? A longitudinal investigation of infants' selective helping and sharing across the third year of life



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Prosocial behaviors are an indication of healthy development, and include helping and sharing behaviors that emerge in infancy (Dunfield, 2014). Previous research has also indicated that children are selective in their prosocial behaviors by age four (Hastings, 2005). However, it is unclear when such selectivity emerges. This present study longitudinally examined infant's helping and sharing behaviors towards caregivers and strangers across the third year of life. Two-hundred-thirty-one infants (98 female) participated in a helping and sharing task in the home at 1-to-2 years of age ($M_{age} = 17.64$ months, $SD = 3.24$) and again at 2-to-3 years of age ($M_{age} = 29.76$ months, $SD = 3.12$). In each task, the infant observed an adult (experimenter or caregiver) demonstrate a need (e.g., dropped object) or desire (e.g., did not have crackers), which provided an opportunity for the infant to engage in helping or sharing behaviors, respectively. Infant's behavior was coded on a 1-to-5 scale and analyzed using a Repeated-Measures Generalized Mixed Linear Model with main effects and interactions of target (experimenter, caregiver), task (helping, sharing), and time point (Time 1, Time 2), with infant age as a covariate. The results of the model are reported in Table 1, and the estimated marginal means of each effect and interaction are displayed in Table 2. The effects of target, task, and time point were significant, as well as the interactions of Person X Task, and Task X Time. Pairwise comparisons further explored these significant effects and interactions. Specifically, children were significantly more prosocial towards caregivers ($M = 3.50$) than experimenters ($M = 2.87$; $p < .001$), and overall engaged in significantly more helping behavior ($M = 3.63$) than sharing ($M = 2.73$; $p < .001$). Additionally, children's overall prosocial behavior increased significantly over time ($M_{T1} = 2.97$, $M_{T2} = 3.40$; $p = .034$). Children helped their caregivers ($M = 4.07$) and experimenters ($M = 3.20$) significantly more than they shared with caregivers ($M = 2.92$) and experimenters ($M = 2.53$; $ps \leq .002$). Furthermore, these helping and sharing behaviors were significantly greater towards caregivers than experimenters ($ps \leq .002$). At Time 1 and Time 2, children helped ($M = 3.54$, $M = 3.72$) significantly more than they shared ($M = 2.39$, $M = 3.07$; $ps < .001$). However, only sharing increased significantly across time ($p = .002$), whereas helping did not differ across time ($p = .42$). These results demonstrate longitudinally that infants' overall prosocial behavior increases across the 3rd year of life. However, this pattern differed by target and type. Specifically, infants increased their sharing toward caregivers and strangers across time. However, infants' helping did not increase across time. These results add to a growing body of research suggesting that children become more selective in their prosocial behaviors over time (Allen et al., 2018), with the current findings suggesting that children's selectivity in sharing emerges during the 3rd year of life. Additional implications for the emergence and selectivity of children's prosocial behaviors will be discussed.

P3-H-149: The translation and cross-cultural adaptation of a parent-infant interaction coding scheme into Spanish

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Background/Objective: Early life stress can have devastating and long-lasting impacts on a child's development (Felitti et al., 1998). Understanding factors that may buffer the adverse effects of early life stress is critical. Responsive caregiving is a putative target for intervention as it is malleable to change, may buffer the effects of early life stress, and has been linked to improvements in emotional, social, and cognitive development (Afifi & MacMillan, 2011; Black et al., 2017). To measure parent-infant interactions, the field has largely moved towards micro-social coding techniques, evaluating both the quality and quantity of parental responsiveness at the moment to moment level thus providing more accurate data about parenting behaviors. One coding scheme that assesses moment-to-moment parenting behaviors is the Simple Interactions: Reciprocity Scale (Murphy et al., Simple Interactions Video-Coding Tool, unpublished measure available upon request from the authors, 2018). This scale measures contingent responsiveness by having trained coders assess 15-second intervals of recorded parent-infant interactions. A significant limitation to the scalability of this coding scheme is that it is currently only available in English. As characteristics of parent-child interactions depend on both personal and cultural factors, it is necessary to consider how cultural differences may influence parental responsiveness. This project aims to translate and culturally adapt the Reciprocity Scale of the Simple Interactions coding scheme to create a Spanish version. As Hispanic people continue to be the largest minority in the United States (Census, 2015), and roughly 13.4% of the U.S. population speaks Spanish, having measures that are not only translated but adapted to Spanish is crucial. Methods: To translate and adapt the Simple Interactions: Reciprocity Scale, we followed the guidelines established by Beaton et al. (2000) for cross-culturally adapting self-report measures (see Figure 1). These particular guidelines were used as a template as they were created based on a review of the literature in medical, sociological, and psychological fields. In addition to adapting the scale, our research team established a training protocol for the use of the Spanish version. Creating a training protocol included establishing a set of training videos as well as creating gold-standard videos for assessing reliability. In addition to discussing the process of adapting the Reciprocity Scale, this poster will also address strategies for overcoming unexpected barriers. This information will guide other research teams hoping to translate and culturally adapt parent-infant measures. Future directions will be discussed, including the use of the Spanish version of the Reciprocity Scale to evaluate intervention effects for the Filming Interactions to Nurture Development (FIND) video coaching program.

I-Emotional Development

P3-I-150: The type of care during infancy and child behavioral and emotional problems: Evidence from Chile

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Although a large and increasing proportion of children across the world start nonmaternal care during the first year of life, few studies, most in industrialized nations, have analyzed the association between different types of nonmaternal care during the first year of life and child behavioral and emotional problems. Evidence from developed countries shows that extensive exposure to nonmaternal care during the first year of life can negatively affect children's



affective and behavioral functioning. Attendance to care centers during the first year of a child's life is associated with higher levels of externalizing problems compared to children who remain with their mothers (Belsky et al., 2007; National Institute of Child Health and Human Development Early Child Care Research Network, 2000, 2003; National Institute of Child Health and Human Development., 2006; NICHD Early Child Care Research Network, 2004). However, given the well-known negative consequences of externalizing problems on child development, understanding whether nonmaternal care during infancy is associated with child behavioral problems is crucial. Hypotheses This study aims to compare levels of behavior and emotional problems at 24-48 and 72-96 months old for children who, during the second half of their first year of life, had been in maternal care--the most prevalent type of care in Chile--or various types of nonmaternal care--center-based, grandparent, other relative, and non-relative care. One hypothesis is as previous studies attendance to centerbased care during infancy is associated with higher levels of externalizing problems compared to children who remain with their mothers. Study population. We use data from the Chilean panel survey 'Encuesta Longitudinal de la Primera Infancia' (ELPI), a nationally representative sample of children between six months and five years old. We use the two waves from the ELPI dataset currently available (2010 and 2012). The sample used for this analysis consists of children that enter at nonmaternal care between 6 and 12 months old (n=5,112). Methods: We use OLS regressions and propensity score matching techniques to compare the outcomes for those children who started nonmaternal care early with those who remained in maternal care. Results On average, children who experienced nonmaternal care in infancy present fewer behavioral problems later on compared to children who experienced maternal care during the same period (Table 1). However, when we analyze the association between each type of nonmaternal care and child behavioral outcomes, we find that the type of nonmaternal care matters. Compared to those in maternal care, children in center-based care or other-relative-care (mostly aunts) had more externalizing and internalizing problems (in 2010 and 2012). By contrast, compared to children in maternal care, children in non-relative-care had less internalizing problems (Table 2). This study contributes to debates about benefits of national policy supporting specific types of nonmaternal care during the first year of life.

P3-I-151: A randomized controlled trial on the effectiveness of a daily skin-to-skin contact intervention in mothers and their full-term infants on maternal mental health and breastfeeding

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In preterm and low birthweight infants, many studies have documented the beneficial effects of mother-infant skin-to-skin contact (SSC). Nowadays, SSC is also encouraged post-delivery in mothers with healthy full-term infants. To date, only one study examined the effectiveness of a SSC intervention in mothers and full-term infants beyond the first postnatal hours. They found that mothers in the SSC group had lower levels of postnatal depressive symptoms and higher breastfeeding rates in comparison to the control group. These results are promising, but this study did not use a randomized controlled design. The present randomized controlled trial investigated the effectiveness of a daily SSC intervention in mothers and their full-term infants. This presentation will focus on maternal mental health and breastfeeding as outcomes.

Method: Participants were 116 healthy mother-infant dyads (56 SSC intervention; 60 control). 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. All mothers noted the amount of SSC in a daily logbook (Figure 1). Mothers 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 12 months of age, mothers indicated the months that their infants received (exclusive) breastfeeding. Repeated measures ANCOVA and linear regression analyses were used for the analyses. Results: For maternal depressive, anxiety, and stress symptoms, no differences were found between the SSC and control condition. Also, no differences were found when only mothers in the SSC condition were selected who strictly adhered to the daily hour of SSC during the intervention period. For breastfeeding, exclusive and continued breastfeeding duration did not differ between the SSC and control condition. However, when only mothers in the SSC condition who strictly adhered to the daily hour of SSC were examined, differences were found (see Table 1). These mothers reported a longer duration of exclusive and continued breastfeeding than mothers in the control condition. The breastfeeding intention in pregnancy did not significantly differ between the groups. For breastfeeding frequency, no differences were found between the SSC and control condition. Also, no differences were found when only SSC mothers were selected who adhered to the SSC protocol. Discussion: For the total group the results indicated that daily SSC is not effective in improving maternal mental health and increasing breastfeeding rates in mothers and their full-term infants. However, when only the SSC mothers that strictly adhered to the daily hour of SSC were selected, differences were found. SSC mothers reported on average more than 1.5 month longer duration of exclusive breastfeeding and almost three months longer duration of continued breastfeeding in the first postnatal year compared to control mothers. The difference cannot be explained by the prior breastfeeding intention in pregnancy. The study indicates that daily SSC is a promising, cheap, and accessible intervention that may extend breastfeeding duration in healthy mothers and their full-term infants.

P3-I-152: Effects of mother-infant skin-to-skin contact on mothers, infants, and their long-term relationship

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A quasi-experiment with intervention and control groups longitudinally examined the effect of mother-infant skin-to-skin contact (SSC) on full-term infants' social-cognitive development and their mothers' behavior over the infants' first three months. Nine years later these dyads were assessed for dyadic communication about emotion. SSC and control group mothers (N=90) were recruited in perinatal clinics at two hospitals with similar demographics in northeastern Canada. Hospitals were designated as either the SSC or control group site. Mid-way through the study, the designations were switched: SSC site became the control site and vice versa. SSC group mothers were requested to provide SSC for their infants 6 hours/day (cumulative) in the infants' first week, then 2 hours/day until the infants were one month. Control group mothers received no request to provide SSC. Mothers in both groups kept daily records of the amount of SSC they provided (see Table 1). At 1 week, 1 month, 2 months, and 3 months, data were collected during home visits on infant feeding (exclusive breastfeeding, partial breastfeeding, no breastfeeding), postpartum depression (Edinburgh Postnatal Depression



Scale), and infant engagement in mother-infant interaction (Still Face Task). A nine-year follow-up study examined dyads' communication about emotion (AEED: Autobiographical Emotional Events Dialogue). At one week, the percentage of breastfeeding mothers was similar (SSC: 77%; control: 73%); fewer control group mothers were breastfeeding at each following visit, whereas the percentage of breastfeeding SSC group mothers remained unchanged. SSC group mothers had lower postpartum depression scores at one week and one month. At one week, both SSC and control group infants showed the still face effect with their attention, indicating from the newborn period infants can detect changes in their mothers' behavior. At one month, SSC group infants, but not control group infants, showed the still face effect with their affect, indicating these infants were reacting to violations of expectations for affect sharing. At three months, SSC group infants, but not control group infants, were actively social bidding to their mothers in the still face phase, indicating an awareness of themselves as effective agents in instigating social interaction. In a follow-up study nine years later, the mother-child dyads engaged in conversations about times when the child felt happy, sad, mad, and scared. The AEED coding system includes seven maternal scales that form a Maternal Sensitive Guidance score capturing mother's overall ability to guide/support her child in the conversations, seven child scales that form a Child Cooperation and Exploration score assessing the child's elaborations and willingness to talk about the remembered events, and two narrative scales that form an Emotionally Coherent Narrative score reflecting the coherence of the stories. SSC group dyads had higher Maternal Sensitive Guidance scores and Child Cooperation and Exploration scores than control group dyads. Differences in Emotionally Coherent Narrative scores were non-significant. Thus SSC group dyads had more open, accepting, and reciprocal exchanges when discussing the children's remembered emotional events. SSC set the mother-child relationship on a positive trajectory in infancy that was associated with benefits to the relationship nine years later.

P3-I-153: Infant behaviors during a mobile phone modified still-face paradigm and their relations to parental technofence and beliefs regarding technofence

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The proliferation of mobile phones create new challenges and opportunities for parents and infants developing in a digital world. Interruptions to parent-child interactions due to technology, or "technofence", have been related to negative child developmental outcomes (e.g., Beamish, Fisher, & Rowe, 2018). Yet, the influence of technofence on parent-infant interactions and infant behaviors has received less attention (Myruski et al., 2018). For this study, parent-infant dyads (n=227, infant age M = 8.03, SD = 2.51, range = 5-14 months; 48% female) completed a modified Still Face Paradigm (SFP) with mothers using a mobile phone during the still-face portion of the protocol (Tronick & Cohn, 1989). The SFP protocol was completed in the home in an attempt to more closely mimic contextual cues for infants. Infant responses were coded for positive and negative affect, object and parent orientation, self-comforting behaviors, and escape attempts during the three main phases of the SFP (Free Play, Still Face, Reunion). Parents also completed a 5-item scale regarding beliefs about technofence (e.g., "it is okay for me personally to use digital media when my child is playing



with toys") and an additional 5-item measure of how often they use their mobile device when their infant is awake and present. Factorial repeated measures ANOVAs were conducted to examine patterns of behavioral changes across the three phases (FP, SF, and RU) of SFP (within-subject factors) with infant age (nine months and younger or over nine months) as a between-subjects factor. Results showed a robust main effects, with infants displaying increased negative affect ($F(2, 202) = 85.40, p < .001$), decreased positive affect ($F(2, 202) = 33.68, p < .001$), increased self-comforting ($F(2, 202) = 10.98, p < .001$), object orientation ($F(2, 202) = 183.65, p < .001$), and escape behaviors ($F(2, 202) = 99.31, p < .001$). Post-hoc probing of the main effects further demonstrated that infants frequently failed to return to baseline levels during the reunion phase following behavioral changes produced during the modified Still Face when parents were engaged with their mobile device (see Figures 1 & 2). A multigroup SEM further examined associations between parental reports of their own technoference and beliefs regarding technoference. Parents self-reported technoference was positively associated with object orientation during SF ($\beta = .15, p = .042$) while parents beliefs that it is appropriate to use media with their child present was positively associated with infant escape attempts ($\beta = .22, p = .002$). Parental technoference related beliefs were also related to infants self-comforting behaviors during the reunion phase ($\beta = .15, p = .019$). Age differences were observed. The current study suggests that a modified version of the traditional SFP produces a robust still-face effect, with infants becoming distressed during the SF and often failing to return to baseline after brief interruptions to parent-infant interactions as a result of mobile phone use. As such, findings suggest that parents should be mindful regarding potential disruptions to parent-infant interactions as a result of mobile and digital technologies.

P3-I-155: Temperament and caregiver psychological distress predict internalizing and externalizing symptoms in children with autism features

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The core social-communicative and repetitive-behavioural symptoms of autism spectrum disorder (hereafter, 'autism') co-occur at high rates with internalizing (depression and/or anxiety) and/or externalizing (inattentive/hyperactive, oppositional, and/or aggressive behaviour) symptoms. However, the processes that contribute to internalizing and externalizing symptoms in autism remain unclear. Child temperament characteristics (i.e., early-emerging and biologically-based emotional, behavioural, and attentional traits) and caregiver psychological distress (i.e., depression, anxiety, and/or stress symptoms), are known independent risk factors, though understanding about the reciprocal relations of child temperament and caregiver psychological distress in autism is lacking. Studies comprising children with normative development suggest that caregiver psychological distress might engender child temperamental negative affectivity and emotional dysregulation, which further exacerbates caregiver psychological distress. These reciprocal relations between child temperament and caregiver psychological distress, in turn, have been shown to predict increases in child internalizing and externalizing symptoms. Here, we explored the unique and

reciprocal effects of child temperament and caregiver psychological distress in the prediction of internalizing and externalizing symptoms among infants with early autism signs tracked prospectively . Participants were a community-referred sample of 103 infants (68% male) showing early signs of autism. Caregiver-report measures of child temperament (Infant/Early Childhood Behavior Questionnaire) and psychological distress (Depression Anxiety Stress Scales) were completed when infants were aged around 12- and 18-months, and caregiver-report of child internalizing and externalizing symptoms (Infant-Toddler Social and Emotional Assessment) was taken at 12- and 18-months and again at 24-months. Cross-lagged path models (conceptual representation shown in Figure 1) were used to examine reciprocal associations between child temperament (negative affectivity, dysregulation) and caregiver psychological distress from 12- to 18-months in the longitudinal pathway to children's internalizing and externalizing symptoms at 24-months, while controlling for the within-time covariation and cross-time stability of constructs. Results indicated that each of child temperament, caregiver psychological distress, and child internalizing and externalizing symptoms were stable over time and also concurrently associated with one another at certain timepoints. Caregiver psychological distress had a direct effect on child internalizing symptoms, and an indirect effect at trend level on child internalizing symptoms through child dysregulation ($p = .051$). Neither caregiver psychological distress or child temperament contributed to the prediction of child externalizing symptoms, and there was no effect of child temperament on subsequent caregiver psychological distress. These results suggest a common pathway from caregiver psychological distress to child dysregulation to child internalizing symptoms in the context of autism risk as has been reported elsewhere for normative child development. The provision of mental health support to caregivers of infants with symptoms of autism might therefore help alleviate temperament-related risk and improve outcomes for infants themselves.

P3-I-156: Zooming in on the transmission of adults unresolved loss/abuse to infant disorganised attachment: A latent class analysis

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Background Infant disorganised attachment is predicted by parents' unresolved states of mind about loss or abuse, which are identified based on lapses in the monitoring of reasoning, discourse, and behaviour surrounding loss/abuse in the Adult Attachment Interview (AAI; George et al., 1984, 1995, 1996; Main & Hesse, 1990). Recent meta-analytic results indicate an effect size of $r = .21$ for this association (Verhage et al., 2016). Research has assumed that unresolved states of mind are a unitary construct despite the fact that unresolved loss/abuse is identified based on a large variety of indicators. This study attempted to gain deeper insight into unresolved states of mind and the transmission to infant disorganisation. The following research questions were investigated: 1) Can groups of interviewees be identified who show similar profiles of indicators of unresolved loss/abuse (i.e., lapses in reasoning/discourse/behaviour)? 2) How are these profiles associated with unresolved states



of mind and infant disorganised attachment? Methods Data included 999 caregiver-child dyads within 11 studies in the Collaboration on Attachment Transmission Synthesis. AAI data were available from 999 dyads and infant disorganisation (measured in the Strange Situation; Ainsworth et al., 1978) was available from 747 dyads. Latent class analysis (LCA) was performed on subsamples of adults with applicable loss ($n = 872$) and abuse ($n = 238$). Indicators of unresolved loss/abuse were dichotomised as coder ratings were inconsistently available (present/not present). Latent class probabilities were used to predict unresolved score (continuous: 1-9) and infant disorganisation (continuous: 1-9), using multilevel linear regression. This study was pre-registered on OSF (<https://osf.io/w65fj/>). Results Table 1 shows preliminary results from the LCA. For both unresolved loss/abuse, the two-class solution was the best fit. As seen in Figure 1, latent profiles of unresolved loss were distinguished based on the probability of showing six specific indicators. The latent profiles of unresolved abuse were distinguished based on the probability of showing disorganised speech or unsuccessful denial of abuse. In the total sample ($N = 999$), higher unresolved scores were significantly associated with infant disorganisation ($B = 0.08$, $SE = 0.04$, $p = .035$). The latent class probabilities for unresolved loss and abuse were not significantly associated with unresolved score and infant disorganisation ($ps > 0.135$). Conclusions The findings do not indicate distinct subtypes of unresolved loss. Rather, they suggest high- and low-lapsing subgroups. For unresolved abuse, findings indicate two subgroups, one characterised by a high probability of showing disoriented speech and one characterised by a high probability of showing unsuccessful denial of abuse. The indicators distinguishing the subgroups of unresolved loss/abuse were among the most frequently occurring lapses. It may be possible that these are particularly important for identifying unresolved loss/abuse. However, further scrutiny is needed, given that no information was available regarding the strength and frequency of occurrence of indicators within interview transcripts. The latent profiles of unresolved loss/abuse were not associated with infant disorganised attachment. As a next step, statistical learning techniques will be used to predict infant disorganisation based on specific indicators of unresolved loss/abuse.

P3-I-157: "I can't do it" or "It doesn't work" correlates of toddler sex differences in attributions during challenging tasks

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Introduction Persistence is a key skill linked to academic and social outcomes (Chen & George, 2005; DiLalla et al., 1990). Variations in persistence are evident in toddlerhood (Bannerjee et al., 2007). How children demonstrate and attribute challenges to persistence may be largely influenced by maternal emotional functioning, particularly as related to characteristics such as parental regulation of emotion (Oattes et al., 2018) and their beliefs and responses to children's emotions such as anger and frustration (Sanders et al., 2013). Moreover, boys and girls are socialized differently with regard to attributions of failure (Lahbeck et al., 2017); it is possible that these differences begin to emerge in very early childhood. AIM: We examined toddler sex as moderating associations between maternal characteristics (lack of emotional awareness, beliefs about toddlers' emotions, self-reported negative responses to toddlers' emotions) and toddlers' persistence and attributions of difficulty in a challenging task. Material/Methods Mothers ($N=104$) completed questionnaires in a lab visit: Low personal emotional awareness



(Difficulties in Emotion Regulation scale-Awareness; Gratz & Roemer, 2004), beliefs about toddlers' emotions (Emotion Related Parenting Styles; Patterson et al., 2012), and responses to toddlers' negative emotions (Coping with my Toddler's Negative Emotions Scale; Spinrad et al., 2004). Toddlers (Mage=26.4 mos.; 51 girls) completed a videotaped challenging lab-task. Persistence reflected duration in seconds that the child attempted task. Attributions were coded as self-directed (I can't do it) or toy-directed (It doesn't work). Productive vocabulary (McArthur-Bates Communicative Development Inventories; Fenson, 2007) was covaried. Linear regression models with interaction terms were employed. Simple slopes tests were examined for significant interactions. Results There were no sex differences in persistence, type or total number of attributions, or vocabulary. Mothers reported more emotionally-supportive responses to boys, $F(1,102)=5.60$ $p=.02$. Maternal characteristics were unrelated to persistence. Girls made more self-attributions when mothers had: less emotional awareness, $\text{Adj } R^2=.22$, $F(4,99)=8.313$, $p<.001$, $\beta=.39$, $p=.000$ (Figure 1) and engaged in more emotion coaching $\text{Adj } R^2=.14$, $F(4,99)=5.114$, $p<.001$, $\beta=.25$, $p=.001$ (Figure 2). Boys made more toy attributions when mothers had less emotional awareness, $\text{Adj } R^2=.29$, $F(4,99)=11.651$, $p<.001$, $\beta=.29$, $p=.019$. Unsupportive responses were related to increased toy attributions, $\beta=-.28$, $p=.02$, but were not moderated by sex. Conclusions Girls showed more self-attributions when mothers were emotionally unaware and when they were encouraging of emotions. Although we cannot test causal mechanisms, existing literature suggests potential explanations to pursue. For example, girls' experience greater socialization to the nuances of relationship characteristics, such that girls may be more likely to self-internalize in the case of an emotionally-dysregulated parent and/or by encouragement of emotional expression. Likewise, research suggests that girls are more likely to learn to self-blame. This may be especially true if mothers with low emotional awareness or more emotionally-expressive mothers are modeling self-attributions. Moreover, it is possible that when emotion coaching is greater, girls are aware of all emotions, including those of anger and frustration.

P3-I-158: Associations between parental reflective functioning and parental mind-mindedness in a low-income sample of parents and infants

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Introduction: Parental reflective functioning (RF) refers to the parent's capacity to mentalize and appropriately identify and consider the internal mental states of the self and the infant (Slade & Fernyhough, 2015). Similarly, parental mind-mindedness may be considered a form of RF in action as it reflects the parents' attributions of mental states to the infant during their interactions together (Rosenblum, McDonough, Sameroff, & Muzik, 2008). Both RF and mind-mindedness are related to infants' attachment security as well as to later theory of mind and other social-emotional competencies, underscoring the need to better understand associations between these constructs. Among economically-vulnerable parents, RF may play a particularly important role in promoting a parent's ability to mentalize during interactions, despite the stressors of chronic poverty that can compromise parents' emotional availability.

The aim of this study was to examine mind-mindedness over time and to investigate associations between parental RF and mind-mindedness among low-income parents in the U.S. Methods: Data from 90 low-income parents (96% mothers; 45% black, 55% white; 54% with a high school education or less) participating in an Infant Mental Health (IMH) home visiting program in the U.S. were utilized for the current study (Mage parents=27.10, SD=6.95; Mage infants at enrollment=9.84 months, SD=8.42; 55% female). Data were collected in the home at study enrollment, at 6-months and at 12-months post enrollment. Measures assessed included parental RF (Parent Development Interview; Slade, Aber, Berger, Bresgi, & Kaplan, 2014) and mind-mindedness (Meins & Fernyhough, 2015); the latter included total number of mind-related comments (MRCs), total number of appropriate mind-related comments (reflecting accurate interpretation of infant mental states), and total non-attuned (reflecting inaccurate interpretations) during a videotaped, 8-minute free play interaction. Maternal sensitivity (assessed via Q-Sort; Pederson & Moran, 1995) was included as a covariate. Parenting stress, demographic risk and depressive symptoms were not significant covariates and were dropped from the analytic plan. Results: Although MRCs declined slightly over time, appropriate MRCs increased significantly from baseline to 6 months, $t(66) = -2.29$, $p = .025$, and non-attuned MRCs declined significantly from baseline to 6 months $t(66) = 2.07$, $p = .04$ (Table 1). Using linear mixed modeling allowing for random intercepts, RF was tested as a time-varying predictor of total appropriate MRCs. The total number of parental comments to the child during interactions at each time point was a time-varying covariate. RF was a significant predictor of total appropriate MRCs, $est = 0.61$, $SE = .21$, $p = .0047$. Parental sensitivity at baseline was also related to appropriate MRCs, $est = 1.50$, $SE = .68$, $p = 0.03$. Conclusions: Declines in mind-minded comments may reflect a "watch and wait" stance in parents' interactions, particularly given the increased appropriate/decreased non-attuned comments. Further, supporting parental RF may be an important goal in IMH-informed parenting support programs as a way to support parents' capacities to consider the internal mental states of their children.

P3-I-159: Maternal report of infant negative and orienting/regulatory behaviors: Relations with maternal stress and observed infant behavior

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Caregivers reporting higher levels of stress can perceive their infants as significantly more negative, shaping caregiver-infant interactions and future child behavior (Mantymaa et al., 2006). Caregivers reporting increased infant negativity may also report lower infant regulation (such as attentional orienting; Rothbart et al., 1992), suggesting they perceive their infants as dysregulated. Maternal subjectivity, then, may impact perceptions of trajectories of infant temperamental development. Here, we examine mother-infant dyads from pregnancy through infancy to study how early maternal stress and adversity relate to infant temperamental development. Specifically, we assessed how various forms of maternal stress (i.e., personal, marital, and parenting) relates to both maternal report and laboratory-elicited infant negativity and orienting/regulation. We hypothesized that mothers who report increased stress will report increased negativity and decreased orienting/regulation behaviors. Additionally, we examined whether maternal reports of infant behavior were related to the actual observed behaviors, anticipating that mothers who reported increased stress may not be as adept at recognizing



their infants' typical temperamental responses. Mothers (n=149) reported on infant orienting/regulation and negative affectivity at 6, 12, and 18 months using the Infant Behavior Questionnaire and at 24 months using the Toddler Behavior Assessment Questionnaire. Infant sustained attention and fear were assessed at 6 months, utilizing a dynamic puppet task (Cuevas & Bell, 2014) and a scary masks task (Lab-TAB; Goldsmith & Rothbart, 1999). At 1 month, mothers self-reported stress and emotional problems on a series of questionnaires. Factor analysis indicated a three factor solution for maternal stressors: personal stress (defined by maternal-reported anxiety, depression, anger expression in the family, and financial stress), marital stress, and parenting stress. As anticipated, maternal stress was significantly associated with maternal report of infant behaviors. Specifically, mothers who report higher levels of personal and parenting stress were significantly more likely to report decreased levels of infant orienting/regulation and increased levels of negativity across timepoints. Mothers reporting marital stress were only likely to report increased levels of infant negativity at 12 months of age, suggesting that, perhaps as a protective factor, mothers do not allow marital stress to color their perceptions of infant temperament as much as personal and parenting stress. Parenting stress was the only maternal variable related to observed infant behavior; specifically, mothers reporting increased parenting-related stress were more likely to have infants who exhibited fear during the fear-inducing task. Results suggest that mothers who report higher levels of stress may report higher levels of infant negative behaviors and lower levels of infant orienting/regulatory behaviors, above and beyond what is elicited in the context of standardized laboratory tasks. Unlike some earlier studies, we do not yet have the data to examine whether earlier maternal perception of temperament predicts later observed temperament. However, observed temperament was assessed again at 24 months; behavioral coding is currently being completed, and future analyses will examine the longitudinal influence of maternal stress on perceptions and expressions of child temperament.

P3-I-160: Elevated cortisol across infancy predicts later-life glucocorticoid resistance

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A growing body of research demonstrates that stress exposure in infancy is linked to later-life health outcomes, with disparities in outcomes emerging as early as childhood (Slopen et al., 2013; Taylor et al., 2011). However, the mechanisms by which early stress might contribute to adverse health effects remain poorly understood. One likely mechanism is via altered glucocorticoid activity (Glaser and Kiecolt-Glaser, 2005). Glucocorticoids (e.g., cortisol in humans) are essential for myriad physiological functions, including the maintenance of cardiovascular tone, provision of anti-inflammatory effects, and regulation of growth, behavior, and cognition (Ramamoorthy and Cidlowski, 2013). Here we assessed if glucocorticoid levels across infancy were associated with impaired tissue sensitivity to glucocorticoids (glucocorticoid resistance) in early adolescence. Data come from a subsample (n = 253) of the Family Life Project, a longitudinal study of 1,292 children and their caregivers living in predominantly low-income, non-urban communities. Children's resting levels of cortisol were assayed via saliva samples collected in their home at 6, 15, and 24 months of age. Following prior recommendations, cortisol values were natural log transformed to correct for positive

skew, and each cortisol sample was regressed on time of day of sample collection to remove linear trends across the day (Curran and Bauer, 2011; Helm et al., 2018). Glucocorticoid resistance at 11-12 years of age was assessed using a well-established protocol whereby whole blood was diluted in phosphate buffered saline and cultured with and without endotoxin lipopolysaccharide (LPS) at a range of concentrations of hydrocortisone (Miller and Chen, 2010; O'Connor et al., 2019). Glucocorticoid resistance was quantified by the difference in inflammatory cytokine (IL-6) levels in response to LPS alone versus LPS with the highest concentration of hydrocortisone. Structural equation modeling was used to create a latent variable of infant cortisol, which consisted of resting salivary cortisol levels at 6, 15, and 24 months of age. The structural equation model with our latent variable of infant cortisol as the main predictor and glucocorticoid resistance as the outcome had good model fit (CFI = 0.99; TLI = 1.35; SRMR = 0.02; BIC = 11638.45). Higher infant cortisol levels predicted higher levels of glucocorticoid resistance nearly a decade later, and the prediction was significant after accounting for multiple covariates (Table 1). Specifically, all models adjusted for demographic and additional covariates, including infant's state of residence, race, sex, age, family income-to-needs ratio, as well as child's body mass index (BMI), health status, and time of blood draw. Our findings support that prolonged elevation of glucocorticoids in infancy may result in a dysregulated response such that the expression and/or function of glucocorticoid receptors become downregulated, suggesting one mechanism linking early cortisol to compromised behavioral and somatic health.

P3-I-161: Maternal emotion difficulties in relation to infant inhibited temperament, parenting behavior, and anxiety risk

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Anxiety is among the most prevalent global health concerns facing children (Merikangas et al., 2009). Stable inhibited temperament across infancy/toddlerhood and parental overcontrol are common predictors of anxiety risk (Chronis-Tuscano et al., 2009; Prior et al., 2000). Transactional models acknowledge dynamic, bidirectional associations between infant/toddler temperament and parenting (Sameroff, 2009). We hypothesized that mothers' emotion reactivity and regulation may determine when mothers respond to their inhibited children with overcontrol that subsequently predicts continued inhibition. The current study comes from a longitudinal, multimethod investigation aimed at understanding links among inhibited temperament, parenting, and anxiety risk across infancy/toddlerhood (ages 1 to 3). We examined unique contributions of maternal protection solicited by the toddler, spontaneous protection, and intrusiveness to the maintenance of inhibition from age 1 to age 3. We then examined whether maternal self-report and biological markers of reactivity/regulation affected the indirect effect of age 1 to age 3 inhibition through parenting behavior. Analyses controlled for maternal anxiety. Mothers and infants (n = 173) participated in laboratory assessments at child ages 1, 2, and 3. Maternal report (Briggs-Gowan & Carter, 1998; Gartstein & Rothbart, 2003) and observation (Fox et al., 2001) of inhibition were considered uniquely at age 1. A composite of mother-report (Briggs-Gowan & Carter, 1998, Rothbart et al., 2001) and observation (Buss & Goldsmith, 2000) was formed for age 3 inhibition. Maternal parenting behaviors were observed during toddlers' interactions with novelty at child age 2. Mothers' reactivity/regulation difficulties (all continuous variables) were represented by higher reported



ffective intensity (Larson et al., 1986) and emotion regulation difficulties (Gratz & Roemer, 2004) (subjective dysregulation) and represented biologically by higher cortisol concentration and cortisol/DHEA ratio (neuroendocrine dysregulation), higher resting heart rate and lower resting RSA (cardiac dysregulation), and greater right-frontal EEG alpha asymmetry (neural dysregulation). Mothers reported their social anxiety (Mattick & Clark, 1989) at ages 1 and 2. Of parenting variables, only solicited protection related to inhibited temperament (Table 1); other parenting behaviors were not considered further. Both age 1 inhibited temperament variables correlated with solicited protection. Only mother-perceived inhibition uniquely predicted solicited protection in a regression including both temperament variables and maternal anxiety. Perceived inhibition indirectly predicted age 3 inhibition through solicited protection (95% CI [0.004,0.191]), controlling for observed inhibition and maternal anxiety. This indirect effect was strongest at low neuroendocrine (95% CI [0.01,0.33]), low cardiac (95% CI [0.02,0.31]), and mean neural (95% CI[0.01,0.22]) dysregulation, as well as when subjective dysregulation (95% CI[0.02,0.26]) and maternal anxiety (95% CI [0.02,0.33]) were high. This suggests that the extent to which inhibited infants elicit protective parenting that maintains their inhibition may depend on mothers being subjectively anxious and dysregulated but biologically well-regulated. Perhaps protective parenting is motivated by subjective negative cognitions but requires biological regulation to enact.

P3-I-162: Temperament and maternal stress: The link between high-stress populations and effortful control

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Effortful control (EC), a subset of temperament, determines one's ability to regulate attention, adapt to novel situations, and inhibit control (Rothbart, 2012). Levels of infant EC have been shown to vary depending on stress levels of the mother. With a sample of mother-infant dyads (N = 42), this study aims to determine whether maternal stress influences EC in infants concurrently at 15 and 24 months of age, whether maternal stress at 15 months will predict EC at 24 months in infants, and discern whether high maternal stress results in mothers' misperceptions about infant EC, when compared to objective measures. Results revealed that maternal Parenting Stress Index- Short Form (PSI-SF-3) scores at 15 months were significantly negatively correlated with Infant Behavioral Questionnaire-EC at 15 months. Maternal PSI-SF-3 scores at 24 months were significantly negatively correlated with Early Childhood Behavioral Questionnaire-EC at 24 months. As expected, higher parenting stress was associated with lower infant EC. Similarly, higher parenting stress when infants were 15 months of age predicted lower EC at 24 months. No difference was observed in PSI-SF-3 between match and mismatch groups at 15 months. However, a significant difference was observed between match and mismatch groups at 24 months. Specifically, mothers who either under-reported or over-reported their child's EC when compared to objective behavioral coding of EC also reported greater parenting stress than mothers who accurately perceived their infant's EC when compared to objective behavioral coding of EC. From EC's acknowledged association with lower levels of child emotion dysregulation, the future trajectory of children's temperament may be shifted greatly due to maternal stress. Strengths and limitations of the presented study are discussed, as well as direction for future research.



P3-I-163: Mothers' perceptions of support in the NICU for direct breastfeeding their premature infants

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Purpose The purpose of this study was to describe the experiences of mothers of premature infants who desired to feed their infants at breast exclusively while in the NICU environment. **Method** A survey method was used for this study. Subjects for the survey were obtained through organizations that support parents of premature infants. An attempt was made to include mothers from across the USA. The survey consisted of questions from existing tools concerning mothers' attitude toward breastfeeding, and questions about the attitudes of others such as the doctors, nurses and the mothers' partners. In addition, questions about their specific experience and choices were also included. **Results** The survey included 478 mothers of premature infants. The majority of the respondents were White, college educated and married; 61% worked outside of the home. Upon discharge, 44% of the mothers were feeding at breast, 21% were feeding their infants formula, and 34% were feeding both at breast and formula. Sixty eight percent of the mothers stated they would have exclusively breastfed if allowed. The major factors that influenced feeding were the NICU nurses' attitudes, and the environmental and practice constraints of the NICU environment. Mothers were strongly influenced by the information provided by the NICU staff. Although the rate of direct breastfeeding differed in some regions of the US, the factors that influenced the mothers were not significantly different. **Conclusions** Most mothers in this study believed that breastfeeding is the best feeding method for their infants even with a preterm birth. Although mothers feel they are encouraged to pump breastmilk for their infants, many do not feel there is adequate support in the NICU to feed their infants at breast or to exclusively breastfeed at discharge.

P3-I-164: Do you want to read a story? Insights into the socialization of emotion understanding by parents of toddlers

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Understanding emotion promotes prosocial behavior and healthy cognition in infancy and childhood (Brownell et al., 2013). Parents likely play a significant role in the emergence of children's emotion understanding (e.g., Racine et al., 2007). However, less is known on how this influence occurs in real time. Research by Knothe and Walle (2018) found that when describing a picture book about discrete emotions (anger, disgust, fear, sadness, joy), parents of 18-to-24-month-olds differentially focused on different aspects of each emotion image (i.e., emoter, referent, label) depending on the discrete emotion being observed. The current study further examined the influence of parents' conversations on their children's emotion utterances while describing a picture book depicting discrete emotion contexts. Two-hundred and thirty-one infants (106 females; Mage = 2.47 years, SD = .26) and their primary caregivers were observed reading together a storybook consisting of professionally drawn cartoon images



featuring a child experiencing a specific emotion (i.e., anger, disgust, fear, sadness, joy) elicited by either an animate (e.g., an injured pet) or inanimate referent (e.g., a dropped ice cream cone; Gelman, 1990; see Figure 1). Parents viewed 10 images in a random order (image gender counterbalanced) each for 45 seconds and were prompted to describe each image. The parents' and infants' utterances were transcribed verbatim and processed with Python code to identify parent and infant words referencing the emoter, referent, and emotion label. Parent and child utterances were analyzed separately using repeated measures generalized linear mixed models with main effects and interactions of picture emotion and image type (animate, inanimate). We pre-registered our hypotheses on the Open Science Framework (10.17605/OSF.IO/THQRX). The results of each model and planned comparisons are displayed in Table 1. For parent variables, all main effects and interactions of picture emotion and task were significant ($p \leq .04$). For infants, the effect of picture emotion for emoter words was significant ($p = .008$), as well as the main effects and interactions of picture emotion and task for words referencing the referent ($p \leq .03$). Anger images elicited the most parent talk about the emoter and referent in anger contexts and the least emoter talk in disgust contexts. Fear contexts elicited the least referent talk and disgust images elicited the most parent emotion labeling. Of particular interest was parents' differential production of referent language as a function of animacy cues. Specifically, parents produced almost twice as many referent words in animate versions of contexts of anger, fear, and sadness as opposed to inanimate versions. Interestingly, infants' production of referent words was significantly associated with that of their parents, $r = .30$, with infants producing almost twice as many referent utterances in the animate versions of anger and fear contexts compared to inanimate versions. Taken together, these results demonstrate that parents, and to a lesser degree, infants, differentially focus on different aspects of emotion contexts as a function of emotion. Additionally, parent conversations about emotions may scaffold children's emerging emotion understanding. Implications for parental conversation as a socializing mechanism in infant emotion understanding will be discussed.

P3-I-165: Interactions of marital harmony and lasting trauma on parental depression during the transition to parenthood

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This study examined associations of prior trauma exposure on depressive symptoms in mothers and fathers during the transition to first-time parenthood. The transition to parenthood is a unique time of heightened stress (Epifanio et al., 2015), and heightened prenatal stress and perinatal parental depression are predictive of dysfunctions in child and adult well-being (Thomason et al., 2014; Huizink et al., 2003). However, "stress" rarely captures lingering trauma and rumination of negative experience as captured by post-traumatic stress symptoms (PTSS). Interestingly, little research has looked at how the magnitude of civilian PTSS impacts depression of early parents. As previous research has linked stronger marital relationships with improved parental mental health during this transition (Parfitt & Ayers, 2014), we hypothesized that trauma exposure would be linked with depressive symptom levels and that marital harmony would moderate these relations, such that linkages between trauma exposure and depressive symptoms would be less strong when marriages were harmonious than when they were not. Participants included 112 first-time expectant couples in a randomized clinical



trial of a Family Foundations (FF) coparenting adaptation intervention. Prenatal data (T0) were collected prior to intervention and postnatal data (T1) were collected 1-month after childbirth. Each parent completed three surveys at each time: the Couples Satisfaction Index (CSI; Funk & Rogge, 2007); the Beck Depression Inventory (BDI; Beck et al., 1961); and the civilian PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013). In addition, change scores for depressive symptoms were calculated by subtracting prenatal BDI scores from postnatal scores; such that higher change scores indicated increased depressive symptoms postpartum. Change score regressions controlled for parental assignment in coparenting intervention groups. Regression analyses led to disparate results for mothers and fathers. Only mothers' T0 marital harmony significantly linked to T0 depression, $p < 0.01$). No other correlations for mothers were significant. By contrast, fathers' T0 PTSS ($t(110) = 4.23, p < 0.001$), T0 marital harmony ($t(110) = -1.89, p = 0.06$), and their interaction ($t(110) = -3.54, p < 0.01$) significantly predicted prenatal depressive symptoms. Probing this interaction, results supported our moderation hypothesis in that when marital harmony for fathers was low, the link between PTSS and depressive symptoms was stronger than when marital harmony was high. Mothers did not share this interaction. T0 findings were not replicated T1 for either mothers or fathers; however, analysis of pre-to-postnatal change in depressive symptoms revealed that mothers who reported higher levels of PTSS prenatally experienced decreases in postpartum depressive symptoms compared to mothers with lower PTSS. No significant results were found for fathers in change of depressive symptoms. Consistent with expectations, among fathers, linkages between prenatal reports of trauma exposure and depressive symptoms were stronger when marital harmony was lower than when it was higher. Whereas our pre-to-postnatal change score findings were not intuitive, we believe the birth of a newborn may temporarily offset the potential impact of trauma on depression. Additional analyses will be presented, particular those that more fully examine prenatal predictors of postnatal depressive symptoms at T1 and later time points.

J-Translational Science and Policy

P3-J-166: Child temperament as a moderator of parent functioning among families participating in the Promoting First Relationships intervention

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As numerous parent-child interaction interventions are now available (National Center for Parent, Family, & Community Engagement, 2015), Early Head Start (EHS) is a relevant context to test parenting models with infants and toddlers in US low-income families (e.g., Berlin, Martoccio, & Jones Harden, 2018). We trained EHS staff to incorporate the Promoting First Relationships intervention (PFR; Kelly, Zuckerman, Sandoval, & Buehlman, 2008) into ongoing weekly home visits with young children and mothers. We were interested in the role of child temperament in moderating outcomes of PFR, when incorporated into everyday EHS practice. Our research question was: Does child temperament influence the effectiveness of PFR in (1.) reducing parenting stress, (2.) improving family functioning, and (3.) promoting positive parent-child interactions? EHS families ($n = 102$) were randomly assigned to an intervention



group where they participated in the 10-session PFR intervention at the outset of the study, or to a waitlist-control group where they received typical EHS services. Children had a mean age of 19.8 months; 45% were female. Families were typically in poverty, with a mean monthly income of US \$1,695. Children were primarily Hispanic (56%) and Black, non-Hispanic (23%). Mothers completed these questionnaires pre- and post-intervention: the Parenting Stress Index (PSI-SF; Abidin, 1990) to measure parenting stress, the Family Assessment Device (FAD; Epstein, Baldwin, & Bishop, 1983) to measure family functioning, and the Infant Behavior Questionnaire (IBQ-R VS: Putnam, Helbig, Gartstein, Rothbart, & Leerkes, 2014) or Early Childhood Behavior Questionnaire (ECBQ VS; Putnam, Jacobs, Gartstein, & Rothbart, 2010) to measure child temperament (surgency, negative affect, effortful control). Parent-child interactions were observed by researchers using a play-based assessment, the Three Bags Task (NICHD Early Child Care Research Network, 1997). For the control group, data collection sessions were spaced approximately 14 weeks apart. We used linear regression to examine children's temperament as a potential moderator of PFR efficacy on outcomes related to parenting stress, family functioning, and parent-child interaction. For families where children showed higher levels of surgency (extraversion), after participating in PFR mothers' parenting stress was significantly reduced, with decreases in both the Difficult Child and Parent-Child Dysfunctional Interaction subscales of the PSI. See Table 1. Increases in positive family functioning approached, but did not reach, statistical significance. Finally, when children showed higher levels of negative affect, mothers demonstrated higher sensitivity in parent-child interactions after participating in PFR. See Table 2. As children's temperament moderated relationships with some family outcomes associated with PFR, this suggests that family characteristics are relevant to the selection of parenting curricula in programs such as EHS. In a recent latent profile analysis using a national EHS sample, Dalimonte-Merckling and Brophy-Herb (2019) found that two of three identified profiles paired temperamentally reactive children and mothers having challenges with parent-child interactions and parenting stress. Our findings suggest that parenting interventions including PFR have potential to serve as a buffer in such situations, reducing parents' stress levels while promoting positive parent-child interactions.

P3-J-167: Birth-related pain, fatigue, & perceived trauma: Can regular maternal-infant skin-to-skin contact influence healing after delivery?

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Research on caregiver-infant skin-to-skin contact (SSC) shows myriad health benefits for preterm and low birthweight infants and beneficial effects on maternal mood and behaviour, even months after birth (e.g., Feldman et al., 2002). In healthy infants, post-delivery SSC has been associated with decreased infant pain and faster infant healing (e.g., Gray et al., 2000). Despite this, few studies examine the potential long-term effects of regular SSC on mothers of healthy, full-term infants. The only published study found that SSC mothers had lower levels of depressive symptoms and reduced physiological stress than mothers in a control group one-month post-birth (Bigelow et al., 2012). Considering these effects on physiological and mental health, it is reasonable to propose that maternal physical health may also benefit. The current study is a randomized controlled trial investigating whether daily SSC between



mothers and their healthy, full-term infants influenced maternal reports of pain, fatigue, and perceived birth-related trauma over time. Method: Participants were 116 healthy mother-infant dyads (56 SSC intervention; 60 control). Mothers in the SSC group were asked 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 reported on their pain, fatigue, and perceived birth-related trauma at 2, 5, 12 and 52 weeks after birth. Pain was assessed using two questions modified from the Medical Outcomes Scale SF-36 (Ware & Sherbourne, 1992), fatigue was assessed using the Multidimensional Fatigue Inventory (20 items; Smets et al., 1995), and perceived trauma was assessed using the Traumatic Experiences Scales - Birth edition (17 items; Wijma, 2012). Maternal outcomes were examined individually in a repeated measures multi-level framework with theoretically relevant control variables. Results: No differences were found between the SSC and control condition on maternal reported pain or perceived birth related trauma, even when only mothers in the SSC condition who strictly adhered to the daily hour of SSC during the intervention period were selected (N = 16). Preliminary analyses looking at maternal reports of fatigue at weeks 12 and 52 indicate that mothers in the SSC felt more fatigued at 12- but not at 52-weeks post-delivery. Planned analyses (once all data have been fully entered) incorporating fatigue data from weeks 2 and 5 will examine whether this was a one-time phenomenon or a trend. We also plan to examine clinical levels of birth-related PTSD as a potential moderator of the intervention's effects on pain and fatigue. Discussion: Preliminary results indicate that an intervention designed to promote SSC between mothers and their full-term, healthy infants had no effects on maternal perceptions of pain or trauma over time. However, 4 months after the birth (and 7 weeks after the cessation of SSC), mothers in the SSC condition reported feeling more fatigued than mothers in the control condition. Until we examine these data across time, we refrain from interpreting this result. Finalized results will be discussed in terms of their clinical and practical implications.

P3-J-168: Does the perception of young infants developmental status vary with the educational background of the observer?

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To assess infants' developmental status researchers often collect data from parents or daycare teachers via questionnaires, observation sheets, or interviews. These measures can be biased, however. The relation to the child, knowledge about early development, and the general educational background of the observer may impact results. Studies exploring such biases are still rare. MONDEY (Milestones of Normal Development in Early Years, Pauen, 2011; 2018) is a standardized observational tool for caregivers to assess the developmental status of infants, aged 0 to 3 years. Caregivers read rather precise descriptions of everyday behaviors and judge whether they have already observed a given behavior in the child or not. Interestingly, parents were found to judge more milestones as achieved than daycare teachers (Heilig & Pauen, 2013). Furthermore, parents with higher education considered fewer milestones to be achieved than less educated parents (Pauen et al. 2019). The present study aimed at replicating these findings with a larger sample (N = 271) and a broader age-range of infants (i.e. 0-30 months). Data were derived from the MONDEY-Interactive platform (www.monday.de). We compared evaluations from daycare teachers and parents with either



a high education (college or university degree) or a lower education (middle or high school diploma). Each of these four groups revealed the same age-distribution of infants and a similar sample size. Developmental scores for each infant were summed up across all MONDEY dimensions (gross and fine motor, perception, cognition, language, social and, emotional development) and later z-standardized to account for age-differences in the total number of achieved milestones. A z-score of Zero reflects the hypothetical mean score within a given age-population independent of observer group. A 2 (participant group) x 2 (educational background) ANOVA with MONDEY z-Score as dependent measure revealed a significant effect for group, $F(3,267) = 14,57$, $p < .001$. Parents rated the developmental status of infants to be higher ($M = 0,31$, $SD = 0,63$) than day care teachers' ($M = -0,36$, $SD = 1,05$), $p < .001$. No differences were found with respect to the educational background of the observer. When running the same kind of analyses with scores for MONDEY dimensions that are more difficult to evaluate because they refer to mental or social skills (i.e. perception, cognition, social and emotional development), we again found a group effect, $F(3,267) = 14,44$, $p < .001$. This time, evaluations of parents ($M = 0,29$, $SD = 1,04$) and day care teachers ($M = -0,35$, $SD = 0,65$) differed significantly ($p < .001$). Consistent with Pauen et al., (2019), low educated parents reported a higher developmental status than parents with high education, $p < .05$, whereas no such difference was found for daycare teachers (see Figure 1). Even though the origins of these differences cannot be determined based on the data presented, our findings point out that any evaluation of a given infant's developmental status may vary with the background of the observer - especially when parents are asked about their own child. Implications for diagnostics and education will be discussed.

P3-J-169: Embedding language promotion in primary care: Preliminary evaluation of Talk With Me Baby

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Introduction: The quality and quantity of a child's early language interactions with caregivers supports critical brain development and paves the way for more optimal outcomes. Children in low-income families, compared to those in higher-income families, are less likely to receive optimal language interactions (Hart & Risley, 1995; Hoff, 2013; Rowe, 2017). This inequality can create life-long disadvantages in academic performance, graduation rates, income, and health outcomes (Heckman, 2006; National Center for Education Statistics, 2013). Finding ways to reach large proportions of parents (and an estimated 16 million American children; Child Trends, 2015) with information about how to promote their child's language development has been a significant challenge. The pediatric primary care setting is an untapped conduit for this work. In the current study, our goal was to evaluate the feasibility of Talk With Me Baby (TWMB) - a system-level universal language promotion approach for healthcare and community settings. Nurses are trained to deliver education and modeling/coaching for parents in how to engage in language-rich interactions with their child. Participants: In a pediatric primary care clinic, serving a diverse and low-income population (78% Medicaid), nurses ($n=10$) were trained to implement TWMB during WCC for all children under 3 years of age. Parents and their child ($n=63$) were enrolled at their child's 1- or 2-month well-child check (WCC) visit. See Table 1 for demographics. Measures: Nurses outcome measures included:



(a) gains in knowledge about language development and evidence-based promotion practices; (b) perception of TWMB usability/acceptability; and (c) fidelity/implementation rates (collected from the electronic medical record). Parents completed surveys at three time points (1- or 2-month WCC/baseline, 4-month WCC, and 6-month WCC) to measure: (a) their knowledge and language promotion practices with their child; and (b) perception of TWMB usability/acceptability (at 6-month WCC only). Results: After TWMB training, nurses reported gains in their knowledge about TWMB (90% agree or strongly agree), would recommend the program to other nurses (90% agree or strongly agree), perceived the program as important for support child development (90% very important). During the initial phase of implementation, nurse reported perceiving TWMB as feasible and important (87%=strongly agree TWMB is feasible to deliver during WCC; 100 strongly agree TWMB education and coaching is important to their own professional practice). Data collection for parents knowledge and language interaction behaviors is ongoing. We have completed data collection for all baseline (1- or 2-month) WCC's (see Table 1) and we will complete data collection for 4- and 6-month WCC's in March 2020. Data on fidelity and rates of implementation will also be available at the time of the conference. Conclusions: Results offer preliminary evidence for the feasibility and acceptability of embedding universal language promotion in a pediatric primary care clinic serving an at-risk and diverse population. Results will have implications for scaling the intervention to a larger scale controlled evaluation trial of the efficacy of language promotion within the primary care setting.

P3-J-170: What do expectant mothers from low income urban communities know about child development?

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Many studies have focused on disparities seen in early development in young children growing up in under-resourced communities (e.g., Hoff, 2013; Noble et al., 2015) These disparities, however, are likely to exist even before birth and pregnancy is an important time at which to engage with parents from disadvantaged communities to develop effective interventions. We describe expectant parents' knowledge of child language development, beliefs and attitudes about parenting, and psychosocial characteristics collected from survey interviews. We asked: What do expectant parents know about infants' early cognitive and communication skills? And how does this differ by factors such as self-efficacy, stress, and financial strain? Stress, knowledge and attitudes were assessed using an interview made up of several standardized questionnaires and demographic questions. Data was collected from 43 mothers (mean age 29.3 years, SD 5.32) recruited from community health clinics and workshops. Sixty-one percent of the sample reported annual household incomes of under \$15,000. Mothers' knowledge of child development was examined using the Knowledge of Infant Development Inventory (KIDI; Center for Prevention Research and Development, 2016). This focuses on developmental knowledge across language, motor, cognitive, social, and behavioral domains using true/ false questions. Mean overall scores were 40.5/58, (SD 4.9). Overall, scores were similar to those collected by Alper et al. (2019) for a low-income sample of mothers. KIDI scores were not associated with stress or annual household income, and the level of education mothers received about child development was not associated with any other measures.

Stress was measured using the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983). Stress in this group was lower than might be expected in other low-income groups of mothers, with a mean score of 14.67 (SD 9.55) out of a maximum stress score of 40. Another study of pregnant women reported a higher mean PSS score of 18 (Chaaya et al., 2010), suggesting that our sample was resilient. Resilience is an important protective factor in the face of adversity. The teaching and play subscales of the Self-Efficacy for Parenting Tasks-Toddler Scale (Coleman & Karraker, 2003) were used to measure parents' perceived efficacy as their child's future playmate or teacher. The mean score for this group was 85.23 (SD 87), similar to that of caregivers from another low-income sample: 81.0 (Alper et al., 2019). Mothers scored a mean of 47.9 (SD 4.94) on the teaching scale, and a mean of 37.4 (SD 4.94) on the play scale. Parenting self-efficacy and knowledge of development were positively associated ($r=.341$, $p=.03$). So, parents who thought they were good playmates and teachers also had higher knowledge of child development. We will also present data about which sources of knowledge about development these mothers consulted. Overall, these data provide us with an important foundation for building interventions aimed at expectant mothers from low-income neighborhoods by giving us with information about their knowledge and the difficulties they face.



Poster Session 4

A-Motor and Sensorimotor Processes

P4-A-1: Enhancing diurnal cortisol regulation for internationally adopted infants and young children with a parenting-based intervention

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Infants and young children in institutional care settings exhibit dysregulated hypothalamic-pituitary-adrenal (HPA) axis activity. Specifically, institutionalized children have lower wake-up cortisol levels and flatter diurnal cortisol slopes than non-institutionalized children (Carlson & Earls, 1997; Chernego et al., 2019). The consequences of early institutionalization for HPA axis activity persist after children are adopted into highly enriched caregiving environments (Johnson et al., 2011; Flannery et al., 2017). This pattern of dysregulated HPA activity is associated with behavioral problems (Koss et al., 2014). The objective of this study is to evaluate the efficacy of parenting-based intervention for improving diurnal HPA axis functioning among infants and young children adopted internationally after experiencing early institutionalization. The Attachment and Biobehavioral Catch-up (ABC) intervention was designed to enhance biological and behavioral regulation in young children who experienced early adversity (Dozier & Bernard, 2019). ABC has been shown to improve diurnal HPA activity among children involved with Child Protective Services (Bernard, Hostinar, & Dozier, 2015). The current study examines whether the ABC is also effective at altering HPA axis functioning among children adopted internationally. The study involved 85 infants and young children (48% female) who had been adopted internationally when they were between 4 and 33 months old ($M = 16.12$). Prior to being adopted, over 70% of the children had experienced institutional care. Adoptive families were enrolled in the study shortly after the adoption. Families completed a pre-intervention assessment and then were randomly assigned to receive either the ABC intervention ($n = 46$) or the control intervention ($n = 39$). The ABC intervention focused on increasing parental nurturance to child distress, increasing synchronous parent-child interactions, and decreasing frightening parental behaviors. The control intervention provided educational information about child development to parents. Both interventions were manualized and involved 10 sessions implemented by a trained parent coach in families' homes. In order to measure diurnal HPA activity, parents collected salivary cortisol samples from children at the time of wake-up and at bedtime on three separate days. Salivary cortisol samples were collected during an initial assessment with families prior to the interventions and between 1 and 8 months after the intervention. Cortisol outcomes prior to the intervention were examined to ensure there were no preexisting differences between children who had been randomly assigned to the ABC intervention versus the control intervention. Prior to receiving the interventions, the two groups of children had similar wake-up, bedtime, and diurnal cortisol levels (Figure 1). However, differences between the two groups of children were apparent after the interventions (Figure 2). Specifically, children who had received ABC group had higher wake-up cortisol values ($\beta = .36, p < .001$) and steeper diurnal slopes ($\beta = -.26, p = .034$) than children who had received the control intervention. Bedtime cortisol levels did not significantly differ between children who had received ABC versus the control



intervention. In conclusion, the ABC intervention promoted a healthy pattern of diurnal HPA axis regulation among infants and young children who had been adopted internationally.

P4-A-2: Sensorimotor and visual body experience accelerate mirror self-recognition

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Mirror self-recognition is often used as an index of early self-concept. Mirror self-recognition is commonly tested by placing a spot of makeup/face paint on infants' faces, and then seeing whether they attempt to wipe off or point to the spot upon looking in the mirror. This ability appears to be present in about half of children by around 18-20 months of age (Amsterdam, 1972; Brownell et al, 2010). It is likely related to noticing a contingency between one's own movements and a reflection (Bahrick & Watson, 1985). We attempted to accelerate self-recognition by providing earlier contingent mirror and sensorimotor body experience using a tactile/visual stimulus (1.5 cm vibrating buzzer). Experimental group infants had also previously participated in a face reaching task away from the mirror with the vibrotactile stimulus. Experimental group infants came in for monthly visits starting at 14 months of age (N=17). They touched or removed the buzzer after it was applied to the face away from and then when facing a mirror. Subsequently, we tested whether they reached/pointed directly to a spot of green face paint and/or verbally indicated self-recognition when looking in the mirror. The average age of self-recognition was 16.32 months (number of infants with self-recognition before 21 months = 15). We age-matched a control group (average age = 16.41 months) to the age of first self-recognition for each infant in the experimental group. Twelve out of 15 infants in the age-matched control group did not appear to respond to the rouge, indicating earlier self-recognition for the experimental group (Fisher's exact test p-value <.05; Figure 1). Only 1/15 control group infants reached directly to the rouge while looking in the mirror. (The other two infants reached to the general region of the face where the rouge was applied but did not directly contact the mark.) Results suggest that additional tactile/visual stimulus experience before a mirror accelerated self-recognition, and that mirror self-recognition appears related to sensorimotor body knowledge.

P4-A-3: Development of infants' means-end problem solving in relation to gross motor milestones

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INTRODUCTION. Cognitive development during infancy can be tested with means-end problem-solving (MEPS) tests like the towel-pull test, which involves pulling a towel (means) in order to obtain an out-of-reach toy (end) supported by the towel. This task evaluates infants' understanding of relations between objects, and ability to identify goals and plan and implement a sequence of actions (Brandone, 2015; Piaget, 1953; Sommerville & Woodward, 2005; Willatts, 1999). Successful MEPS depends on the development of sensorimotor abilities, such as postural control, visual attention, reaching, grasping, and object manipulation



(Bremner, 2000; Johnson, Slemmer, & Amso, 2004; Lobo & Galloway, 2008). The current study aimed to empirically evaluate the relation of infants' fine and gross motor development to their MEPS skills to characterize motor-cognitive relations during infancy. METHODS. Twenty-four infants born full-term (14 males, 37-42 weeks gestation, Mean=39.4±1.1) and 30 infants born preterm (10 males, 22-30 weeks gestation, Mean=26.5±1.7) were tested longitudinally for MEPS and motor development milestones at 6, 9, 12, 18, and 24 months. MEPS was assessed in a towel-pull task (three 30-sec. trials). MEPS trials were classified as successful (toy contact with prior visual attention to the toy) or unsuccessful (otherwise). All recorded behaviors were categorized as goal-directed (GDB; likely to lead to toy attainment) or non-goal-directed (NGDB; not likely to lead to toy attainment); percent time performing each category of behaviors was calculated. Infants' motor development was assessed via the fine- and gross-motor subscales from the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III); raw scores were used for analyses. Inter- and intra-coder reliability exceeded 95%. Hierarchical Linear Modeling was used to relate infants' MEPS to motor outcomes. RESULTS. Infants with more advanced fine and gross motor skills performed more GDB and less NGDB. They also showed higher rates of success in MEPS compared to those with less advanced motor skills (Tables 1 & 2). DISCUSSION. From 6 through 24 months of age, infants' with more advanced fine and gross motor skills were more successful in the MEPS task. These results suggest that infants with more developed motor skills may have a better understanding of means-end relations and are better able to problem-solve, plan, and execute the actions necessary for MEPS. Early motor behaviors, including reaching, object exploration, sitting, and mobility, likely facilitate early learning and cognitive development (Bahrick et al., 2004; Bushnell & Boudreau, 1993; Dusing & Harbourne, 2010; Gibson, 1988; Soska et al., 2010). Early intervention should target these fundamental fine and gross motor skills to advance infants' problem-solving skills.

P4-A-4: Is toddlers' motor expertise related to the accuracy and stability of their action prediction?

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Predicting others' actions is essential for interacting in the social world (Sebanz & Knoblich, 2009). Action predictions are built upon the same neural motor plans that are used for action execution (Kilner et al., 2007; Wilson & Knoblich, 2005). Consequently, when children learn a new motor act, they acquire a motor representation of it that enables them to predict the same action in others (Stapel et al., 2016). More active experience might lead to a more stable motor representation of the action, which may be reflected by reduced movement variability when carrying it out (Chen et al., 2010). This study aimed to examine the relationship between toddlers' motor expertise in placement action and the temporal accuracy and stability of their predictions when observing others performing it. Fifty-eight 20-month-old toddlers (34 girls, mean age: 20 months) were tested in a within-subjects design with eye tracking and motion tracking tasks. Firstly, toddlers were presented with a set of videos of an adult actor carrying out a placement action, while their eye gaze was recorded. The actor grasped a toy, transferred it to the other side of the screen and placed it on a higher surface off the screen



(Figure 1a). Part of the screen was always occluded by a black rectangle, so that for a short time, the actor's movements were hidden from view. Toddlers' action prediction was operationalized as their fixation to the area of reemergence of the hand grasping the toy from behind the occlusion that was closest in time to the actual event. Then, toddlers' motor expertise was measured by recording their execution of the same action with a motion tracking system. They had to transfer a ball from a lower surface to a higher one (Figure 1b). The toddlers who displayed more mature and adult-like velocity profiles of action execution were expected to be more accurate in their temporal predictions of others' actions. Thus, mean velocity and the point of peak velocity were expected to relate to action prediction accuracy (average difference between children's prediction and hand reemergence). Moderate evidence was found for a lack of relationship between those measures (Table 1, BF01 = 5.2). Moreover, children's predictive looks were not anticipatory, i.e. they were on average approximately half a second after the start of the hand re-emergence. The toddlers who displayed more stable movements (low movement variability) were expected to be more stable (less variable) in their predictions of others' actions. Consequently, variability in movement time and straightness ratio of toddlers' movement were expected to relate to the variability in action prediction (the difference in action prediction across trials). Moderate evidence was also found for a lack of linear correlation between action stability and movement time variability (p n.s., BF01 = 3), and straightness ratio (p n.s., BF01 = 3.7). To sum up, we found no evidence for the hypothesized links between motor expertise and action prediction. These results can be explained in terms of children's failure to make anticipatory eye movements during the unfolding of the action, either due to lack of motivation or ability. Furthermore, children's advanced proficiency in the action execution at that age could have resulted in too low individual variability to allow for correlational analysis.

P4-A-5: Does infant supine head orientation preference predict hand preference trajectories across infancy?

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Background and Aims: Michel (1981) demonstrated that neonatal supine head orientation preference (SHOP) predicts hand-use preference when reaching for objects at 22 weeks. Michel proposed that the SHOP contributes to lateralized differences between the hands, differences which extend to the development of arm and hand control when maneuvering toward objects located in space. Michel (1983) hypothesized that the neonatal head orientation preference reflects later developing hand preference via a cascade of neuromotor events. Head orientation preference leads to visual asymmetries of the hands, which contributes to differences in neuromotor activity between the hands. Differences in lateral neuromotor activity contribute to a bias in skill, leading to hand preference. This study, demonstrates a connection between infants' head-orientation preferences and hand-use preferences throughout the child's first year, using lateralized hand movements from 4-16 weeks, and handedness assessments from 6 to 11.5 months. Methods: SHOP was assessed in 11 infants at 4 and 8 weeks, infants' heads were held in mid-line for 60 seconds, and behavior was recorded for 60 seconds after release, in order to assess SHOP (Michel, 1981). Infants were observed for hand preference while sitting in a semi-upright position at 4, 8, 12, and 16 weeks using observations of arm movements, wrist movements, finger wiggles, self-touch of the



upper and lower body, and object touch, based on previous procedures (Thomas, Karl, & Whishaw, 2015). At 6, 7.5, 9, and 11.5 months, handedness was assessed using established procedures (Michel et al., 2014). Z-scores for SHOP and hand preference were determined using the frequency of right and left-lateralized movements. A linear regression analysis was conducted to predict hand preference z-scores (from 8 data points) based on SHOP. Results: The strength and direction of the relation between SHOP, and handedness from 4 weeks to 11.5 months was examined using a regression analysis. The results of the regression analysis show that as z-scores for SHOP increase, z-scores for hand preference increase as well. Conclusion: This study demonstrates a relation between infant SHOP, an early neuromotor asymmetry, and hand preference, as measured by self-touch and handedness assessments throughout infancy. Infant SHOP predicted hand preference; as z-scores for SHOP became more lateralized, z-scores for hand preference also became more lateralized. These results support the cascade theory of development which states that the development of new behavior is based on previous behaviors (Michel, 1983). Further evidence for the mechanisms by which infants continue to become increasingly lateralized should be investigated.

P4-A-6: BabyRhythm: Early infant audio-motor rhythmic synchronization predicts later language outcomes

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The BabyRhythm project is a longitudinal study of 113 infants from two- to 30-months-of-age, investigating the importance of neural entrainment and motor synchronization to acoustic rhythm patterns for typical language development. In child populations, the temporal accuracy of neural rhythmic entrainment and of tapping to the beat are predictive of phonological language outcomes, but infant studies are not yet available. Multiple infant entrainment measures using EEG and motion capture were taken over the first year of life, and a battery of language outcome measures was then administered over the pre-school years. We expected individual differences in infancy to predict later language outcomes. To measure audio-motor rhythmic synchronisation, motion capture technology recorded infant drumming to a 2 Hz (500 ms inter-onset-interval; IOI) fixed rate drum beat ('Drum'), a 2 Hz repetition of the syllable 'ta' ('Syllable'), and baseline spontaneous drumming rate ('Spontaneous Motor Tempo'; SMT). For the current analyses, 30 five-month-old infants were pseudo-randomly selected. Not all infants produced a drumming response in all conditions (SMT N = 27, Drum N = 21, Syllable N = 14). Across conditions, infants drummed with a periodicity of around 800 ms (Table 1). In order to determine if infants were matching their movement to the auditory stimuli presented, a difference score was calculated between the mean periodicity of infant drumming and the target IOI of 500 ms. Lower tempo mismatch reflects less difference from the target ISI and can be considered more accurate performance (Table 1). No difference between conditions ($p > .05$) suggests infants were not reliably adjusting away from their SMT, consistent with expectations for this young age group. Five-month performance can be further viewed in relation to our two earliest language outcome measures. The Communicative Development Inventory (CDI) was first administered to our cohort at 10-months-of-age, and is a parent report measure of vocabulary comprehension and production. The Computerized Comprehension



Task (CCT) is an active measure where infants indicate which of two items pictured on a touchscreen represents a spoken label, and was first administered at 12-months-of-age. Regression analyses confirmed that tempo mismatch in the Drum condition at five-months predicted language production ($F(2,18) = 4.93, p = .0394, R^2 = .215$), though not comprehension ($F(2,18) = 1.31, p = .267, R^2 = .0679$), for the CDI at ten-months. Similarly, tempo mismatch at five-months in the Syllable condition trended towards predicting language production ($F(2,11) = 3.57, p = .0854, R^2 = .245$), but not comprehension ($F(2,11) = 2.13, p = .17, R^2 = .151$), at ten-months. Further, tempo mismatch in the Drum condition at five-months predicted performance in the CCT at 12-months ($F(2,10) = 9.19, p = .0127, R^2 = .479$), Figure 1). Our preliminary results confirm that infant audiomotor rhythmic synchronization at five-months-of-age can predict language outcomes measured at ten- and twelve-months. As we continue to collect outcome data, and synthesize our infant neural data from the same population, we hope to build a comprehensive picture of the critical role of rhythm in language development.

P4-A-7: Motor planning deficits in toddlers with autism spectrum disorder

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Background Behavioral studies have shown that individuals with autism spectrum disorder (ASD) have problems coordinating their own motor actions (meta-analysis: Fournier et al., 2010). There is also evidence that delays and atypical patterns of development emerge early in the onset of ASD (Iverson et al., 2019). One hypothesis is that motor impairments in ASD are due to difficulties in motor planning. The present study explored two EEG markers during the execution of motor actions to shed light on the neural processes involved in planning and executing actions in toddlers and preschoolers with and without ASD. Methods Participants were between the ages 21 and 59 months (mean age = 41.1 months). Quality data was obtained from 23 typically-developed (TD) children and 23 children with ASD, whose diagnoses were confirmed on the ADOS-2. The toddlers engaged in a task with a minimum of 15 trials in which they grasped a small toy (e.g., fish) placed on the table and placed it in a container (fishbowl). EEG data were recorded during action execution to measure frontal theta activity, as an index for motor planning, and central alpha activity, as an index for motor activity. Results Frontal theta activity immediately after action onset revealed group differences in recorded power, $F(1, 40) = 5.47, p = .02, \eta^2 = .12$, with the ASD group ($M = -.23; SD = .88$) showing less frontal theta power compared to the TD group ($M = .67; SD = 1.50$). During the execution of the actions (grasp and place), the two groups did not differ in central alpha power, $F(1, 40) = 0.37, p = .55, \eta^2 = .01$. Conclusion The current results provide new support for the hypothesis that children with ASD struggle with the planning of their action, but have similar activation in motor cortex during action execution when compared to TD children. This finding helps us to better understand the neural processes that underlie motor deficits in young children with ASD. If the difficulties are specific to motor planning, this would suggest the need for new or modified therapies to improve motor skills in ASD.

P4-A-8: Quantity and quality of motor affordances in the low socioeconomic status infants' home



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Introduction: During the first year of life, infants are in constant process of neuroplasticity (intense neurogenesis, migration neuronal, synaptogenesis, myelination, grow axonal and dendritic). The particular biological, physical, chemical, social and psychological factors of each individual directly influence on the development of motor, cognitive, personal-social and language functions. Therefore, infants receive, interpret and respond to the extrinsic affordances of the environment. Since there are 3.4 billion individuals, slightly less than half of the world's population, in poverty, unable to meet basic life needs, it is of paramount importance to ascertain whether low socioeconomic status can influence on the quantity and quality of affordances in the infant's home in their early childhood. Methods: Participants in the study, 102 infants born at term, healthy, which are divided into two groups in accordance with the socioeconomic status, classified according to the ratio of household income to the poverty level specific to area of residence, Poverty Income Ratio (PIR), associated to the level of schooling maternal: infants without social environment risk (Without -RG, n = 51, age = 3.50 months (± 0.59), PIR = 5.95 (± 7.89)), and infants with social environment risk (With -RG, n= 51 age = 3.53 months(± 0.49), PIR= 1.28 (± 0.50)). All the responsible for the infants responded to Brazilian version of Affordances in the Home Environment for Motor Development - Infant Scale (AHEMD-IS), an inventory that measures the quantity and quality of affordances in the home by the dimensions (Space, Variety of Stimulation, Gross- Motors Toys, and Fine-Motor Toys, Total Score). The scores obtained on the dimensions were analysed and compared to the intergroups. Descriptive analysis and Mann-Whitney test were performed, with a significant level of 5%.Results: When compared to Without -RG, With -RG showed significantly less affordances in the Gross-Motor Toys dimensions (U = 797.00; z = -3.43; p = 0.01; r = 0.33; With -RG, md = 2.00 [1.61 - 2.38] vs Without -RG, md = 3.00 [2.78 - 4.04]); Fine-Motor Toys: U = 779.50; z = -3.59; p <0.01; r = 0.35; With-RG, md = 1.00 [0.81 - 1.76] vs Without-RG, md = 2.00 [1.94 - 3.19]) and Total Score: U = 714.50; z = -3.93; p <0.01; r = 0.38; With-RG, md = 15.00 [14.91-16.85] vs Without-RG, md = 19.00 [18.00 - 20.81]). In the dimensions Space (U = 1264.50; z = -0.24, p = 0.80, r = 0.13; With-RG, md = 2.00 [1.90 - 2.80] vs Without-RG, md = 3.00 [1.95 - 2.82]) and Variety of Stimulation (U = 1102.50; z = -1.34; p = 0.18; r = 0.13; With-RG, md = 11.00 [9.63 - 10.87] vs Without-RG, md = 11.01 [10.27 - 11.76]) there was no difference and significance between the groups. Conclusions: Infants exposed to the low socioeconomic status may have less motor affordances in the home for the development of motor function, cognitive, personal-social and language to 3 months, compared to infants who are not exposed to low socioeconomic status. The poverty directly influences on childhood, because the development process requires experiences, social interactions, motor affordances, health, housing, nutrition, appropriate stimulus, key elements, so that infants explore their full potential development psychomotor which contributes to the functionality and social participation, supporting the formation of healthy and active adult individuals in society. Acknowledgements: São Paulo State Research Support Foundation.

P4-A-9: Are there differences in bimanual performance according to handedness, toy, or age?

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Background and Aims: A relation between handedness for acquiring objects and role-differentiated bimanual manipulation (RDBM) was demonstrated with infants using the same hand to perform these actions despite handedness for RDBM appearing months after that for acquisition (Babik & Michel, 2015). RDBM occurs when one hand stabilizes an object while the other hand performs a fine motor action on the object. These complex actions require two hands working together to accomplish a goal (Babik & Michel, 2015). Previous research has demonstrated that consistent handedness provides an advantage for performing cognitive functions (Nelson et al., 2017), that toy-type affects the frequency of RDBMs performed (Babik & Michel, 2015), and that RDBM frequency increases with age (Nelson et al., 2013). This project assessed the effect of handedness consistency, toy-type, and age on RDBM performance. Specifically, our research questions focus on whether these factors will influence the speed with which an infant can perform RDBM actions. **Methods:** Data from 44 infants (11 early-right, 11, late-right, 11, late-left, 11 no-preference for acquiring objects) were derived from archived videos to explore the relation of acquisition hand preference, toy-type, and age with RDBM efficiency (speed of an infant completing an RDBM). This project used video data from 9- to 14-months for each infant. Infants were presented with a set of 30 objects which afford and promote RDBM actions. Objects elicited simple (poking, stroking, or sliding) or difficult actions (pushing, pulling, spinning, twisting, insertion, or removal). A research assistant demonstrated the object, then presented the object to the infant on the surface of a large table. The time to complete simple and difficult RDBMs were recorded for each object. The start time was indicated by the infant's initial contact with an object and stop time was indicated by completion of a RDBM action. **Results:** A mixed repeated measures ANOVA between age and handedness with a Greenhouse-Geisser correction revealed a main effect of age on RDBM speed, $F(3.41, 105.60) = 10.93, p < .001$. There was no significant effect of handedness ($F[3, 31] = .843, p = .48$) and no interaction between age and handedness ($F[10.22, 105.60] = 1.76, p = .08$). Bonferroni post hoc tests showed that RDBM speed at month 9 was significantly different from months 11-14 (see Fig. 1). A one-way repeated measures ANOVA with a Greenhouse-Geisser correction revealed that object-type does not have a significant effect on RDBM speed, $F(1, 45) = .05, p = .83$. **Conclusions and implications:** Infants with different handedness did not demonstrate different times to complete RDBM. The type of object does not affect speed of RDBM performance. The average times for RDBM completion decreased across age, meaning RDBM efficiency increased with older infants. Any differences that may exist between handedness groups for speed when performing RDBMs may occur sooner than 9 months.

P4-A-11: Tools for reproducible developmental science

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Many fields of scientific research face daunting challenges of reproducibility. The science of infant development is no exception. In this presentation, we will describe a set of free and open source software tools we have developed that support fully reproducible data collection, cleaning, visualization, and analysis workflows that are suitable for many types of developmental research, including studies using video recordings. The tools draw upon data



stored in the Databrary.org data repository and use packages written in R and Python to access data using the Databrary API and manipulate it using cloud storage services like Box. The tools can be readily adapted by other development researchers for use in their own data processing pipelines. Example use cases will be drawn from the Play & Learning Across a Year (PLAY) project, a large-scale study of natural mother-infant behavior in the home.

P4-A-12: Does how I walk matter to you? The examination of whether gait parameters are predictive of toddlers gross motor skills

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The Peabody Developmental Motor Scales (PDMS-2; Folio & Fewell, 2000) is a standardized tool utilized worldwide to assess toddlers' gross motor skills (see Tavasoli, Azimi, & Montazari, 2014; Veldman, Santos, Jones, Sousa-Sá, & Okely, 2019), with numerous studies providing support for its test-retest reliability (Griffiths, Toovey, Morgan, & Spittle, 2018) and high concurrent validity with other commonly used assessment tools (e.g., the Bayley Scales for Infant & Toddler Development [Bayley-III]; Bayley, 2006; Gill et al., 2019). Little research has focused upon how the scores from the PDMS-2 and the Bayley-III are related to the parameters of one's gait. The current study therefore aimed to provide insight into the nature of the relationship between toddlers' gait parameters and their overall gross motor skills. Twenty-eight toddlers between the ages of twenty-three to forty-two months were recruited to complete a series of tasks that assessed their gait parameters (via the GAITRite mat; CIR Systems Inc., 2014) and their gross motor skills (via the PDMS-2 and the Bayley-III). Structural equation models were subsequently tested to examine whether objective measures of toddlers' gait parameters (e.g., spatiotemporal or spatial gait measures) were predictive of their gross motor skill performance on standardized assessment tools. Two models (a primary and alternate model) were tested using structural equation modelling (MacCallum & Austin, 2000), and BIC-based model comparisons were utilized to determine which model fit the data better (using the Lavaan package in R Studio Version 1.2.5001 [RStudio Inc, 2019]). The absolute difference between the BIC values for the primary and alternate theoretical models was greater than 10, providing strong support for the model with the lower BIC-value: the primary theoretical model (Kass & Raferty, 1995). As illustrated in Figure 1, the primary structural equation model examined the relationship between two latent variables: the toddlers' gait parameters (a construct measured via the spatial gait parameters collected on the GAITRite mat) and their gross motor skills (a construct measured via the locomotion subtest scores of the PDMS-2 and the gross motor scores of the Bayley-III). The alternate structural equation model (Figure 2) utilized the spatiotemporal aspects (e.g., velocity and cadence) of toddlers' gait as measures to quantify the construct of gait parameters. Although both the primary and alternate models appeared to have a good fit (with the primary model fitting the data better), neither model revealed a strong relationship between the toddlers' gait parameters and gross motor skills. This lack of association is unlikely to be a result of the measures utilized to quantify the constructs because each measure was significantly related to the latent variable. Although the preliminary findings suggest that neither the spatial nor spatiotemporal aspects of toddlers' gait were strong predictors of their gross motor skills, these findings should be interpreted with caution due to the relatively small sample size of the study. However, these findings do suggest that clinicians should be mindful of relying solely on



utilizing standardized tests when assessing and diagnosing developmental delays, especially ones that are characterized by gait impairments, such as developmental coordination disorder or autism spectrum disorder (Fulceri et al., 2019; Gill et al., 2019).

P4-A-13: Do the locomotion: Movement and social approach in infants with autism spectrum disorder

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Human movement is central to both typical and atypical social interaction. Disordered movement and atypicalities in social approach are characteristic of infants with autism spectrum disorder (ASD) and are used to characterize the heterogeneity of the disorder (Wing, 1997; APA, 2013). In clinic settings, infants with ASD exhibit slower angular (turning) velocity (though perhaps only in a counter-clockwise direction) and slower velocity (distance traveled) than TD infants (Cohen et al., 2014; Yang et al., 2019; Velinsky et al., 1981, Teitelbaum et al., 1998). Infants with ASD have also demonstrated a greater latency to approach parents (Cohen et al., 2014) and demonstrate decreased frequency in approaching peers (Jahr et al., 2007). In this study, we compare objective measurements of angular velocity (turning), Euclidean velocity (movement), and social approach between infants with ASD and typically developing (TD) infants in an inclusive preschool classroom during repeated multi-hour observations. Observations of four preschoolers with ASD and eight TD preschoolers in an inclusive preschool classroom on five days yielded 53 observations, with 7.07 hours of data per child. Objective measurements of position and orientation were collected using the Ubisense system, which tracked a right and left tag worn by each child (in a vest) to an accuracy of 15 cm within the classroom (8.86 x 8.97 m) using ultra-wide radio frequency identification. Right and left tags yielded orientation, direction faced, via coordinates (xR,yR) and (xL,yL). For each child, angular velocity was computed as the difference in orientation angle while Euclidean velocity, angle of movement, and approach velocity (the sum of moving toward and away velocities) from child A to B were computed as the difference in location between consecutive tenths of a second [t-1, t]. Multilevel models (days nested in each child) indicated that infants with ASD exhibited larger absolute mean angular velocity than TD infants (see Figure 1, $p < .001$). Infants with ASD turned significantly more rapidly in both the clockwise and counterclockwise direction ($p < .001$). There was no difference in Euclidean velocity between the groups ($p = .57$). Tests of high velocity differences (top speeds), 75-100th %iles also indicated angular ($p < .001$) but not Euclidean velocity differences ($p = .16$). Overall, social approach tended to be negative indicating greater velocities of moving away than moving toward peers. Main effects from multilevel models indicated that TD infants are faster than infants with ASD in both approaching and being approached. An interaction term indicated that infants with ASD approached other infants with ASD more slowly than all other pairings of infants ($p = .001$). Multi-hour, objective measurements in a preschool inclusion classroom indicated that infants with ASD exhibited higher velocity turning but did not move through space with more quickly than other infants. Strikingly, infants with ASD are slower at approaching and being approached than TD infants. The results suggest the potential of automated measurement for an objective understanding of typical and atypical (social) movement in infancy.



B-Developmental Neuroscience

P4-B-14: Survey of well-being of young children - Brazil (SWYC-BR): Psychometric properties for developmental screening in preterm infants

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Children born preterm are at higher risk of developmental disabilities and require systematic follow-up in the first years of life (WONG et al., 2016). In low-and-middle-income countries, the paucity of standardized and validated developmental-behavioral screening tools impairs the identification of at-risk children and early intervention (GLADSTONE et al., 2015). The Survey of Well-being of Young Children (SWYC) may be an option for screening developmental delays in children up to 66 months old (Perrin et al. 2013). The SWYC tool comprises screening questionnaires for developmental and behavioral domains, parents' concerns, and family risk factors. It was adapted to Brazilian Portuguese (SWYC-BR) by researchers of the Federal University of Minas Gerais (UFMG) and Santa Catarina (UFSC)(Moreira et al. 2018; Moreira et al. 2019). This methodological study aims to examine the internal consistency and concurrent validity of SWYC-BR in the first two years in children born preterm. The Ethical Committee approved the study and the informed consent (CAAE 29437514.1.0000.5149). The psychometric qualities of the "Developmental Milestones" questionnaires (DM-SWYC-BR) were analyzed in a convenience sample of children born preterm (33% was born ≤ 31 weeks of gestational age; 48,7% male) in two public hospitals, reference for high-risk deliveries, in Southeast Brazil. Children's development was screened at 4, 6, 9, 12, 15, 18 and 24 months-old visits using DM-SWYC-BR and Ages & Stages Questionnaires, 3 edition - Brazil (ASQ-3BR) (SQUIRES et al., 2009; FILGUEIRAS et al., 2013; SANTANA et al., 2015). A total of 1069 interviews using SWYC-BR and ASQ-3BR, done at key-age visits, were analyzed (Figure 1). The internal consistency was examined using Cronbach's alpha (CA) and Composite Reliability (CR). The concurrent validity of DM-SWYC-BR was performed in relation to ASQ-3BR. The child's development was considered abnormal when the child scored less than -1SD below the group means. This decision was made due to the lack of normative data with Brazilian children for both tools. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), the area under the Receiver Operating Characteristic (AUC) curve, Spearman's rank correlation coefficient, and Cohen's Kappa concordance coefficient were calculated. The AC and CR values were ≥ 0.60 at all ages. The Spearman's coefficient correlating MD-SWYC-BR and ASQ-3BR scores were 0.64. In comparison to ASQ-3BR, the DM-SWYC-BR sensitivity was 57.6%, specificity 90.6%, PPV 54.1%, NPV 91.8%, AUC 0.74 (Figure 2), and Kappa 0.47, considering all observations. These findings suggest the DM-SWYC-BR has acceptable reliability and satisfactory accuracy measures to screen development delays in infants born preterm in most of the ages. Considering the SWYC-BR psychometric qualities, comprehensiveness, and feasibility, it seems to be a promising tool for monitoring the development of preterm infants in Brazil.

P4-B-15: Language experience influences audiovisual speech integration in unimodal and bimodal bilingual infants



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A few weeks after birth and several months before they begin producing canonical babbling, infants can perceptually integrate audio and visual cues of speech articulation (Kuhl & Meltzoff, 1982; Patterson & Werker, 1999, 2002, 2003). Moreover, a shift of attention from the eyes towards the mouth of talking faces occurs around 6 months (Lewkowicz and Hansen-Tift, 2012). Interestingly, bilingual infants who experience two different phonological systems show different visual scanning patterns of talking faces (Pons, Bosch, & Lewkowicz, 2015). At 4 months, they show increased attention to the mouth compared to monolinguals, which results in no preference for the mouth or eyes of a talking face in this group. These results suggest that patterns of visual attention during audiovisual speech processing are influenced by speech and language experience in infancy and are unlikely to be driven mainly by maturation. To further investigate this question, we recruited a rarely studied group of infants : hearing infants with deaf mothers. Despite having full hearing, these infants, whose mothers use sign language as their preferred mode of communication, are likely to experience a reduced amount of auditory spoken language. Many deaf signing individuals use speech to communicate with hearing people, but the extent to which they actually 'voice' their speech and produce sound, as opposed to silently mouth, is extremely variable (Bishop & Hicks, 2005). When addressing her infant, a deaf mother may use sign and/or spoken language, though spoken utterances by deaf mothers tend to be reduced in length and frequency compared to that of hearing mothers (Woll & Kyle, 1989). On the other hand, hearing infants with deaf mothers experience a very special case of bilingualism in which they acquire one spoken language (e.g. English) and one sign language (e.g. British Sign Language). Here, we present data from 73 hearing infants between 4 and 8-month. These infants are from three groups who differed in their language experience: monolinguals (n=28), unimodal bilinguals (infants exposed to two or more spoken languages; n = 22) and bimodal bilinguals (hearing infants with deaf mothers; n = 23). Eye-tracking was used to study patterns of face scanning while infants were viewing faces articulating syllables with congruent, incongruent and silent auditory tracks. Monolinguals and unimodal bilinguals increased their attention to the mouth of talking faces between 4 and 8 months, while bimodal bilinguals did not show any age difference in their scanning patterns. This finding suggests that this shift in the focus of visual attention is driven by language experience and not fully explained by maturation. Moreover, older (6.6 to 8 months), but not younger, monolinguals (4 to 6.5 months) showed increased visual attention to the mouth of faces articulating audiovisually incongruent rather than congruent faces, indicating surprise or novelty. In contrast, no audiovisual congruency effect was found in unimodal or bimodal bilinguals. This result could indicate increased tolerance to articulatory inconsistencies and imprecision. Taken together, these results suggest that speech and language experience influences audiovisual integration in infancy. Specifically, reduced or more variable experience of audiovisual speech from the primary caregiver may lead to less sensitivity to the integration of audio and visual cues of speech articulation.

P4-B-16: In search of the putative TVSA in infancy



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Introduction Early on, infants exhibit visual speech processing skills. By four months of age they can match auditory speech sounds to corresponding mouth movements (Kuhl & Meltzoff, 1982) and discriminate between languages just by watching someone speak (Weikum et al., 2007). However, little is known about visual speech processing network in infancy. Adults have a specialised cortical network for visual speech processing, involving inferior frontal gyrus (IFG), superior temporal gyrus and sulcus (STS/G), as well as a putative temporal visual speech area (TVSA, Bernstein & Liebenthal, 2014; Venezia et al., 2017). The TVSA was found to be more responsive to visual speech than any other type of mouth movement and is thought to be the site of visual speech representations, integrating dynamic and configural information (Bernstein & Liebenthal, 2014). The development of the functional specialisation of the putative TVSA and its role in preverbal infants remains to be tested. We hypothesised that selective cortical responses to speech will be observed in the left posterior temporal cortex at 10, but not at 5 months of age. **Methods** We conducted a cross-sectional study, testing infant neural correlates of visual speech processing at 5- and 10-months of age. In total, 41 infants (5.0 - 6.5 months) were tested in the younger group, while data gathering in the older one (9.0 to 10.5 months) is being finalised. Infants were presented with video clips showing either silent visual speech (syllables /ba/ and /ga/) or non-speech mouth movements (gurning). Cortical responses were recorded with a 32-channel NTS Gowerlabs fNIRS system, using a custom-made headgear designed to cover bilaterally the IFG, STS/STG, and the putative TVSA. 21 infants contributed data for the younger age group (20 infants were excluded due to infant behaviour or improper headgear fitting). **Results** Results of univariate (RM ANOVA, see Table 1) and multivariate pattern analyses (MVPA, see Figure 1) indicate that at 5 months of age the visual speech processing network involves superior temporal regions. Both types of mouth movements elicit left hemisphere activations. The left putative TVSA is involved in the perception of both speech and non-speech mouth movements, but shows no preference for speech, while its right homologue area is active only to visual speech. **Discussion** This is the first fNIRS study to uncover the neural correlates of visual speech processing in infancy. We show that cortical organisation at 5 months of age is already sensitive to facial motion but the left hemisphere is not yet specialised to differentiate visual speech from gurning. Observed right hemisphere activation might reflect right TVSA specialisation for differentiation of similar mouth movements (as observed in adult studies, e.g., Files, Auer, Bernstein, 2013). It is likely given that syllables are visually more similar to each other than presented gurning gestures. This presentation will also discuss findings from the older group and age-related changes in the visual speech processing network. These results will clarify the development of the neural substrate of speech and face processing as well as action observation in infancy.

P4-B-17: The effect of face orientation on audiovisual speech perception in infancy: An eye-tracking study

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Introduction Speech perception is a crucial part of our everyday communication. Although mostly studied in the auditory domain, speech is a source of temporally synchronized multimodal information. Relations between auditory and visual information streams coming from a talking face are especially important. The McGurk illusion shows that incongruent auditory and visual information can be integrated into new, illusory percepts (McGurk & McDonald, 1976). Infancy is a period of increasing specialization of both speech and face processing (Maurer & Werker, 2013). Between 7 and 10 months of age, infants lose the ability to discriminate between non-native phonemes (Werker & Tess, 1984) and shift from featural to configural face processing, as indexed by the face inversion effect (see Cohen and Holt, 2015). Patterns of scanning articulating faces also change across the first year of life. Infants shift from looking to the eyes towards looking to the mouth around 9 months of age, and back to the eyes around 12 months of age (Lewkowicz & Hansen-Tift, 2012). However, little is known about the specialization in audiovisual speech perception in relation to the development of face processing. We hypothesized that face inversion will affect the patterns of face scanning and the processing of audiovisual speech information. Methods Eye-tracking was used to study patterns of face scanning and looking duration while 5-, 9- and 12-months-old infants from Polish monolingual families (N=215) were viewing upright and inverted faces articulating syllables with congruent (visual BA-auditory BA & visual GA-auditory GA) and incongruent (visual BA-auditory GA & visual GA-auditory BA) auditory tracks. Results The results showed face inversion affects looking patterns. All infants looked longer at upright than inverted articulating faces. However, inversion effect changed with age. Face orientation affected audiovisual speech processing in 9- and 12-months-olds, but not in 5-month-olds. The age-effect differed depending on visual syllable. Face inversion affected looking duration to visual BA syllable already at 5 months of age conditions, while to visual GA syllable only at 9 months of age. Finally, we observed a shift in face scanning. Infants at 9- and 12- months of age preferred looking to the mouth region in upright but not inverted conditions, whereas 5-month-old infants were looking more to the eyes region of both upright and inverted faces. Discussion Upright face orientation is especially important for processing visual speech. Face orientation affected looking duration to the mouth but not to the eyes and it influenced face scanning pattern of infants from 9 months of age. Given these age-related differences, configural face processing is important for audiovisual speech perception. Furthermore, we observed that infants shift their attention from looking to the eyes of the upright faces at 5 months to looking more to the mouth at both 9 and 12 months of age.

P4-B-18: The effect of face orientation on audiovisual speech perception in infants at 5-6 months of age: An EEG/ERP study

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Introduction: Infants acquire knowledge of speech sounds effortlessly using both auditory and visual information of the syllable. The conflict between two sensory domains, as demonstrated



by the McGurk effect (McGurk & MacDonald, 1976), suggests that they may not be processed independently from each other. Substantial evidence indicates that upright and upside-down faces are processed differently in adults, with infants demonstrating robust differential processing at the end of the first year of life (deHaan et al., 2002). Differences in perception between two orientations are commonly attributed to changes in configuration of facial features with inversion, and few studies have explored its effect on audiovisual (AV) speech perception in adults (Eskelund et al., 2015; Rosenblum et al., 2000). In light of these research findings showing the importance of upright (relative to inverted) faces for AV speech perception, studying 5- to 6-month-olds who have no face orientation effect can be informative for linking face processing and AV speech. Objectives: Using the EEG/ERP technique and the McGurk paradigm, this study aims to investigate the impact of face orientation on AV speech perception in 5 to 6 months old infants. Methods: We measured high-density event-related potentials (ERPs) in the group of 5- to 6-month-olds ($n=26$) during two testing sessions in response to videos of audiovisually matching and mismatching syllables /ba/ and /ga/, presented in upright and inverted orientations. Mismatched combination of these syllables results in either phonologically legal and fusible /da/ or illegal /bga/ percepts. If these cannot be integrated, a developmentally transient audiovisual mismatch response (AVMMR) is observed. Results: Preliminary results on nine 5- to 6-month-olds replicated previous findings (Kushnerenko et al., 2008) and showed significant increase in the amplitude of AVMMR to visual /ba/ auditory /ga/ stimulus relative to congruent /ba/ ($p=.003$) and /ga/ ($p=.029$) as well as to mismatched but fusible visual /ga/ auditory /ba/ ($p=.015$) stimuli. This means that 5- to 6-month-olds can detect the mismatch of illegal syllable and fuse the illusory percept in upright faces. However, no mismatch to visual /ba/ auditory /ga/ relative to congruent and fusible stimuli was detected in inverted faces, indicating that face orientation modulates the integration of AV stimuli already at the age of 5-6 months. Conclusion: Even though literature suggests that face processing mechanisms during the first year of life are immature, our preliminary data shows that already at the age of 5-6 months AV speech integration in infants depends on whether the talking face is upright or inverted. To our knowledge, this is the first study to investigate the effect of face inversion on AV speech processing in infants. Since the project and data collection are still ongoing, further analysis on infants at the age of 5 to 6 months and 9 to 10 months will be included in the presentation.

P4-B-19: Newborns' event-related potentials reveal asymmetrical processing of native vowels

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Newborns know much about their native language: they recognize it amongst foreign languages, produce cries with native-language melody, and listening to streamed native vs. foreign language activates special areas in their cortex (Moon et al. 1993, Mampe et al. 2009, May et al. 2018). Besides the well-evidenced prenatal entrainment to the global, prosodic characteristics of speech, fetuses might also be learning about the individual sounds that make up their mother's language (Moon et al. 2013). Here we tested whether prenatal native-language attunement occurs at the level of individual speech sound segments. Since some acoustic properties of vocalic sounds, such as low frequency composition and duration, are well transmitted to the womb, we hypothesized that humans will start acquiring the categories



for (some) native vowels already during prenatal development. To that end, we assessed newborns' basic sensory as well as higher-level neural processing of vowels and of comparable nonspeech stimuli. We focused on the infants' processing of native phones and contrasts [fa]-[fE] and [fE]-[fE:], acoustically realized as differences in low-frequency vowel spectrum and duration, respectively, and compared it to their processing of identical distinctions in tone complexes. EEG was recorded from 120 full-term, 1-2 days old sleeping infants listening to two roving-standard blocks of syllables or tones, one containing changes in spectrum and the other in duration. We measured the event-related potentials (ERPs) to each stimulus type individually (to assess sensory processing) and the differential mismatch response (MMR) elicited by a change between the two members of each contrasts (to assess higher-level processing of stimulus function beyond its physical properties). Both the sensory ERPs and the MMR were measured in an early and a late window. The data were analyzed with Bayesian linear mixed-effects models starting with uninformative normal priors and estimating posterior distributions of the parameters Domain, Dimension, Stimulus/Deviant, Anteriority, Laterality, and Hemisphere, and including per-participant random intercepts and slopes for all the within-subject factors. The meaningfulness of effects was inferred from 89% credible intervals of the posteriors. The sensory-response results showed that infants auditorily processed differences in both speech and nonspeech stimuli (and did so stronger on midline than laterally). The MMR results showed that on the left hemisphere, some of the speech contrasts yielded a reliably negative, i.e. mature, early MMR (Domain*Deviant*Hemisphere, est. -16.37, CI=-30.17..-2.80; see Figure). We found that in speech, newborns more strongly processed changes from [fa] to [fE] and from [fE] to [fE:] than vice versa, resembling a previously-reported phonology-based directional asymmetries in adults' perception (Lahiri & Reetz 2010) and contradicting the asymmetries proposed for language-general perception before native categories are acquired (the Natural Vowel Referent framework, Polka & Bohn 2011). The direction of the asymmetry in speech and its lack in nonspeech could be explained by prenatal exposure. Anchor vowels such as spectrally focal [a] and short vowels (compared to their nonfocal and long counterparts) are in utero psychoacoustically prominent and thus learnable. Hearing a change from a well-formed to a less-well-formed category at birth then elicits a larger prediction error (MMR) than vice versa.

P4-B-20: Face specialization and emerging symptoms of ASD in etiologically-distinct high-risk infants

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Background: Etiologically-distinct infants at high risk for autism spectrum disorders (ASD) have demonstrated atypical neural responses during face processing (Guy et al., 2018). Relative to low-risk control (LRC) infants, infants with fragile X syndrome (FXS) demonstrated greater amplitude face-sensitive event-related (ERP) responses, while infant siblings of children with ASD (ASIBs) demonstrated an attenuated response. Investigating the relation between ERP responses in infancy and the development of ASD symptoms will improve understanding of multiple pathways to ASD. Objectives: The current study utilized a multimethod approach to examine infant face specialization in connection to emerging symptoms of ASD in etiologically-distinct, 12-month-old infants. Electrophysiology, neuroimaging, and behavior were examined



in ASIBs and infants diagnosed with FXS. Methods: Patterns of neural activation and behavior associated with emerging ASD were examined in 21 ASIBs, 15 infants with FXS, and 21 LRC infants recruited at 12 months of age. Cortical source analysis was completed using realistic head models that were created from participant structural MRIs and group-specific average head models. Current density reconstruction (CDR) was calculated to examine activation in regions of interest (ROIs) believed to be relevant to face processing. Twelve-month-olds completed the Autism Observation Scale for Infants (AOSI) and 36-month-olds completed the Autism Diagnostic Observation Scale-2 (ADOS-2) for identification of behaviors associated with emerging symptoms of ASD. Analyses focused on the N290 ERP component, which has been most closely associated with infant face processing (Guy et al., 2016). Results: Results revealed unique patterns of neural activity and behavior associated with N290 amplitude across high-risk infants. CDR analyses revealed a significant main effect of stimulus type, $F(1,55)=21.47$, $p<.001$, and an interaction of group, stimulus type, and ROI, $F(34,935)=1.45$, $p=.046$. Participants demonstrated greater activation to faces than toys. LRC infants showed greatest activation to faces in areas believed to reflect specialized face processing (i.e., middle and anterior fusiform gyrus, parahippocampal gyrus, and lingual gyrus). ASIBs showed reduced activation in these areas, while infants with FXS displayed high levels of activation to faces across all ROIs examined. AOSI results revealed an interaction of group, electrode cluster, and electrode hemisphere, $F(8,102)=2.49$, $p=.016$. Additionally, there was an interaction of group, stimulus type, and ADOS score, $F(2,4680)=11.02$, $p<.001$. Across these measures, more negative N290 responses in infants with FXS were associated with higher scores of ASD symptoms, while N290 amplitude in ASIBs was less closely associated with symptoms of ASD. Conclusions: High-risk infant groups demonstrated unique patterns of neural activation, which may be associated with emerging behavioral characteristics of ASD and that did not support typical development of face specialization. Neural correlates of social processing measured in infants with FXS could be especially valuable for the prediction of ASD outcomes, as greater N290 amplitude was associated with higher AOSI and ADOS-2 scores. Greater N290 amplitude may be driven by increased ASD risk in a subset of participants with FXS. However, questions remain regarding the behavioral correlates of ASIBs' neural responses to faces in infancy.

P4-B-21: Neural responses to live social and nonsocial displays in infants with older siblings with ASD and/or ADHD

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Introduction: While neurodevelopmental disorders like ASD are not diagnosed until childhood, measures of brain function may show alterations earlier in life (e.g., Elsabbagh et al., 2012). For example, individual differences in neural responses to social and non-social stimuli presented on a screen at 6 months of age are associated with later ASD (Lloyd-Fox et al., 2018; Jones et al., 2016). However, the degree to which screen-based stimuli may capture ecologically valid differences in social attention is unclear. Indeed, several studies have shown that differences between social and nonsocial attention are more pronounced in the infant brain in response to live action (e.g. Jones et al., 2015). Here, we investigated how neural



activity during live social and non-social experiences is affected by having an elevated familial likelihood for developing ASD. Method: Participants were 86 five-month old infants with a first degree relative with ASD, ADHD or typical development. Infants watched an experimenter singing nursery rhymes (social condition) or operating toys (non-social condition) while EEG was recorded with a 128-channel Geodesic Sensor Net. EEG was filtered (.1-30Hz), and segmented into one-second segments; log theta power (3-5Hz) over frontal cortex (following Jones et al., 2015) was extracted from artifact-free segments using a fast fourier transform. Video coding of infant gaze was used to restrict analysis to segments of social or non-social attention. Data was analysed using repeated measures ANOVA with Greenhouse-Geisser correction with number of segments spent on looking at stimulus or frontal theta power as the dependent variable, stimulus type (soc vs. nonsocial) and where relevant laterality (left, right, centre) as a within-subject variable, and familial likelihood of ASD and/or ADHD as between-subject-variables. Results: Looking to social vs nonsocial features of the display did not differ by familial likelihood of ASD and ADHD ($F_s < 1$, $p_s > .3$). Frontal theta power was greater for the social than nonsocial condition ($F(1, 77) = 9.82$, $p = 0.002$). However, condition differences significantly varied by ASD likelihood ($F(1,77) = 3.93$, $p = 0.05$). Inspection of the group means indicates that infants with a first degree relative with ASD showed a significantly reduced elevation of the frontal theta response to social vs non-social videos than infants with no familial risk for ASD. There was no interaction between condition and ADHD risk status ($F(1,77) = 0.037$, $p = 0.85$). Conclusion: Preliminary results indicate that five-month-old infants at elevated likelihood for ASD do not show the typical elevation of frontal theta power during live social versus nonsocial attention. This effect was not observed for familial likelihood of ADHD, indicating a degree of specificity to ASD risk. Greater frontal theta power during social vs nonsocial attention has been shown to strengthen over the first year of life in typically developing infants (Jones et al., 2015). Thus, it is possible that our results are consistent with delayed development in infants with older siblings with ASD. Further analyses will explore this prediction in data from the same infants taken at 10 and 14 months, and examine relation to ASD outcome.

P4-B-23: Infant sleep patterns moderate the association between socioeconomic status and frontal brain activity

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Background: Socioeconomic status (SES) differences in brain activity (Tomalski et al., 2013) and structure (Betancourt et al., 2016) are well documented in infancy. In a separate line of work, sleep loss has been shown to affect cognitive abilities via mechanisms like alertness and attention (Short and Banks, 2014), learning and memory consolidation (Diekelmann & Born, 2010), and neural plasticity (Tononi & Cirelli). Few studies have examined the interactive influences of SES and sleep on early cognitive development (Bernier et al., 2013; Hoyniak et al., 2018; Buckhalt et al., 2009), but to our knowledge, none have examined these associations during infancy using neuroimaging techniques. Methods: Three-month-old infants (current $N=52$, 35 males) from socioeconomically diverse households (maternal ED=10-26 years, annual family income=\$12K-\$500K) were recruited for this study. Five minutes of resting EEG was recorded while the infants watched a video of engaging, non-social, stimuli. Caregivers filled out a sleep questionnaire (BISQ; Sadeh, 2004) and reported on day and night sleeping



patterns. Total amount of daily sleep and the proportion of night sleep to the total daily sleep was calculated (Night Sleep Ratio, NSR) in an attempt to quantify infant "mature sleep". We posit that higher NSRs represent more mature patterns of infant sleep. Results: Maternal ED did not correlate with any of our sleep variables (p 's>0.12) or frontal low alpha (6-9 Hz) activity ($p=0.82$), but maternal ED did correlate with frontal high alpha (9-13 Hz) activity at trend level ($t=1.82$, $p=0.07$). Next we were interested in investigating interactions between sleep quality and SES on brain activity. Regression analysis predicting frontal high alpha activity indicated a significant main effect of maternal ED ($\beta=1.53$, $p=0.05$), a trending main effect of NSR ($\beta=1.32$, $p=0.10$), and an interaction (ED x NSR) ($\beta=-2.01$, $p=0.10$), but these were not statistically significant. To examine this interaction further, infants were categorized into low (ED < 16 years) and high (ED > 16 years) maternal education groups, and low (ratio <0.7) and high (ratio > 0.7) NSR groups. (see Figure 1). For high NSR babies, SES did not predict high alpha brain activity from the frontal electrodes. However, for low NSR babies, SES was significant in predicting this brain activity. Conclusion: Results suggest that sleep quantity may impact associations between SES and brain activity early in life. Future analyses will be conducted with a larger sample size and explore behavioral correlates of frontal high alpha brain activity (i.e. attention and memory) to test the functional significance of this association. Examining how SES interacts with sleep to potentially influence neural activity may help to explain SES differences in both brain activity and behavior in infancy.

P4-B-24: Test-retest reliability of infant EEG connectivity is optimised when using multiple short epochs

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Introduction: Investigating brain EEG connectivity during infancy informs us on the development of connections between regions, and is a key part of how the brain works. Individual variability in whole brain connectivity and network characteristics may reflect individual variability in developmental trajectories. Collecting sufficient artifact-free EEG data from infants however is challenging. In this study, we explore optimal segmenting methods given certain amounts of data in a test-retest study in young infants. Methods; We analysed data from our previous study where 64 10-month-old typically developing infants were assessed in 2 sessions with a 1-week interval (Van der Velde, Haartsen, & Kemner, 2019). Infants watched naturalistic videos during EEG recording (32 channel Biosemi ActiveTwo system). Clean pre-processed EEG data were cut into epochs with different lengths (1, 2, 3, 4, 5, and 6 seconds). We randomly selected different numbers of epochs (20 - 150) from the individual datasets. 41 infants provided sufficient clean EEG data in both sessions. We then calculated alpha EEG connectivity (6-8 Hz) from Fourier Transformed data using the phase lag index (PLI) and the debiased weighted PLI (dbWPLI; after Vinck, Oostenveld, Van Wingerden, Battaglia, & Pennartz, 2011). The following metrics were derived from the EEG connectivity matrices: whole brain connectivity (average of all connection strengths) and network characteristics: normalised clustering coefficient, normalised path length, and small-worldness index (Rubinov & Sporns, 2010). Test-retest reliability was defined as the intra-class



correlation between measures in the 2 sessions. Results; Reliability of whole brain connectivity increased with increasing total amounts of EEG data (e.g. ICC = 0 for 30 1-second epochs, and ICC = .82 for 120 1-second epochs in Figure 1). Whole brain connectivity was more reliable when derived from the dbWPLI than the PLI, and more reliable for 120 1- than 120 2-second epochs. Next we examined reliabilities of connectivity metrics when the total amount of EEG data was kept constant (Figure 2). Reliability for whole brain connectivity (.43 < ICC's < .68) was higher than for the normalised clustering coefficient (.23 < ICC's < .59), which in turn was higher than for the normalised path length and small-worldness index (0 < ICC's < .44). For the dbWPLI, whole brain connectivity and network characteristics were overall more reliable for 1 and 2-second epochs compared to other lengths. For the PLI, the pattern was more mixed and optimal reliability for each metric varied with segmenting methods. Conclusions; We conclude that EEG connectivity can be reliably estimated from at least 120 1-second segments, where data availability is a stronger driving factor than segmenting methods. Considering the infants watched 6 minutes of naturalistic videos, this would allow us to get reliable whole brain connectivity estimates from about 90% of the infants tested in the first session. Measures of network characteristics are less reliable for this amount of data, possibly due to the emerging network properties at this young age, more EEG data is needed to reliably measure these, or a higher density of electrodes is needed.

P4-B-25: How to obtain clean EEG data? Conclusions from a large-scale longitudinal infant study

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Introduction EEG is a widely used method to study infant brain development, due to its relative noise-resistance and non-invasiveness. Data quality is often low and given the typically small sample sizes in infant studies, data loss is accepted. However, testing infants is costly, time-consuming, and requires the support of both parent and child. This begs for a better understanding of the external reasons that contribute to data loss. To our knowledge, no current study has examined the extent of such factors in contributing to data loss in EEG studies. One likely explanation is that such studies need a large sample size to study these phenomena. The current study, therefore, addresses this situation: our main aim is to describe how a range of external factors potentially impacts EEG data quality in a large population-based longitudinal study Methods We use data from the YOUth project in Utrecht to study the data quality of 1279 five-month-old infant sessions, 1024 ten-months-old infant sessions, and 109 three-year-old toddler sessions. In total 1307 unique subjects were tested. Data quality is measured as data loss $((N \text{ trials removed} / N \text{ expected trials}) * 100)$. Both an ERP experiment and a continuous EEG experiment are studied separately. Several external factors, possibly interfering with data quality, are studied. Also studied is the data loss both over the course of a single task and the entire study. Lastly, data quality is compared within-subject, by comparing their individual data quality over time to check for possible personality traits influencing data quality. Results Results for both continuous and ERP EEG data quality are similar, with continuous EEG having slightly lower data loss. Which assistant is present during the data gathering influences data quality greatly. Notable differences in data quality were also found comparing the fit of the EEG cap, head shape of the infant, and time of day, with earlier testing generally yielding better results. Test date also influenced the results, with testing during the



spring and summer yielding significantly better results compared to winter or autumn testing ($t(2187) = 3.5286, p < 0.0001$). No differences in data-quality were found between the 5 and 10m waves, but 36-month-old toddlers did perform noticeably better (figure 1). During the task, data quality trended downwards for both tasks, with spikes of increased data quality present right after mandatory breaks (figure 2). Lastly, no correlations were found of data loss within subjects over sessions, indicating no influence of personality on data loss. Conclusions External factors greatly influence data quality in large-scale longitudinal studies. This has to be taken into account when studying individual differences in these large datasets. This is especially true for external factors that are forcibly non-randomized, like current season during testing. Studies with a between-subject or within-subject study design that are non-randomized in time could, therefore, be affected by impaired data quality in a particular test group, which can influence study outcome. Extra care needs to be taken when designing large-scale longitudinal studies, to minimize the effects of these external factors.

P4-B-26: Sensitivity to speech sound distributions declines over the first year of life

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Perceptual attunement to the native phonetic repertoire occurs over the first year of life, such that infants' discrimination of non-native phonetic contrasts declines while their discrimination of native phonetic contrasts improves. Infants can track the statistics of speech sound distributions and this facilitates both the collapsing of non-native phonetic boundaries, and improves the discrimination of non-native and difficult native contrasts (Maye et al., 2002; Maye et al., 2008). This type of statistical learning is widely considered a domain general ability that persists throughout life. However, there is evidence that distributional learning (DL) is most effective during the period of perceptual attunement. 10-month-old infants require twice the exposure to speech sound distributions as 6-8 month old infants to shift their perceptions (Yoshida et al. 2010). Additionally, a decline in the efficacy of DL has been reported for both non-native vowel and tonal contrasts (Wanrooji et al., 2014; Lui & Kager, 2017). However, this decline may be explained by an inability to perceive the distributional information after perceptual attunement. If DL is most effective only during this critical window, it should decline across the first year of life, even for native phonetic contrasts. We use electroencephalography (EEG) to investigate whether neuronal responses to 'ra' and 'la' sounds are modulated by exposure to either a bimodal or unimodal sound distribution spanning the [r]~[l] phoneme space, and how this response changes over the period of perceptual narrowing. Methods: 132 English monolingual infants aged 5-, 9- and 12-months were familiarized to either a unimodal or bimodal distribution of ra-la speech sounds for 2.3 minutes (Figure 1). The continuum from which the distributions were drawn contained 140 unique sound tokens, to better model the variability encountered in the real world. After familiarization, discrimination of 'ra' vs 'la' was tested in an ERP oddball task using a 64-channel HydroCel Geodesic Net. Results: ERPs to the standard and deviant sounds were generated for each infant (Figure 2) and difference waves calculated to generate the mismatch response (MMR). At 5-months, the MMR amplitude was significantly different between the bimodal and unimodal conditions (t-test with Welch's Correction, $p = 0.02$). By 9-months, the MMR significantly differed between conditions only in the more difficult order ('ra' standard with 'la' deviant; 1 way ANOVA with Tukey's Multiple



Comparison, $p = 0.0051$). While 12-month-olds showed a MMR in response to the deviant stimulus, there was no evidence for an influence of familiarization condition (t-test with Welch's Correction, $p = 0.92$). Conclusions: We find that brief exposure to a ra-la distribution is sufficient to alter neuronal responses to subsequent 'ra'/'la' speech sounds at 5-months, but that this sensitivity declines across the first year of life. These results are the first to capture the progressive decline in sensitivity to distributional statistics in the environment, even when a native phonetic contrast is used. This suggests that the decline in efficacy of distributional learning is not driven by an inability to perceive the presented distribution, which may be the case for non-native contrasts after the period of perceptual attunement ends. Instead, it suggests that infants' phonetic categories are stabilized, and no longer easily influenced by environmental information.

P4-B-27: Neural dynamics of pain observation in infancy

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The experience of empathy is a fundamental interpersonal process that characterizes human nature and shapes our social life since very early in life. In particular, perception of pain in others is considered of great evolutionary significance for the development of human empathy (Decety et al, 2010). As such, pain observation paradigms have been extensively used to study the neural basis of empathy by using very simple stimuli depicting limbs (Fan et al., 2015) or faces (Sessa et al., 2015) in painful situations. However, infants' sensitivity to others' pain hasn't been investigated so far. Here we explored the neural temporal dynamics of infants' processing of others' pain by measuring ERP activity while 6-month-old infants observed a painful tactile stimulation directed towards the eye and a neutral tactile stimulation on the eyebrow. Based on previous electrophysiological studies conducted with children and infants (Decety et al., 2015; 2017), we analyzed both earlier (Nc) and later (LPP) ERP components. Results have shown that painful touch elicited a prominent Nc (300-500 ms) throughout frontal, central and parietal sites. A rmANOVA with Electrode Cluster (Frontal, Central, Parietal), Condition (Pain, Neutral) and Hemisphere (Left, Right) showed a significant main effect of Condition, $F(1,19)= 6.281$, $p = .02$. The Nc was greater in amplitude in response to Painful compared to Neutral touch (Figure 1a). Such divergent activity was also visible in a subsequent component, the centroparietal LPP (550-750 ms). In fact, a rmANOVA on preliminary data with Electrode Cluster (Central, Parietal), Condition (Pain, Neutral) and Hemisphere (Left, Right) as within-subject factors, showed a significant main effect of Condition, $F(1,19)= 5.848$, $p = .03$. The LPP was greater in response to Neutral compared to Painful touch (Figure 1b). Overall, our results show that infants discriminated at the cortical level between the two tactile stimulations and paid more attention to the painful touch compared to the neutral one. This study shows that 6-month-olds detect the sensory consequence generated by a tactile stimulation on others' bodies. This early sensitivity to others' painful tactile experiences might represent a prerequisite for the development of emotional contagion and human empathy.

P4-B-28: Maternal stress risk score associated with visual evoked potential (VEP) development during the first year of life



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Exposure to early adverse experiences has been associated with increased developmental risk, in part from early alterations to developing neural circuitry. Visual Evoked Potential (VEP) amplitude and latency, thought to index the integrity of cortical pathways and global neural maturation, may be used as a read out for how adversity impacts brain development (Narducci et al., 2018). Moreover, it may predict later risk for neurodevelopmental or cognitive impairment (Calloway et al., 1973; Jensen et al., 2019; Torres-Espinola et al., 2018). However associations between early risk and VEP development in humans, particularly within the first year of life, are not well understood. Pattern-reversal VEPs were recorded from scalp electrodes longitudinally at 6 (n = 33), 9 (n = 31), and 12-months (n = 32) of age from infants from predominantly low-SES backgrounds. Amplitude and latency of the three major components of the VEP (N1, P1, N2) were extracted from occipital electrode Oz (Figure 1). Composite scores of early post-natal risk exposures were created for Demographic Risk (maternal age < 25, marital status single, education < high school, income < \$25,000/year, neighborhood poverty low/med/high), and Maternal Stress and Mental Health (Edinburgh Postnatal Depression scores, perceived stress, exposure to stressful life events). Scores were also standardized and summed to create a Total Risk score. Bivariate Pearson correlations found no associations between Total Risk and VEP at 6 or 9 months. At 12 months Total Risk was significantly and negatively correlated with N1 amplitude ($r = -.437$, $p = .01$). Positive trends were observed between Total risk and P1 amplitude ($r = .325$, $p = .07$) and latency ($r = .30$, $p = .09$), and N1 latency ($r = .30$, $p = .09$). Significant correlations and trends were followed up with hierarchical linear regression including both Demographic and Maternal Stress Risk. At 12 months Maternal Stress scores were associated with larger N1 and P1 amplitudes at 12 months, while Demographic Risk was not a unique predictor. Moreover, Maternal Stress explained 29.7% of the variance in N1 amplitude and 21.7% of the variance in P1 amplitude above and beyond Demographic risk (Table 1). Because VEP amplitude exhibits a developmental decrease across the first year, higher amplitude may index a less mature pattern in infants whose mothers report higher levels of stress and/or depression symptoms. Change in P1 amplitude from 6-12 months also correlated with 12 month Mullen Scales of Early Learning Visual Reception scores ($r=.448$, $p=.047$), and in a subset of infants with 24 month Mullen outcomes assessed (n = 16), partial correlations adjusting for 12-month Visual Reception scores reveal a trend towards smaller N1 and P1 amplitudes at 12 months correlated with better Visual Reception scores at 24 months (N1: $r = .463$, $p = .06$; P1: $r = -.482$, $p = .08$). Associations between early VEP development and developmental outcomes suggest functional consequences of these early neurodevelopmental patterns.

P4-B-29: Hydrokinesiotherapy in hospitalized preterm newborns: Is it necessary?

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Hydrokinesiotherapy administered inside bucket has been widely used in neonatal care units. However, evidence to support its administration to preterm newborns is lacking. We examined



the effects of hydrokinesiotherapy in a bucket on physiological parameters and clinical outcomes of hospitalized preterm newborns with low birth weight. In this randomized controlled trial, 34 preterm newborns (32.62 ± 1.08 weeks of gestation) with low birth weight ($1,722.62 \pm 345.95$ grams) were randomly allocated into experimental (EG) or control (CG) groups. Both groups were assessed four times in two alternate days: pre-intervention, post-intervention, 15 minutes after the intervention, and 30 minutes after the post-intervention. Between pre- and post-intervention in both days, the EG underwent hydrokinesiotherapy in a bucket for 10 minutes (Figure 1). The CG had only the diaper changed. Heart rate, respiratory rate, oxygen saturation, axillar temperature and body weight gain were primary outcomes. Behavioral state was a secondary outcome. Mixed-design and one-way analyses of variance were used for statistics. . Groups were similar in the pre-intervention. Changes in heart rate and respiratory rate after intervention were transitory in the EG (p 's ≤ 0.045). Oxygen saturation was higher in the EG than in the CG at the post-intervention (p 's ≤ 0.006) and up to at least 15 minutes after the post-intervention (p 's ≤ 0.032) in both days. The EG became in a more active state than the CG in the post-intervention in both days ($p < 0.01$). All these changes occurred within normal range and were not clinically relevant. Body temperature (p 's ≥ 0.217) and body weight gain ($p=0.232$) did not differ between groups. In conclusion, the bucket hydrokinesiotherapy was safe for clinically stable hospitalized preterm newborns. However, it did not benefit physiological parameters and clinical outcomes in these infants.

P4-B-30: The effect of sleep on rule learning and consolidation in 6-month-olds: An fNIRS study

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Introduction. During the first year of life, infants sleep between 12 and 15 hours a day. While the effects of sleep on adult memory and learning are starting to be understood (Diekelmann & Born, 2010), little is known about how sleep impacts learning in infancy. To address this issue, we test how infants learn non-adjacent linguistic regularities with or without sleep. Previous research suggests that infants can learn such regularities at 10 months (Martinez-Alvarez et al. 2019). In this study, we test the hypothesis that sleep may help infants consolidate learning and when tested after sleep, infants younger than 10 months may also be able to learn. Methods. Three groups of 6-month-olds were presented with sequences following an AXB rule (e.g. "pedibu", "pegabu") and otherwise similar random controls (e.g. "dibupe", "bugape"). Infants' brain activity (hemodynamic response) was measured in the temporal, parietal, and frontal cortices using a 20-channel functional near-infrared spectroscopy (fNIRS) (Figure 1). All participants were tested twice: before and after overnight sleep (Group 1), before and after a nap (Group 2) or twice with an interval of X hours in the absence of sleep (control, Group 3). Results and Conclusion. Data collection is still ongoing, but preliminary analyses of the pre-sleep session of Group 1 ($n=10$) shows larger activation (oxyHb) for the rule than for the random condition in bilateral temporal and frontal areas (Figure 2), similarly to the bilateral fronto-temporal activation previously found in 8-10-month-olds (Martinez-Alvarez et al. 2019), suggesting that even before sleep, infants as young as 6 months of age may be able to learn non-adjacent dependencies. We are currently in the process of completing the overnight group and acquiring data in the other two groups. Direct



comparisons between the pre- and post-sleep results in all groups as well as comparisons across groups will be conducted once the three groups are completed.

P4-B-32: The effect of kinematic boundary cues on action sequence processing during infancy: An ERP study

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Recent work with adult participants has reported that kinematic cues (how an action is performed) can signal the presence of a boundary between sub-units of an action sequence: Hilton et al. (2019) found that a lengthening of the action prior to the boundary (pre-boundary lengthening) and an absence of movement at the point of the boundary (a pause) are perceived as markers of a boundary within an action sequence, and that the presence of these boundary cues prompts segmentation of pre-boundary actions into a sub-unit. Little is known, however, about the role played by these kinematic cues in action processing during infancy. It is possible that infants capitalize on the information provided by these bottom-up kinematic cues as an initial strategy to determine the structure of action sequences, parallel to the role of prosody in bootstrapping early speech segmentation (Gleitman & Wanner, 1982). To address this issue, we examined ERP responses to kinematic boundary cues during infancy. 12-month-old infants (N = 31) were presented with videos in which a computer-generated animated character performed a sequence of three actions (e.g. jump, stretch and spin). On no-boundary trials, the actions were performed as one continuous sequence, while on boundary trials, kinematic cues (pre-boundary lengthening and pause) marked a boundary between the second and third action. The sequences were performed by different characters, and the character disappeared from the screen after each sequence had finished. Results showed that the ERP response to the third action differed according to whether the action was preceded by a boundary or not. Specifically, in the boundary condition, the third action evoked a negative peak approximately 500-600 ms following action onset, largest over frontal and central electrodes. This component could be interpreted as a manifestation of the Nc component (de Haan, 2007), a marker of attention orientation (Reynolds & Richards. 2005) which is more pronounced for unexpected than expected events (e.g., Kaduk et al., 2013). No comparable Nc-like peak was found in the no-boundary condition. A potential explanation for this finding is that the 12-month-olds processed the boundary cues as marking the completion of an action sequence after two actions, meaning that the onset of the third action was unexpected on boundary trials and thus evoked an Nc-like component. Given the novelty of the paradigm, however, the exact nature of this component requires further investigation. In any case, we argue that the difference in response to the third action offers potential evidence that infants process the preceding kinematic cues as marking a boundary, which would be an important prerequisite for action segmentation.

P4-B-33: The effect of auditory social noise on infants' neural responses to emotional vocalizations

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The human voice conveys important information about peoples' emotions. Modulations of the voice embedded in speech or nonverbal vocalizations (such as laughter, cry, sighs) can tell us whether someone is happy, frightened, sad or angry. From birth, infants can differentiate between emotional vocalizations. As they reach the end of the first year of life, infants can also use people's emotional vocalizations to learn about their surrounding environment (e.g., Vaish & Striano, 2004). Previous event-related potential (ERP) studies suggest that, similar to adults (e.g., Pell et al., 2015; Schirmer and Kotz 2006), infants' processing of emotional vocalizations proceeds in a multi-step fashion (e.g., Crespo-Llado et al., 2018), from sensorial and perceptual to more elaborate cognitive computations. However, all previous research has focused on understanding how the infant brain responds to emotional vocalizations when presented in isolation from the auditory environment typical to everyday life. Thus far we have limited understanding of infants' abilities to segregate emotional vocalizations from other sounds. In order to address this limitation, the present study tested the effect of auditory social noise on infants' neural responses to peers' nonverbal vocalizations of emotions. We also investigated how these effects may differ with age across infancy, and as a function of individual differences in infants' own emotionality. Towards these aims, 3- (N=32), 5- (N=30), and 12-months-old (N=35) infants were presented randomly with 1400 ms long auditory recordings of infant cry and laughter (4 exemplars/condition). In a blocked fashion, for half of the trials the nonverbal vocalizations were presented on the background of a 16-talker speech babble noise, at a stimulus-to-noise ratio of -10 dB. The electrical cortical signal was recorded from 64 channels using an ANT Neuro system. The IBQ-R (Gartstein & Rothbart, 2003) was used to assess infants' temperamental characteristics. In line with previous research (e.g., Crespo-Llado et al., 2018; Pell et al., 2015; Schirmer and Kotz 2006), preliminary analyses show that the sound of peers' cry and laughter elicit in infants ERP responses (e.g., P200 and LPC at frontal regions of interest; LSW at parietal regions of interest) consistent with a multi-step processing of emotional vocalizations. The ERP components of interest (e.g., frontal P200 and LPC - Figure 1) differentiate between cry and laughter in an age specific manner and are related to infants' emotion regulation abilities. Importantly, the presence of the speech babble noise significantly diminishes these responses. However, even in this more challenging soundscape, the cry sounds (in 3- and 5-months-olds) and laughter sounds (in 12-months-olds) still tended to elicit an increased voltage of the LPC in comparison to the contrasting emotional condition. These results are discussed in terms of their implications for understanding the ontogeny of emotional vocalizations processing in infancy, by taking into account the complexity of the auditory environment in which these emotion expressions are embedded in everyday life, as well as infants' emotion regulation abilities.

P4-B-34: Pupillometry in infants at increased likelihood for developing autism spectrum disorder

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Autism spectrum disorder (ASD) is a neurodevelopmental condition, which is diagnosed by trained clinicians through observational methods. At an early age, this diagnosis is often



difficult to establish. Underlying mechanisms that explain the behavioral symptoms are not yet fully understood. In search for tools to reveal possible underlying differences, pupillometry shows to be a promising index. The pupil is a window into the autonomous nervous system, and therefore is an interesting, yet easy to measure, subject. In reaction to light, a pupil constricts. Pupillometry can measure the baseline pupil size, the amplitude of the change in diameter and the latency to the maximum constriction, among other parameters. In our meta-analysis, we show that the latency to maximum pupillary constriction during the pupillary light reflex robustly differs between individuals with ASD and their typically developing peers, with a Cohen's d of 1.13 in the overall comparison. The latency of this pupillary light reflex is significantly prolonged, but age seems to be a modulating factor. While the latency is prolonged in children, adolescents and adults with ASD, an opposite effect with significantly shorter latencies was observed in infants at increased likelihood of developing ASD at the age of 10 months (Nystrom et al, 2015). Further studies are needed to confirm this age effect, which constitutes a major aim of our current study. In our longitudinal study, our aim is to investigate the maturation of the autonomous nervous system by tracking the evolution of this parameter during infancy. We measure the pupillary light reflex at the age of 5 months, 10 months and 14 months in infants at an increased likelihood of developing ASD: siblings of children with an ASD diagnosis and prematurely born children, born before 30 weeks of gestational age. We also collect data from healthy control infants from the general population. The pupillary response is recorded with a Tobii pro X3-120 eyetracker, while infants sit on their parents lap and watch a black screen shortly flashing white. Currently, data collection and data analysis is still ongoing, but group comparisons of the first timepoint (age of 5 months) will be presented at the conference.

P4-B-35: The transgenerational impact of maternal discrimination during pregnancy on neonatal brain connectivity

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The Transgenerational Impact of Maternal Discrimination During Pregnancy on Neonatal Brain Connectivity Kristiana Barbato¹, Antonette Davids², Bradley S. Peterson^{3, 4}, Catherine E. Monk^{1, 5} Dustin Scheinost⁶, Marisa N. Spann¹ ¹Columbia University Irving Medical Center, New York, NY ²Dartmouth College, Hanover, NH ³Institute for the Developing Mind, Children's Hospital Los Angeles, Los Angeles, CA ⁴Keck School of Medicine, University of Southern California, Los Angeles, CA ⁵New York State Psychiatric Institute, New York, NY ⁶Yale University School of Medicine, New Haven, CT There is emerging evidence that chronic exposure to racial discrimination during pregnancy is associated with various negative psychological and physical maternal outcomes including increased risk of depression, anxiety, and systemic inflammation (Chaney et al, 2019; Giurgescu et al, 2016). However, there is a lack of research examining the impact of maternal racial discrimination on offspring brain development. The current study aims to determine whether maternal exposure to racial discrimination affects neonatal functional connectivity of the hippocampus and amygdala, areas that have been linked to stress and depression. Forty-five pregnant women, aged 14-



19, were recruited from Columbia University Irving Medical Center. They received routine prenatal care and had no major health problems. A majority of the women were Hispanic (88%). At 34-37 weeks gestation, the women completed self-report psychological assessments including the Experiences of Discrimination Scale. Resting-state functional MRI data were acquired in the neonatal period. Standard seed connectivity from the right and left hippocampi and amygdalae were performed. Women reporting discrimination during pregnancy compared to women who did not had neonates with weaker connectivity between the right hippocampus and dorsolateral prefrontal cortex. In kind, women experiencing discrimination relative to those who did not had neonates with weaker connectivity between the left amygdala and anterior prefrontal cortex. Our findings suggest that maternal exposure to racial discrimination is associated with neonatal connectivity of the hippocampal and amygdala regions to the prefrontal cortex, which are all brain regions implicated in stress and emotion processing. Previous studies with adults have also shown that the prefrontal cortex is involved in racial processing (Katsumi et al, 2018; Quadflieg et al, 2009; Knutson et al, 2007), and further, that social evaluative stress is associated with altered prefrontal connectivity with brain regions involved in emotion regulation and attention (Berger et al, 2014). The amygdala has also been implicated in the processing of 'other race' faces in adult minorities (Sankar et al, 2018; Liu et al, 2015). As our findings with infant brain connectivity are consistent with these brain regions associated with racial processing and social evaluative stress in adults, there could be a transgenerational effect of discrimination that will require further study. Future studies are necessary to relate these connectivity patterns to racial information processing in offspring, and to determine whether racial discrimination during pregnancy is associated with negative psychological and physical outcomes in offspring.

C-Perception

P4-C-36: Myelin development and neurodevelopmental outcomes in very preterm and typically developing children

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Background: Myelin mapping, using T1-weighted and T2-weighted magnetic resonance images as a ratio, can provide important insight into the maturity of myelin. Children born very preterm (VP) are known to have developmental vulnerability of myelin. The aims of this study were to (1) compare myelin measures between VP and full-term (FT) children at term-equivalent age, 7 and 13 years of age; and to determine whether the trajectory of myelin development differs by birth group or sex; (2) determine how perinatal variables relate to myelination in VP children, including moderate to severe brain abnormality, bronchopulmonary dysplasia, small for gestational age birth and infection; and (3) examine associations between myelin measures and neurodevelopmental outcomes at 13 years, and whether these associations differed by birth group. Methods: 198 VP children and 56 FT controls underwent T1 and T2-weighted brain imaging at term-equivalent, 7 and/or 13 years



of age. T1-T2 ratio whole brain myelin maps were calculated and parcellated into 47 white matter regions of interest using the John's Hopkins University neonatal and adult atlases. Intelligence quotient (IQ), motor outcomes, memory and learning, and behavior were assessed at 13 years. Group differences and associations were examined using linear mixed effects models. Results: At 7 years, the T1-T2 ratio was higher in the cingulum bundles in the FT compared with the VP group (Figure 1). At 13 years, T1-T2 ratios were higher in the FT group in the cingulum bundles and left tapetum (Figure 1). Across both groups and sexes, T1-T2 ratio increased in almost all white matter regions between term-equivalent and 7 years and between 7 and 13 years of age, with no significant interactions for birth group or sex. T1-T2 ratios at 7 years were significantly lower for VP children with moderate to severe brain abnormality in the corpus callosum and left tapetum compared with VP children who did not have brain abnormality. At 13 years, T1-T2 ratios were lower in the fornix, bilateral tapeta, and right cingulum for those with moderate to severe brain abnormality. T1-T2 ratios at 7 years were lower for VP children born small for gestational age across most regions compared with those born appropriate for gestational age. At 13 years, T1-T2 ratios were lower in the pontine crossing tract and bilateral corticospinal tracts for VP children with infection compared with no infection. An increase in the T1-T2 ratio trajectory between 7 and 13 years of age in the uncinate fasciculus was related to higher IQ scores at 13 years, and increased T1-T2 ratios in almost all white matter regions at age 13 years were associated with improved motor functioning, in both groups. Conclusion: Myelin, assessed using the T1-T2 ratio, matured throughout childhood. There was reduced myelin, predominantly in the white matter of the limbic system, in VP compared with FT children. Myelin was particularly affected in those born small for gestational age or with moderate to severe brain abnormality. Better myelin development was associated with improved IQ and motor outcomes in both VP and FT children.

P4-C-37: Maternal intrusiveness and multisensory integration are negatively related in older infants

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Maternal influence on subsequent infant and toddler development is multifaceted in importance. In particular, maternal sensitivity (MS) involves contingent and cooperative behavior when interacting with her child, and has been shown to influence many domains of development, such as attention and expressive vocabulary (Tamis-Lemonda, Bornstein, & Baumwell, 2001). MS is evaluated by behavioral measures including maternal attention facilitation, positive affect, and intrusiveness. Multisensory integration (MSI) refers to the ability to perceive information from two or more sensory systems based on their shared, amodal properties (Bahrck & Lickliter, 2000) and MS is related to MSI skills in 24-month-olds (Bruce, in progress). However, it is currently unclear which specific attributes of MS are responsible for its relation to MSI: is MS positivity (i.e., attention facilitation, positive affect) or MS intrusiveness more predictive of MSI skills? Here, data analyses were conducted to determine which aspects associated with MS were significantly related to MSI in older infants. In this study, 36 infants ages 22-27 months, (female = 22, M = 23.79 months, SD= 1.51) were tested on a MSI task. The infants were shown short clips of women telling stories; on each trial two women were speaking simultaneously with only one of the two women's facial movements



matching the soundtrack. Each infant's MSI skills were calculated by measuring total look duration to the audiovisual match. "Matching" was then calculated as a ratio of looking time to the correct match by total looking time to either lateral event. Higher Match values indicate greater MSI skills. During the session, the mother and infant had a 10 minute free-play session in which the mother was told to play with her child as she would at home. MS (i.e., attention facilitation, positive affect, intrusiveness) was measured during the free-play interaction and was carefully coded by two trained and reliable coders. First, a Pearson correlation was conducted to determine the relationship between Matching and the two MS indices: MS positivity (defined as attention facilitation+positive affect) and MS intrusiveness. Results indicated that only MS intrusiveness was significantly correlated to Matching ($r = -.385$, $p = .019$); no significant relationship was found between MS positivity and Matching ($r = .243$, $p = .148$). To determine the predictive value of the two MS indices and Matching, a linear regression was conducted with MS positivity and MS intrusiveness as the two predictors, and Matching as the dependent variable. The overall model was significant and explained 11.5% of the variance in MSI skills, $R^2 = .16$, $F(36, 2) = 3.34$, $p = .04$. However, only MS intrusiveness significantly predicted Matching, $\beta = -.342$, $p = .04$; MS positivity did not significantly predict Matching, $\beta = .135$, $p = .41$. Thus, it seems maternal intrusiveness demotes the ability of older infants to locate and maintain attention on congruent face+voice events. This result will be discussed in terms of learned aversion and/or increased social anxiousness in the first two years of postnatal life.

P4-C-38: Look here! A new automated gaze-contingent approach for rapid assessment of infant visual acuity

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From the moment infants are born they begin exploring and learning about their visual world, and these early visual experiences fuel developing cognitive systems. Although eye movements are present at birth, visual clarity is dramatically limited due to a combination of factors, including retinal and lens immaturity, as well as limited myelination and cortical development (Johnson, 1990). Moreover, some at-risk populations are particularly prone to visual deficits due to perinatal retinal injury (e.g., preterm infants) and early detection of acuity issues is key for rapid intervention. In addition to these obvious clinical applications, there are basic research applications as well. For example, researchers who use visual tasks to assess general cognitive development would benefit from a quick and easy visual assessment that would help ensure individual differences in performance are not driven by low-level visual deficits. A classic approach for assessing infant vision is to measure their ability to resolve fine details using square wave gratings to assess acuity (i.e. the Teller Acuity Cards). Utilizing a paired-comparison technique, an experimenter holds a test card in front of the infant and observes their visual behavior. On one side of the card is a patch consisting of black and white stripes (i.e., a square wave grating) and on the other, a uniform grey field. If infants can see the stripes of the grating, they should orient preferentially to that side. If, however, the infant cannot see the stripes, they should show no systematic preference. Acuity is assessed in cycles/degree as the highest spatial frequency for which an infant shows a reliable preference. Following this basic approach, we created an eye tracking version of this task. However, rather than square wave gratings, we used sine wave gratings passed through a gaussian filter (i.e.,



"gabor patch", Figure 1). 5-, 8, and 11-month-old infants ($n=77$) were shown increasingly difficult gabor patches (spatial frequency increased by octaves from .16 to 20.48 cycles/degree, patch size 17.53° , max Snellen equivalency approximately 20/30). Gratings were presented to the left and right of fixation, and testing continued until the infant either detected all gratings or failed to detect left and right gratings on two consecutive blocks. Infants were then shown a control trial consisting of a brightly colored gabor patch. If infants failed to detect the control grating, then inattention was assumed and data were not included ($n=2$ @ 5months). A "hit" was counted if infants fixated the patch within 2 seconds for both left and right patch presentations. This allowed for rapid trial progression, and when tested binocularly, the task was often completed within 60-90 seconds. Though data show a good deal of variability, results demonstrate clear developmental effects (Figure 2). A one-way ANOVA conducted on log₁₀ transformed scores revealed a significant effect of Age, $F(2,75)=6.005$, $p=.004$. Follow-up analyses revealed 5-month-olds to have significantly lower acuity than both 7-month-olds ($p<.001$) and 11-month-olds ($p<.001$). These results highlight the utility of assessing acuity to examine both typical developmental changes and individual deficits likely to influence performance on other visual cognition tasks.

P4-C-39: Flexible top-down modulation on infants' visual perception of ambiguous figures

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Recent neuroimaging findings has suggested that infant perception can be modulated by disparate, higher-level regions of the infant brain. For example, in an audiovisual learning task, the prefrontal cortex modulates the visual system at 6 months on a trial-by-trial level (Jaffe-Dax et al., 2019). Findings like this suggest that that higher-level cognitive systems can influence perceptual systems in infancy and that infant vision may be capable of a high-level of flexibility. However, there is imitated behavioral evidence for this kind of flexibility in infant perception to date. Here, we investigate whether infants' visual perception of an ambiguous Rubin's Vase figure can be flexibly biased by learned audio cues. Forty 7- to 12-month-olds infants (224 to 375 days, 19 females) participated in the study. They first learned a sound (e.g., guitar C#) associated with images of faces and another sound (e.g., tuba F) with images of vase (Figure 1, left panel). After the learning phase, infants saw a Rubin's Vase (an ambiguous figure that can alternate between face and vase percepts) while hearing the face sound or vase sound. The image of Rubin's Vase was identical to that used in Takashima et al. (2014), which was shown to induce ambiguous face-vase percepts in infants. However, we examined whether the learned audio cues induce a percept of faces when infants heard the face sound and induce a percept of a vase when the vase sound played even though the same ambiguous, Rubin's Vase figure was presented. We used infants' horizontal saccade distance to index infants' perception of faces and that of a vase. A larger horizontal saccade distance is expected when face perception is induced as compared to that when a vase is seen. To justify the measure of visual perception, we also presented trials with unambiguous faces and unambiguous vase with the trials of ambiguous Rubin's Vase figure (Figure 1, right panel). Infants exhibited significantly larger horizontal saccade distance when they saw unambiguous faces than when they saw an unambiguous vase (paired t-test, $p = .007$), suggesting the measure can distinguish infants' perception of face from that of a vase. Using this measure of



face vs. vase perception, we found that the sounds induced different perceptual states of the Rubin's vase in infants. Infants showed significantly larger horizontal saccade when they heard the face sound than when the vase sound was played (paired t-test, $p = .048$, Figure 2). This finding suggests that infants' perception of ambiguous figure can be flexibly modulated by the learned audio cues. With a control experiment ($n = 29$), we excluded the possibility that the learned cues induced different horizontal saccade providing further evidence that it is the perception of the figure that is being modulated by different cues. Together, the current study indicates that infants' perceptual capacities may not merely be passive reflections of sensory input as previously assumed but, like adults, infants exhibit flexible changes in perception based on learning and information from higher-level cognitive systems.

P4-C-40: The use speech temporal cues in phonetic processing: An electrophysiological study with infants and adults

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The current project explores the interaction between auditory and speech perception abilities during early development. We know that, before 10 months of age, infants are not yet attuned to the consonant contrasts of their native language, meaning that, compared to adults, they are sensitive to certain non-native phonological contrasts. We also know that the auditory system continues developing until late adolescence. How, then, are such young infants able to detect these varied phonological contrasts? Psychoacoustic models suggest that the auditory system decomposes a complex speech signal in a series of narrowband signals modulated over time. According to these models, speech information is mainly conveyed by the temporal modulations at the output of cochlear filters. Particularly, these modulations can be described at two different time scales: a relatively fast one, the frequency modulations (FM) and a relatively slow one, amplitude modulations (AM). Speech analysis-synthesis tools called "vocoders" are used to generate a continuum of speech sounds with increasing/decreasing spectro-temporal complexity in order to assess the role of these modulations in speech perception. Recent studies have shown that, while adults are able to rely solely on the slowest AM ($< 8\text{Hz}$) of speech to discriminate syllables in quiet, 6-month-olds may require faster fluctuations of AM cues in order to discriminate consonants in quiet. Such results suggest that 6-month-olds weight fast AM cues more heavily than adults for speech perception. Yet, the neural underpinnings as to how such modulation cue weighting changes over the course of development remain unknown. To tackle this question, we used electroencephalography (EEG) to measure the cortical auditory evoked potentials (P1-N1-P2 complex) underlying auditory detection of native and non-native consonants in French-learning 6-month-old ($N=20$) and native-French adult listeners ($N=20$). We used vocoders to process three Vowel-Consonant-Vowel syllables: French voiced /aba/, French unvoiced unaspirated /apa/, and an English unvoiced aspirated /apha/. Three vocoder conditions were designed to: i) preserve original FM and AM, "Intact condition", ii) reduce FM and preserve original AM, "Fast AM condition", and iii) reduce both FM and fast AM, "Slow AM condition". Overall, the analyses of P1 responses suggest that adults use linguistic cues while 6-month-olds rely more on the acoustic cues when processing consonants (Fig1). Specifically, in the Intact and Fast AM conditions, adults' P1 responses to the two native-French stimuli are higher in amplitude compared to the non-native English stimulus. In 6-month-olds, we observed an interaction



between Consonant and Condition showing that Fast AM condition elicits a difference in P1 amplitude between the aspirated-unaspirated consonants (English /apha/ vs French /apa/), while the Slow AM condition elicits a P1 difference between the voiced-unvoiced consonants (French /aba/ vs French /apa/ and /English apha/). Data collection for 10-month-olds (so far, N=10) will help to understand the effect of maturation and experience with the native language on the neural processing of the acoustic cues of speech during phonological development. We hypothesize that, since 10-month-olds are more attuned to the consonants of their native language, they should show patterns approaching those observed in adults.

P4-C-41: Investigating the contagious cry in utero: Interpretation of physiological response

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The newborn baby shows peer-specific sensitivity to the sound of other newborn cries by crying themselves (Simner, 1971; Martin & Clark, 1982). Many have interpreted the 'contagious cry' as evidence for the precursors to empathy (Hoffman, 1975) whilst an alternative explanation is that the infant cries due to a confusion of the auditory input with the infants' own cry (Piaget, 1962). The newborn cry itself is shaped by the native language, with French babies producing a cry with a rising melody contour compared to German babies who produce a falling melody contour (Mampe et al., 2009). We examined early response to the sound of externally-presented newborn cries, in utero. We aimed to A) investigate the mechanisms behind the 'contagious cry' by comparing responses to a newborn cry to a backwards (perceptual control condition) cry in utero, before participants have heard the sound of their own cry, and B) assess the 'peer-specific' nature of this behaviour by comparing responses to native and non-native cries. Previous research using fetal heart rate (FHR) as a measure has shown fetuses in the third trimester have a sensitivity to social stimuli (Weikum et al., 2012; Granier-Deferre et al., 2011). We measured FHR during four 2-minute conditions; A) Native cry, B) Backwards Native Cry, C) Non-Native Cry, D) Laughter. Order of presentation was randomly-generated for each participant. We hypothesised that, should this behaviour be adaptive, fetuses should process a neonatal cry sound differently to other sounds and, thus, physiological response should differ across conditions. Should this behaviour be the result of social processes attuned to peer-specific communication, fetal response should be unique to the forwards, native cry. Should this behaviour be the result of non-social, perceptual processes, fetal response should be similar across forwards and backwards native cries only. Investigating the effects of condition, stimulus order of presentation and time course across the trial on fetal heart rate, linear mixed effects models were applied to the data using an incremental approach (Baayen, Davidson & Bates, 2008). Figure 1 shows average HR across the 120 second trials for each condition across 4 blocks of presentation. Our results indicate that there was a significant interaction between condition, order of presentation, and time course of trials ($X^2(45) = 502.09, p = >0.001$). In response to the native cry sound, FHR response was mixed with those in block two showing a rising FHR and those in block 4 showing a decreasing FHR. For the non-native cry sound, a general decrease in FHR across the trial was found for those in blocks 1, 3 and 4. An increase in FHR was found in response to laughter in block 3 and 4 and backwards native cry in block 2. Thus, physiological data indicates differential response to conditions. Fetal response to laughter and backwards native cry



sounds were often responded to differently to native and non-native sound files. This indicates a social, non-peer specific, response to cry sounds in utero. Behavioural coding of facial expressions during this study are currently under analysis.

P4-C-42: Infant detection of facial emotional expressions across the visual field

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Infants are sensitive to emotional expressions from very early on in development. Intriguingly, it has been demonstrated that 9- to 12-month-olds detect threatening stimuli more quickly than non-threatening ones, i.e. snakes compared to flowers and angry compared to happy faces (LoBue & DeLoache, 2009). Past research has investigated these developmental mechanisms within strict laboratory-controlled conditions, using simplified images presented centrally on computer displays. In reality, the majority of visual information in the environment is not restricted within central locations but also extends to more peripheral locations. Peripheral vision is particularly good at detecting movement and sudden changes (McKee & Nakayama, 1984; To, Regan, Wood, & Mollon, 2011) and it is the first visual region to be stimulated by an incoming threat. The present study aims to investigate visual detection across the visual field comparing infant's sensitivity to different emotional expressions in mid-peripheral visual areas. In particular, we hypothesised that threatening facial expressions might be more rapidly detected at peripheral locations than neutral ones. Twenty-three 9-month-old infants were presented with neutral or angry faces appearing in the mid-periphery and moving towards the centre of a screen (from 60° to 30° at 5°/s). The final sample included 19 infants (11 females; M=278 days) with 4 additional participants excluded due to technical issues. A flashing Gaussian patch was presented as central attention grabber and 4 photographs of neutral and angry faces from the Radboud Faces Database (Langner et al., 2010) were used as peripheral targets. Each trial began with a central stimulus which disappeared as soon as the infant looked at it in a gaze contingent eye-tracking procedure. The central stimulus was followed by either a competing or a non-competing trial, in which a face appeared in one hemifield or two faces simultaneously appeared in both the hemifields, respectively. A total of 32 trials per infant were presented. Saccadic latency to the peripheral target was measured and compared across conditions. Trials were considered valid if the infant initially fixated on the central stimulus before the onset of the peripheral target (251 over 608 trials, 41.3%). Saccadic latencies were discarded if less than 100ms or the gaze shift did not occur within 5s from the onset of the peripheral target (25 trials, 10%). Looking at competing trials, a repeated measure ANOVA on saccadic latency with facial expression (neutral, angry) and trial type (same expression on both side, different expressions) yielded a main effect of facial expression ($F(1,7)=8.7$, $p=.021$) and no interaction with trial type. Saccadic latencies were faster when the first look was directed towards an angry face ($M=895.5$, $SE=96.7$) than a neutral one ($M=1192.7$, $SE=149.1$, $p=.021$). Considering non-competing trials, only trials in which the infant oriented towards the correct AOI were further analysed (88 trials, 77.9%). Although these trends did not reach significance, we found shorter saccadic latency for angry faces ($M=1295.9$, $SE=205.9$) compared to neutral ones ($M=1643.9$, $SE=207.1$). On average, saccadic latency to peripheral emotional expressions were generally shorter for targets appearing to the right ($M=1193.3$, $SE=221.2$) than to the left



(M=1746.5, SE=203.8). This work provides initial support for an early detection bias to threatening stimuli across nonfoveated visual space.

P4-C-43: Cross-modal emotion discrimination in 9-month-old infants: An eye-tracking study

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The ability to detect and distinguish discrete emotional expressions is studied extensively in young infants. Most studies examine infants' ability to distinguish between emotions that differ in valence, such as happy and angry (Grossmann et al., 2007). The extent to which infants are able to distinguish between similar, within-valence emotions (e.g., angry and sad) is unclear, as the few studies that explore infants' discrimination of negative emotions report mixed findings. Critically, such studies use primarily visual paradigms, neglecting the importance of auditory emotional information in daily social interactions (Serrano et al., 1992). The ability to integrate cross-modal emotion information has been shown in infants as early as 5 months (Walker-Andrews, 1982); however, these findings are limited to contrasting emotions (Xiao & Emberson, 2019). We know much less about infants' cross-modal integration of auditory and visual information for emotions within the same valence category. The goal of the current study is to investigate infants' ability to integrate auditory emotion information with facial expressions to distinguish between negative emotions. We are recruiting 75, 8- to 10-month-old infants for the current study. To date, 12 infants (Mean Age = 9.65) have been recruited and are included in the preliminary findings presented here. Infants were randomized into one of three conditions: 1) Happy-Angry, 2) Happy-Sad, 3) Sad-Angry. The condition determined the two emotions presented throughout the task. For example, infants in the happy-angry condition were presented with happy and angry vocalizations and emotional faces. On each trial, infants heard a 3-second vocalization, followed by a congruent or incongruent emotional face paired with a neutral face. Infants were shown 16 trials, with 4 congruent and 4 incongruent presentations of each emotion. We hypothesized that infants will look longer at the emotional face after hearing a congruent emotional sound compared to an incongruent emotional sound. We expected to find this looking preference both in conditions with emotions that differed in valence (i.e., Happy-Angry; Happy-Sad) and in the condition with emotions from the same valence category (i.e., Sad-Angry). This would suggest that infants can differentiate within-valence emotions (negative vs. negative). To examine looking preference, we calculated percentage looking time to the emotional face ([time looking to emotional face / total time looking to emotional and neutral faces] x 100). A preliminary analysis (n = 4 per condition) shows differences in infants' looking to the emotional face in the Happy-Angry and Happy-Sad conditions, but not in the Angry-Sad condition (see Figure 1). Specifically, infants looked longer at the emotional face after congruent angry and congruent sad vocalizations in the Happy-Angry and Happy-Sad conditions. These preliminary findings suggest that infants may be using auditory information to distinguish between contrasting emotions, such as happy and angry, or happy and sad. Based on the current sample, infants did not show cross-modal integration of emotional information when distinguishing between similar negative emotions. However, these results should be considered preliminary; data collection is ongoing and the results of the study will be presented with a complete sample.

D-Communication 1 (speech perception, phonology and word-level processes)

P4-D-44: 7- to 9-month-old infants prefer fearful but not angry facial expressions

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Children and adults have an attentional bias for negative facial expressions (e.g., Lobue, 2009; Vaish et al., 2008). However, this fear bias is not innate. Newborns and young infants visually prefer happy faces (e.g., Farroni et al., 2007; LaBarbera et al., 1976). A visual preference for fearful faces emerges around 6-9 months (Peltola et al., 2009; Safar & Moulson, 2017). At 8 months, infants show neither a preference for happy nor angry facial expressions (Lobue & DeLoache, 2010). Together the results of these studies suggest that infants' responses to fearful and angry faces may follow different developmental paths. The question of whether infants in this age range have a fear-specific bias or a general negativity bias was addressed in the current study. Seven- to 9-month-old infants' attention to fearful, angry, happy, and neutral facial expressions was assessed in a preferential-looking task. Participants included 56 (Mage = 8.03 months; SD = .93; female = 25) healthy, full-term infants. On each trial, infants viewed two faces displaying different expressions (happy, angry, fearful, or neutral) shown side-by-side on a monitor for 10 seconds (12 trials total: 2 blocks of 6 expression pairs, side counterbalanced). Looking times were coded offline. Infants were classified into crawlers and non-crawlers based on a parent report and observation in the lab. To test the hypothesis that the bias for fearful faces is specific to fear at this age, separate Crawling X Expression Pair within-subjects ANOVAs were conducted on infant looking times (Figure 1). As hypothesized, infants looked significantly longer at the fearful expression when paired with the angry, $F(1, 54) = 19.06, p < .001, \eta^2 = .26$, happy $F(1, 54) = 4.93, p = .03, \eta^2 = .08$, and neutral, $F(1, 54) = 6.03, p = .02, \eta^2 = .10$, expressions. No significant main effects were found for the angry/happy pair, $F(1, 54) = .31, p = .58$, the happy/neutral pair, $F(1, 54) = 3.50, p = .07$, or the angry/neutral pair, $F(1, 54) = .22, p = .64$. No effects of crawling status were found. These results demonstrate that infants around 7-9 months have a reliable preference for fearful faces over angry, happy, and neutral expression and that this fear bias is not a general negativity bias, as is observed in older children and adults. This results also provide evidence that crawling is not related to expression biases at this age. Further research is needed to understand if the general negativity bias emerges during infancy or later into childhood.

P4-D-45: Assessing test-retest reliability of the infant speech preference measures

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The ManyBabies1 collaborative research project (hereafter, MB1; Frank et al., 2017; ManyBabies Consortium, in press) explores the reproducibility of the well-studied and robust phenomenon of infants' preference of infant-directed speech (hereafter, IDS) over adult-directed speech (hereafter, ADS; Cooper & Aslin, 1990). The current study is a follow-on project aiming at further investigating the test-retest reliability of infant speech preference measures. In particular, labs of the original study were asked to bring in tested babies for a second appointment retesting infants on their IDS preference seven to 30 days after the initial appointment. This allows us to estimate test-retest reliability for the three different methods used to investigate preferential listening in infancy: The head-turn preference procedure, central fixation, and eye tracking. Our preliminary sample of infants collected by seven different labs comprised a total of 141 infants with a mean age of 245 days (range: 104 to 283). First, we analyzed infants' preferences of IDS for each session separately. Two two-sampled t-tests revealed that the infants had a preference of IDS over ADS in Session 1, $t(140) = 5.44$, $p < .001$, and in Session 2, $t(140) = 3.81$, $p < .001$, replicating the previous finding from the main MB1 study. Next, we assessed test-retest reliability in two ways. First, we conducted a multilevel analysis, with Lab as a 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, $\beta = -0.04$ (SE = 0.09, $p = .644$). Second, a Pearson correlation analysis suggested that there was no significant correlation between infants' preference in Session 1 and Session 2, $r = -0.02$, 95% CI [-.18, .15], $t(139) = -0.18$, $p = .857$. In fact, these results indicate no reliability at all. We note, however, that both analyses are based on the outlier criterion of MB1, for which the preference score of a single child was included in the main analysis even if the infant had just contributed 2 out of 8 trial pairs. This criterion proved to be too weak to provide a sufficient reliable measurement. Given that an increase in test length leads to higher reliability (Brown, 1910; Spearman, 1910), an increase in the number of trials that infants needed to contribute for inclusion in the analysis from 2 to 8 trial pairs revealed a descriptive growth in test-retest reliability but also considerably reduced the study's effective sample size (see Table 1). Further, assessing test-retest reliability of infants' preference measures separately for each method suggests that HPP might have higher reliability than central fixation and eye-tracking. Taken together, the current follow-on study suggests that the test-retest reliability of infants' speech preference measures is rather low. Therefore, future research on infant development should take into account that not all experimental measures might be appropriate to assess individual differences between infants, and hence, the interpretation of findings need to be treated with caution.

P4-D-46: Developmental cascades linking social contingency, infant vocal behavior, and infant-directed speech in typical development and ASD

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Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder of early onset characterized by deficits in social interaction as well as restricted interests and repetitive behaviors. Disruption of social contingency between infant and caregiver begins in the first year of life and later cascades into other domains of behavior. Although ASD is no longer

defined by deficits in spoken language, speech is universally delayed or deviant in autism, perhaps due to the critical role that social interaction plays in promoting early vocal development. Within speech, children with autism have specific problems producing and perceiving prosodic contrasts, but it is not yet known when these begin. Conversely, "motherese", the special infant-directed register that caregivers adopt when speaking to children, initially relies on exaggerated intonation patterns that are attractive to typically developing infants from birth but seem to be different in ASD. These potential mismatches in the co- evolution of vocal signaling between infant and caregiver that scaffold, and are scaffolded by, early social feedback may exacerbate core features of the syndrome and lead to comorbidities in speech and language. The goal of this study is to explore this hypothesis by determining the relationship between early deficits in social contingency, infant prosody, and infant-directed speech, in autism and typical development. As part of an NIH Autism Center of Excellence (NIH P50 MH100029), we tracked vocal development among 45 high-risk infant siblings 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 vocal behavior and natural language environment. Using automatic 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 analysis to calculate the mean, standard deviation and range of fundamental frequency contours at each time point. Using Functional Data Analysis, we determined developmental trajectories of these measures for each child and mean developmental trajectories for each risk group. Using permutation tests to identify significant differences ($P < 0.05$) between trajectories, we found deviations between high-risk and low-risk groups in all of our measures. Declines in high-risk infant-caregiver interaction starting at 12 months, caregiver volubility at 15 months, and infant volubility at 18 months provide evidence that deficits in social contingency impact vocal responsivity in caregiver then infant. By the end of the first year of life, high-risk infants departed from the natural downtrend in fundamental frequency over time expected in low-risk controls, continuing to exhibit elevated and more variable pitch through the second year. Over the same period, high-risk caregivers either persisted later in infant-directed speech, or switched earlier into adult- directed register relative to the natural transition seen in low-risk controls. All of these results suggest a developmental cascade whereby mechanisms of infant-caregiver vocal signaling and processes of early socialization co-evolve to scaffold typical development but are disrupted in autism.

P4-D-47: Maternal infant-directed speech is differently associated with ASibs language and joint attention at 18 months compared to TD peers: Findings from an infant prospective longitudinal study

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Introduction: In a longitudinal study of Infant-Directed Speech (IDS) to infants at high-risk-of-ASD (ASibs) and a control group of typically developing (TD) infants, we investigated (a) the characteristics of IDS across both groups and (b) associations between maternal IDS and later infant language and Joint Attention (JA) abilities. Hypotheses: Owing to experience with their



older child(ren) with ASD and the sociocommunication difficulties that are a feature of the disorder, we hypothesised that ASibs mothers would use syntactically simpler (lower mean length of utterance, MLU, and more one-word/zero-clause utterances), less lexically diverse (lower VOCD) and less interactive (wh-questions and imitation of infant vocalisations) language with their infants aged 6-12 months compared to TD mothers (Hypothesis I). We further hypothesized that more interactive features of IDS would be associated with better language and JA skills and that less diverse, simpler IDS would be associated with poorer language and JA at 18 months (Hypothesis II). Study population: Nineteen infants (ASibs, n=10, 5f, having at least one older sibling(s) clinically diagnosed with ASD; TD, n=9, 4f) and their Irish English-speaking mothers, well-matched on age, SES and education, were recruited to a prospective longitudinal pilot study of mother-infant interaction. Methods: Using a video-analysis design, mother-infant dyads were filmed in face-to-face interaction at home. IDS at 6, 9, and 12 months was transcribed using the CHAT conventions of CHILDES (MacWhinney 2000) and CLAN commands used to compute indices of maternal language. At 18 months, infants were administered the language tests of the Bayley Scales of Infant Development--Third Edition (BSID-III) and the Early Social Communication Scales (ESCS). Results: Non-parametric one-tailed tests (Mann-Whitney U test and Kendall's tau) were used throughout. Hypothesis I received some support. ASibs and TD IDS was very similar at 6 months, except for significantly more one-word utterances in ASibs IDS. Thereafter ASibs and TD IDS diverged in complexity and diversity. By 9 months, ASibs IDS contained significantly more one-word utterances and significantly lower MLU and by 12 months had significantly more zero-clause utterances and lower VOCD. Hypothesis II was also partially supported. Proportion of one-word utterances at 12 months was negatively correlated with total JA and initiating behavioural requests at 18 months for the ASibs infants only. Overall proportion of maternal imitation was similar across groups but was associated with different outcomes for ASibs and TD infants. For ASibs infants: maternal imitation at 6 months was positively correlated with expressive language ability at 18 months; at 9 months was positively correlated with total JA, and initiating and responding to behavioural requests at 18 months; and at 12 months imitation was positively correlated with initiation of JA and total JA at 18 months. This contrasted with TD mothers' imitation at 6 and 9 months which was negatively correlated with total JA. Conclusion: ASibs and TD IDS significantly deviate over time and support language and JA differently in ASibs and TD infants. In particular, imitation, which by definition is contingent on infant communication bids, appears to be socially reinforcing in interaction with ASibs infants.

P4-D-48: Processing of infant-directed speech by infants at variable likelihood of later autism diagnosis

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Introduction: Attention to infant-directed speech (IDS) has been proposed as a prodromal ASD marker and predictor of ASD heterogeneity. Respiratory sinus arrhythmia (RSA) as an index of physiological self-regulation may provide insights on quality of IDS processing beyond gaze measures alone in infants at varying likelihood for later ASD. Aims: (1) Compare infants at elevated likelihood for ASD (ELASD) to infants at lower likelihood for ASD (LLASD) on gaze and RSA measures during baseline and IDS conditions. Hypotheses: ELASD infants will (a)



look less at faces and IDS vignettes overall and (b) have lower IDS RSA than LLASD infants. (2) Examine correlations among gaze and RSA during IDS exposure, and language measures. Hypothesis: (a) Time viewing IDS videos will correlate with IDS RSA; (b) both variables will correlate with receptive language (RL) and expressive language (EL). Methods: Infants (11-16 months) at ELASD (n=24) and LLASD (n=21) were identified with the First Years Inventory-Lite (FYI-L) screener, and assessed with the Mullen Scales of Early Learning (MSEL). Physiology data were collected during Baseline1, a 2-minute digitized music video; IDS, three 1-minute video vignettes of IDS speakers in a puppet show, storybook reading, and "nonsense toy" demonstration; and Baseline2, return to music video. ECG data were collected with FirstBeat™ devices, using two chest electrodes; eyetracking data were collected with Gazepoint™ software. Predefined areas of interest (AOIs) for eyetracking analysis included the IDS speakers' faces, whole screen, and toys/book/puppet. RSA was computed for Baseline1, IDS, and Baseline2. Results: Aim 1 - a single significant group difference was contrary to H1a: ELASD infants spent more time gazing at the face in the storybook vignette, $F=4.15$, $p=.048$, with a similar, marginal result for the puppet show. Aim 2 - as hypothesized, IDS RSA correlated with time gazing at IDS vignettes, $r(26)=.480$, $p=.007$, but Baseline1 and Baseline2 RSAs did not correlate with time gazing at the music video. IDS RSA correlated significantly with MSEL RL, $r(41)=.274$, $p=.041$, and EL, $r(41)=.279$, $p=.039$. Baseline1 RSA did not correlate with language scores; however, Baseline2 RSA correlated with RL, $r(41)=.454$, $p=.001$. Time gazing at IDS vignettes correlated with EL, $r(45)=.262$, $p=.041$, but time gazing during Baseline conditions did not. Finally, patterns of change in RSA from Baseline1 to IDS to Baseline2 were associated with EL (see Figure 1). Discussion: Findings provide weak evidence for distinguishing ELASD infants from LLASD infants based on gaze during IDS vignettes. The finding that ELASD infants looked more at faces than LLASD infants may reflect less flexibility in shifting gaze between faces and other AOIs. The lack of group differences in RSA is consistent with Sheinkopf et al. (2019), who found differences in RSA emerged for infants with later ASD diagnoses compared to nonASD infants around 18 months of age, slightly older than our sample. Associations between IDS RSA and gaze at IDS vignettes are consistent with previous research with children with ASD (Watson et al., 2010). Our combined findings suggest that IDS processing variables may be more informative for understanding ASD developmental heterogeneity than for predicting diagnosis.

P4-D-49: Effects of bilingualism on the encoding and discrimination of native and non-native speech contrasts

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As a result of ample stimulation from the environment and neural maturation, infants undergo a process of perceptual reorganization in their first year of life. In the domain of speech perception, this process is manifested in an increase in the ability to discriminate native phonetic contrasts and a decrease in the ability to discriminate most non-native contrasts, which takes place around 4-6 months for vowels and lexical tones and around 9-11 months for consonants. While this reflects most evidence from monolingual infants, it remains debated whether bilinguals follow the same developmental trajectory. Specifically, bilingual infants have been found to exhibit protracted periods of perceptual reorganization, taking longer to transition from a universal-listener to a native-listener mode. One possibility is that bilingualism



shapes early speech perception mechanisms due to infants' experience of negotiating two linguistic systems in their environment and of attending to acoustic properties in speech that are typically disregarded by monolinguals. On the other hand, it is possible that bilinguals receive reduced exposure to each of their languages compared to monolinguals' single-language exposure, and thus require more time to accrue the necessary native-language experience to attune to the phonetic categories of each of their languages. To tease apart these possibilities, we assessed native and non-native phonetic discrimination abilities in Spanish-Basque bilingual infants. These two languages are lexically and syntactically distinct, but there is a high degree of overlap in their phonological inventories. Therefore, even though bilingual infants receive reduced exposure to each of their languages, their overall amount of exposure to individual native phonetic categories is similar to that of monolinguals acquiring only one of these languages. Sixty 9-month-old infants completed a visual fixation habituation paradigm. Infants were acquiring Spanish and Basque in a monolingual (N=34) or bilingual contexts (N=26). Infants were habituated to the sound /pa/ (native in both Spanish and Basque) and tested on two contrasts: the native contrast /pa/-/ba/ and the non-native contrast /pa/-/pha/. Results showed that bilingual infants required more trials to habituate to the native sound than monolinguals (bilingual M=10.12; monolingual M=7.85), $t=2.08$, $p=.04$. In the test phase, monolinguals showed discrimination of the native contrast, $\beta=1.91$, $t=3.36$, $p=.01$, but bilinguals did not, $\beta=1.26$, $t=1.49$, $p=.14$. The two groups showed no discrimination of the non-native contrast. These findings indicate that bilingual infants require greater exposure to speech stimuli to encode a native speech category, and they show weaker attunement to native phonetic categories even when acquiring two phonologically similar languages. Therefore, bilingual experience impacts infants' emerging abilities to encode and process the sounds of their native languages.

P4-D-50: Semantic narrowing in bilingual infants: The case of ground-path in verbs

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Languages encode semantic information in different ways. For example, when conveying actions and events via verbs, some languages regularly encode ground-path information within the verb (e.g. Japanese), while other languages do not (e.g. English). Japanese (but not English) has different ground-path verbs based on whether the ground over which the agent moves is bounded (e.g. a street) or unbounded (e.g. a field). Japanese- and English-learning infants at 14 months can discriminate between ground-path contrasts in nonlinguistic motion events (Göksun et al., 2011). However, infants only discriminated across-category ground path distinctions (i.e., physically unbounded vs. bounded grounds) and did not extend to within-category ground path distinctions (i.e., two different bounded or unbounded grounds). By 19 months, only Japanese-learning infants could discriminate across-category ground path contrasts, reflecting 'semantic narrowing' between 14- and 19-months. Here, we investigated semantic narrowing in bilingual infants. Adopting Göksun et al.'s design, we presented English-Mandarin bilingual infants at 14- and 19-months with silent videos of motion events in a familiarization-preference paradigm. Neither English nor Mandarin routinely contrasts ground path information verb-internally. We first replicated Göksun et al.: Monolingual English-



exposed infants (N=32) were familiarized with a motion event (e.g. a person walking across a railroad track) and tested on discrimination of the familiarized event and a novel across-category ground path contrast (e.g. a person walking across an open field). A one-way ANOVA with age as a factor and preference for the novel display as a dependent variable revealed a main effect of age ($F(1, 31) = 5.43, p = .02$) such that only 14-month-olds (but not 19-month-olds) exhibited above-chance fixation to the novel event ($t(15) = 2.44, p = .03$), replicating Göksun et al. in a bilingual society (Figure 1). We then tested English-Mandarin bilingual infants on sensitivity to ground path distinctions at 14- (N=32) and 19-months (N=32). Half the infants viewed a within-category contrast and half viewed an across-category contrast. A 2 x 2 (age x condition) ANOVA showed no significant effect of age ($p = .21$), no effect of condition ($p = .87$) and no interaction of condition and age ($p = .79$). Comparisons to chance showed that bilingual infants did not differentiate within- ($p = .58$) or across-category ($p = .46$) contrasts at 14-months. However, at 19-months, they differentiated both within- and across-category distinctions (within-category: $t(15) = 2.54, p = .02$; across-category: $t(15) = 2.19, p = .045$). A follow-up study was conducted with 24-month-old bilingual infants (N=32), revealing that 24-month-old bilingual infants no longer differentiated within-category ($p = .79$) or across-category distinctions ($p = .29$) (Figure 2). Bilingual infants differ in their sensitivity to ground-path information, demonstrating sensitivity to both between- and within-category distinctions at 19-months. Bilingual infants also did not demonstrate semantic narrowing between 14- and 19-months, but instead showed increased sensitivity to ground-path distinctions. Bilingual exposure may delay awareness of semantic distinctions as suggested for phonological distinctions (Garcia-Sierra et al., 2011) and may heighten children's attention to many possible semantic contrasts within their languages, as reported for phonological perception (Singh, 2018).

P4-D-51: The early emergence of the consonant bias by the end of the first year in Spanish learning infants

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The Consonant bias is evidenced by a greater reliance on consonants over vowels in lexical processing. Although universally attested in adulthood, evidence on its emergence in infancy shows both cross-linguistic commonalities and differences. Studies in French and Italian show an early switch from a higher reliance on vowels at 5 months to a consonant bias by the end of the first year (Hochmann, et al., 2011; 2018; Bouchon et al., 2015; Poltrock & Nazzi, 2015). English and Danish learners however exhibit a completely different pattern (for a review see Nazzi, et al., 2016 and Nazzi & Cutler, 2019). Taken together, these crosslinguistic differences suggest that the native input modulates the developmental trajectory of the Consonant/Vowel asymmetry, and consequently the early contribution of the consonant bias in discovering words from the speech signal. However this body of literature is too scattered across methods, age groups and native languages to identify potential language-specific factors that are critical for the developmental trajectory of the C/V asymmetry in early words. Thus, our study investigated the developmental trajectory of the consonant bias in learners of a third Romance language unexplored so far: Spanish. Importantly, the current study applied the same method at three stages of the first year previously identified as critical for the emergence of the consonant bias: 5 - 8½ and 12 months of age. The method was adapted from the word



recognition task that revealed a consonant bias in French-learning 11 month-olds (Poltrock & Nazzi, 2015): Experiment 1 (the Familiarity task) evaluates the familiarity of the highly frequent words over the non-words in a control group; Experiment 2 (Conflict task) directly measures the effect of vowel vs. consonant alterations on the recognition of the words in a test group at the same age. Thus, our task compared the sensitivity to a consonant vs. a vowel change in familiar words at three ages, using a preferential-looking paradigm in a gaze-contingent central-fixation procedure with eye-tracker. Experiment 1 showed a significant familiarity effect for words (e.g. leche, milk) vs. non-words (e.g. machi) at 5 and 12 months (and a marginal effect at 8½ months, with a familiarity effect restricted to the first block) (cf. Figure 1.I). Experiment 2 revealed that, while 5 months-olds' word recognition performance was significantly more affected by a vowel alteration (e.g. leche → lache), 12 months olds were significantly more sensitive to a consonant alteration (e.g. leche → keche). Interestingly, effects of type of list at 5 and 12 months are consistent throughout the two blocks of the experiment (cf. Figure 1.II). This study tested word recognition during the first year and found conclusive results at 5 to 12 months of age in Spanish-learning-infants tested with the same procedure and stimuli. Together with previous results, we establish that in three Romance languages, infants start out with a vowel bias at 5-6 months and quickly switch to a consonant bias by 11-12 months. These findings strengthen the theory that the consonant bias is a mechanism of early lexical development that is driven by language-specific factors common to possibly all Romance languages. The potential role of syllabic rhythm is discussed for future directions.

P4-D-52: Changes in parental code-switching across infant development

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Bilingual parents code-switch, or mix their two languages, when speaking to their infant. Parental code-switching may influence infants' language development. For example, code-switching slows language processing (Byers-Heinlein, Morin-Lessard, & Lew-Williams, 2017; Potter et al., 2019), hinders word recognition (Morini & Newman, 2019), and may impact vocabulary development (Byers-Heinlein, 2013). However, little is known about parents' code-switching habits in daily life, and even less is known about how parental code-switching may change across the infant's development. To address this gap in knowledge, we examined parents' natural code-switching behaviors in a corpus of infants' language environments, recorded using Language ENvironment Analysis (LENA) devices (Orena, Byers-Heinlein, & Polka, 2019). We asked how the frequency, syntax, and motivation of parents' code-switching may change across their infant's development. Method. Sixteen French-English bilingual families in Montréal contributed three full-day recordings when their infant was 10 months old, and an additional day when their infant was 18 months old. We defined code-switching as any language change by a single speaker directed to the infant. Research assistants identified instances of code-switching, their syntactic location, and the apparent reason for the switch. Here, we report preliminary data from 448 hours of recordings provided by 7 families. Q1. How often do parents code-switch? At 10-months, parents code-switched on average 6 times per hour when speaking to their infant. At 18-months, the frequency of code-switching substantially increased in 5 out of the 7 families to an average of 16 times per hour (See Figure 1). Q2. Where do parents code-switch syntactically? At each age, we calculated the proportion



of code-switches that occurred at three different syntactic locations: between-sentences, within-sentence at a phrase boundary, and within-sentence not at a phrase boundary. Between-sentence code-switches were the most frequent at each age. The proportion of code-switches that occurred between-sentences and within-sentence not at a phrase boundary increased in frequency between 10- and 18-months (See Figure 2). Q3. Why do parents code-switch? At both 10- and 18-months, parents appeared to code-switch most frequently to enhance their infant's understanding (57% and 58%, respectively). The use of conventionalized borrowings (e.g., "bon appétit") was the second most frequent reason at each age (14% at 10-months and 15% at 18-months). The largest change was that parents code-switched to teach vocabulary more at 18-months (12%) than at 10-months (4%). Conclusion. These results show that a) the frequency of code-switching increased across the infants' development, b) most code-switches occur between-sentences, regardless of age, and c) that parents most frequently code-switched to boost their infant's understanding and code-switched to teach vocabulary more at an older age. Taken together, these results suggest parents' code-switching habits do change across their infant's development. Parents alter other aspects of their speech in response to their infant's development, such as tone, pitch, and vowel articulation (Kitamura & Burnham, 2003; Kitamura & Lam, 2009; Lam & Kitamura, 2012). Our results might therefore reflect how bilingual parents change in response to their infant's developing language abilities to use code-switching more strategically.

P4-D-53: Testing the role of audio-visual integration in infant vocal imitation in a naturalistic setting

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Early word learning can be explained by a two-way mechanism involving attention to the auditory-source and articulatory representations (the "dual-stream-model": Hickok, & Poeppel, 2007). In line with the intersensory redundancy hypothesis (Bahrck & Lickliter, 2000), infant ability to integrate different cues from a talking face is related to vocal imitation (in particular, time spent looking toward the mouth: see Imafuku, Kanakogi, Butler, & Myowa, 2019). Several studies have shown this ability experimentally, but none have so far tested for effects in the course of naturalistic adult-child interaction. The aim of the present study is to assess children's looking behaviour during a semi-structured vocal imitation task, using a camera mounted on the mother's head to record the baby's eye movements, in the home, in response to words and non-words. The relationship between the child's ability to imitate the mother's vocal patterns was also analysed. The study involves 12 infants in each of two age groups: (i) 12-month-olds, (ii) 15-18-month-olds. Each mother was first asked to complete the Italian short version of the McArthur-Bates Communicative Development Inventory (MB-CDI; Caselli, et al., 2017); this provided the basis for choosing the stimuli for each infant. Each mother then participated with her child in a vocal imitation task including four disyllabic words or non-words referring to four different objects. Each item was repeated six times. The stimuli consist of 1) one word (F, a word that the child is reported to comprehend and produce) 2) one familiar word (F-, a word that the child is reported to comprehend but not to produce) 3) one segmentally familiar non-word (F, a non-word including patterns that the child is able to produce, as reported by the mother) 4) one segmentally unfamiliar non-word (F-, a word that includes patterns that the child is not able to produce, as reported by the mother). All play



sessions were video-recorded, and the imitations were analysed (i.e., any child attempt to produce a target form that includes at least two sounds). The child's looking time toward the mother's mouth was analysed (see Figure 1, based on the six children per age group analysed to date). The number of child vocal imitations in each condition was tallied (words, $M=3.50$, $SE=.69$; non-words, $M= 1.67$, $SE=.88$). A t-test showed a significant difference between the vocal imitations in the word- vs. non-word conditions ($W = 53.50$, $p < .009$). Correlational analysis showed that looking time towards the mother's mouth in the non-word condition is positively related to the number of vocal imitations for that non-word ($F : r = .620$, $p < .05$ and $F - : r = .733$, $p < .01$, respectively). In sum, the results support the role of the mouth as a visual cue in the child's vocal imitation between the ages of 12 and 18 months. This imitative behaviour supports the suggested role of audio-visual integration for the child's word-learning process.

P4-D-54: Learning the voices of unfamiliar people: Evidence from 4- and 8-month-olds

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A large proportion of infants' waking time is spent looking at faces (Sugden & Marquis, 2017) and hearing speech (Bergelson et al., 2019) - giving infants ample visual and auditory experience to form multi-modal representations of different individuals. Indeed, infants can discriminate between unfamiliar individuals on the basis of facial and vocal features from early on (de Haan, Johnson, Maurer, & Perrett, 2001; Fecher & Johnson, 2019). However, little is known about how infants match face-voice features of unfamiliar people, which presents an additional cognitive demand. For example, infants must learn that specific faces and voices map onto each other, and they must retain these voice-face pairings in memory. In the current study, we examined the developmental and cognitive trajectory of learning unfamiliar voices. We recruited 4- and 8-month-old monolingual infants ($N=48$), and we assessed their talker learning and retention skills using a preferential looking task. On each trial, a pair of static faces was presented on the screen, while one of the speakers on the screen was heard saying "I'm over here! Look at my nose!". There were 8 learning trials and 8 retention trials (Figure 1). During the learning phase, infants saw and heard their mother and an unfamiliar woman (Unfamiliar A). During the retention phase, we assessed infants' learning of Unfamiliar A's voice by pairing her up with another unfamiliar woman (Unfamiliar B). As expected, infants looked longer at their mother than an unfamiliar person when hearing her voice at both 4- and 8-months of age. Interestingly, infants at both ages showed a disambiguation response during the learning phase: they looked towards Unfamiliar A when hearing a novel voice. During the retention phase, 4-month-old infants' looking patterns did not significantly differ whether hearing Unfamiliar A or Unfamiliar B's voice. Impressively, 8-month-olds looked towards the target unfamiliar face when hearing the unfamiliar voices. Taken together, our results reveal that the expectation that novel voices map on to novel faces emerges as early as 4 months of age, and that infants can retain learning of face-voice pairings by 8 months of age. This study provides new insights about how infants learn about voices, and about multi-modal representations in general. Many studies have shown that infants can use mutual exclusivity to learn about object-label pairings (e.g., Merriman & Bowman, 1989), but typically not until well into the second year of life (e.g., Halberda, 2002). Our work shows that infants can use



this bias to learn about face-voice pairings, and importantly, do so at a much younger age. Moreover, while previous studies have suggested that talker identification is difficult for infants and toddlers (Fecher, Paquette-Smith & Johnson, 2019), our findings indicate that infants already have a sophisticated understanding of voices and their relation to individuals in the first year of life.

P4-D-55: The BRIGHT study: Using LENA to assess the linguistic environment of rural Gambia

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The Brain Imaging for Global Health (BRIGHT) project is a multi-method, longitudinal study of infants' neurocognitive development from 0 to 24 months in high-resource (UK) and low-resource (rural Gambia) settings. The aim of the project is to gain some insights into the effects that poverty may have on infant development. Children's home-language experiences can vary substantially as a function of family socioeconomic status (SES). Children from lower-SES backgrounds tend to be exposed to fewer and less complex words than high-SES peers (Hart & Risley, 1995; Hoff-Ginsberg, 1998). During the first year of life, SES-related variations in infants' early-language experiences are predictive of later linguistic and cognitive skills (Huttenlocher et al., 1991). These findings highlight the importance of providing parenting interventions to disadvantaged families. To test the influence of caregivers' verbal engagement on infants' language development, we studied the home linguistic environments of infants living in the Gambia and Cambridge, across two time points (18 and 24 months). Audio-recordings of infants' verbal interactions with family members were obtained over the course of two consecutive days using the LENA system. LENA generates automated counts of language activity in a child's natural environment, including adult words, conversational turns and infant vocalizations. To date, a total of 188 18-month-olds (43 UK; 145 Gambia) and 138 24-month-olds (38 UK; 100 Gambia) have been assessed. The study revealed that infants from both sites are exposed to a similar amount of adult words at 18 and 24 months ($p < .087$). However, differences across sites were observed, whereby infants in the UK engaged more frequently in conversational turns with adults than Gambian infants at both age points ($p < .001$). Furthermore, by 24 months of age, infants differed by site with respect to the amount of daily vocalizations produced ($p = .003$), with UK infants producing 584 more words per day than Gambian infants. Finally, regression analyses showed that LENA conversational counts at 18 months within the Gambian sample predicted child vocalizations at 24 months. That is, higher exposure to turn taking between infant and adult at 18 months was associated with higher volubility at 24 months ($r(54) = .570$; $p < .001$). Furthermore, given that infants in The Gambia are exposed to a multitude of poverty-related risk factors (i.e. undernutrition, frequent infections), preliminary analyses aimed at exploring associations between these risk factors and their potential impact on the caregiving environment and subsequent language development will be presented. By relating social-environmental markers to cognitive and behavioral outcomes, we aim to guide new interventions to enable infants to reach their developmental potential.



P4-D-56: Language input during everyday routines of Hispanic families

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Culture infuses the routines of everyday life, thus guiding the social and language development of children. Certain everyday routines are universally shared (e.g., meal time and getting dressed) whereas others may be more prominent in certain cultures than in others (e.g., bookreading, chores). As toddlers transition from activity to activity, they are exposed to nouns and verbs that are unique to each routine. However, research on the activity contexts of toddler language experiences mainly focuses on European-American families. Here we focus on toddlers from Latinx families, the largest immigrant population in the US, to understand toddlers' everyday routines, and how such routines may shape the language to which toddlers are exposed. What are the routines of everyday life? How do routines shape the language experiences of Latinx toddlers? Participants were 80 mothers and their 1- to 2-year-old toddlers, primarily from Mexican heritage. Dyads were visited at home and video-recorded for 1-2 hours during their spontaneous, everyday routines (M=90 min, range = 60 min to 120 min). Observations were transcribed in Datavyu and exported to CLAN for analysis of word types and tokens in mother language. Utterances, word types, and word tokens were normalized at rate per hour to correct for different times in the home. Videos were coded for 7 routines--grooming, object play, literacy, media, feeding, chores, and unstructured--using a 30-second time-sampling interval coding system. Preliminary analyses based on 42 transcripts showed enormous variation in language inputs to toddlers, even within this homogenous sample. Mothers ranged from 37.5 to 1732.9 utterances per hour; 28.5 to 422 types per hour and between 56 to 3782 word tokens per hour (Figure 1). Routines, coded on a subsample of 24 toddlers thus far, showed that toddlers spent most time in object play (M=45%, range=20-69, SD=13%), followed by unstructured (M=24%, range=8-44, SD=10%), feeding (M=14%, range=2-31, SD=8%), media (M=9%, range=0-53, SD=12%), literacy (M=5%, range=0-24, SD=6%), grooming (M=2%, range=0-12, SD=3%) and lastly chores (M=1%, range=0-5, SD=1). Figure 2 depicts the number of mother utterances by routines. Although overall time in activities such as chores and grooming were low, these activity contexts were rich in language inputs as mothers guided activities by encouraging children to "clean, wash, brush, dress, pick it up"; and spoke about how to engage in such activities by using "water, sponge, towel, shoes, bucket, soap". There were, on average, only 5.5% of silent chores 30-second intervals. Child-focused activities such as play and literacy, which form the crux of research with European American families, were not necessarily contexts high in language input. As expected, toddlers were exposed to the least language when interacting with media (e.g., TV), with 43% of the time spent watching media containing complete silence. We are currently classifying words into conceptual categories (animals, clothes, food, vehicles) to understand how the semantics of language changes as toddlers transition across activities. Understanding the home routines that maximize language interactions in Latinx families may inform language interventions that seek to promote toddler language learning.

P4-D-57: Redundant auditory and visual cues to gender facilitate 6-month-old infants' detection of speech synchrony



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The crossmodal perception of gender (e.g., the expectation that female faces speak with female voices rather than male voices) develops in the first year of life (Walker-Andrews et al., 1991; Richoz et al., 2017). While there is evidence that adults use audiovisual (AV) matches in gender as cues for audiovisual temporal binding of speech (Vatakis & Spence, 2007), it remains to be determined whether this is also the case during development. In this study we employed an intermodal matching task to determine whether infants' detection of temporal synchrony in AV speech is modulated by the match in gender across the auditory and visual components of the speech stream. Two groups of 6-month-old infants (Female voice, matched: n=16; Male voice, mismatched, n=15) were presented with four 30 second trials in which an auditory speech stream (either "Hello baby!" or "Good job!") was presented centrally, accompanied by two side-by-side videos of the same female face, one of which was presenting visual speech in synchrony with the auditory stream, the other presenting the same visual speech in reverse. We calculated the proportion of looking time to the synchronously speaking face from the total looking duration to both faces. Infants looked significantly longer to the synchronously speaking face in the Female voice (i.e., gender matched) condition but showed no preference in the Male voice (i.e., gender mismatched) condition. Furthermore, the preference for the synchronously speaking face was significantly bigger in the Female voice condition than in the Male voice condition. These findings indicate that, at 6 months of age, infants use semantic correspondences (i.e. gender matches) to bind audiovisual speech in temporal synchrony. Further research will help identify whether this ability reflects an increased use of crossmodal semantic cues to bind speech in time, or is the outcome of a perceptual narrowing process in which infants lose the sensitivity to AV speech synchrony when semantic information conflicts across the senses.

P4-D-58: The role of lexical similarity on bilingual parallel activation: A priming study in toddlers

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The non-selective account of lexical access states that bilinguals activate both languages in parallel during language use. The literature suggests that the phonology of both languages seem to interact during both word production and recognition in bilingual adults and toddlers (e.g. Costa, Caramazza, & Sebastian-Galles, 2000; Von Holzen & Mani, 2012). Our study explores the impact of lexical similarity between bilinguals' languages on lexical access in the developing lexicon. Mani & Plunkett (2010, 2011) found that 24-months-old monolinguals implicitly name pictures presented in silence, generating a phonologically detailed label (prime) that interferes with the subsequent recognition of words (target) when both prime and target labels share phonological onset. Using a similar procedure, we aim to extend these findings to bilingual toddlers learning Spanish-Catalan and Spanish-English. Our first hypothesis is that both monolinguals and bilinguals should show inference in target word recognition when prime and target labels share phonological onset, replicating Mani and Plunkett's findings. Our second hypothesis, derived from the parallel activation account, is that bilingual toddlers will generate labels in both languages for the prime image. This should lead



to larger interference in bilinguals when prime labels in both languages share phonological overlap with the target. We will manipulate the cognate status of the prime labels to test our hypotheses: In half of the trials, prime and target labels will share phonological onset (related trials). Unrelated trials (no phonological overlap between prime and target labels) will serve as baseline. In half of the related trials, the prime label will be a cognate (related-cognate trials): both translation equivalents will share phonological onset with the target label (e.g. tiger/tigre -table). In the other half of the related trials, the prime label will be a non-cognate: only the label in the test language will share phonological onset with the target (related-non-cognate trials; e.g. table/mesa - tree). Additionally, it remains unknown whether lexical similarity across languages influences the overall degree of parallel activation during early language acquisition. We predict that lexically close languages, which share a relatively large number of form-similar translational equivalents, should elicit stronger parallel activation than lexically distant languages. Our third hypothesis is therefore that toddlers learning Spanish and Catalan (lexically close languages) will show stronger interference than those learning Spanish and English (lexically distant languages), which would suggest that lexical similarity across languages influences parallel activation during language use. We performed a preliminary analysis on 30-month-old participants comparing unrelated, related-cognate, and related-non-cognate trials. Due to the small and uneven number of participants, we pooled data from participants learning Spanish/Catalan and Spanish/English together into a group of monolinguals (N = 17) and a group of bilinguals (N = 10). Results suggest that in both groups target word recognition was modulated by prime-target phonological relatedness, regardless of the cognate status of the prime. More detailed analyses involving cognate vs. non-cognate trials and Spanish-Catalan vs. Spanish-English bilinguals will be performed after data collection is completed.

P4-D-59: Referential uncertainty in the word learners' input: New insights from the Human Simulation Paradigm

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Foundational to theories of word learning is how infants overcome the uncertainty of reference. That is, how is it that infants unearth the right word-referent pairings from the cluttered visual and auditory world? We propose that a deeper understanding of how infants overcome referential uncertainty entails a better grasp of the problem itself and the processes that shape it. We pursue this proposal via the Human Simulation Paradigm (HSP; see Gillette et al., 1999), in which naïve adult observers watch muted video vignettes of parent-infant interactions and guess the identity of a word masked by a beep. The extent to which observers fail to guess the target word has been interpreted as an index of referential uncertainty (see Cartmill et al., 2013; Gillette et al., 1999; Medina et al., 2011). Here, we examined the answer distributions and error patterns of participants in this paradigm as a window into: (1) the nature of uncertainty, and (2) the frequency of different types of uncertainty. Ten parent-toddler dyads (Mage = 19.7mos, SD = 5.7) played in a home-like laboratory playroom (see Fig 1A). From video-recordings of these interactions, we created sixty 40s vignettes (see Fig 1B) that were muted except for a beep at the 30s mark, which corresponded to the moment parents uttered a target noun in the original recording (e.g., "ball", "truck", "fire", "hug"). Twenty-five adults participated in an HSP study where they watched 30 vignettes and guessed the target noun



for each vignette. This work makes two contributions to our understanding of referential uncertainty. First, answer distributions across participants show only a small number of unique answers per vignette ($M = 4.1$, $SD = 1.8$; see also Gilette et al., 1999, Kako, 2005). Although uncertainty in the input is evident (i.e., participants' overall accuracy was low; $M = 36.5\%$, $SD = 34.5\%$), that uncertainty does not appear to be driven by the oft-mentioned claim that the world is conceptualized in countless ways. That is, participants had a quite constrained and consistent conceptualization of the world (60% offered the most frequent answer; see Fig 2A-B). Furthermore, although the correct answer was the most common answer in only 45% of vignettes, it was in the top 4 for 70% of vignettes (see Fig 2C). This suggests that if participants were not limited to single hypotheses, our estimates of uncertainty may be much lower than commonly presumed. Second, we analyzed the 476 errors across all vignettes and coded whether they belonged to three commonly purported types of uncertainty (synonyms, levels of categorization, and partitives). Analysis of errors suggest that the "problem" of referential uncertainty is made up of many problems, each only accounting for a small piece of the uncertainty pie (see Fig 2D). In summary, understanding how infants overcome the referential uncertainty problem entails a better grasp of the problem itself. Ongoing work in our laboratory is exploring how task manipulations influence estimates of uncertainty, and whether different mechanisms may underlie solving the different types of uncertainty.

P4-D-60: Prior experience with the Headturn Preference Procedure relates to infant direction of preference in learning studies

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Direction of preference in infant behavioral research has been a matter of debate for the past 50 years. Multiple factors have been proposed to account for shifts between familiarity and novelty preferences including age, length of exposure and task complexity (e.g., Hunter & Ames, 1988; Colombo & Bundy, 1983; Aslin, 2007). It is also frequently the case that direction of preference does not conform with researchers' expectations. One frequently overlooked factor is that infants do not arrive at the lab as naïve research participants. Like adults, they bring significant prior experience that may influence their performance. Despite the attempts to override those experiences by using novel stimuli (e.g., unfamiliar languages, sounds, etc.), there may be forms of experience that go unidentified by researchers. One such factor is that many infants participate in more than one experimental session over the course of weeks or months. Here we explore the effect of prior experience with an experimental paradigm - HeadTurn Preference Procedure (HPP) - on direction of preference in learning tasks. We conducted an exploratory analysis on three artificial grammar learning studies with 12-month-olds - Santolin & Saffran (2019), its replication, and Saffran & Wilson (2003), (Fig. 1) - characterized by large variability in infants' number of lab visits (ranging from 1-5 over the preceding few months). Our a posteriori prediction was that infants who had previous HPP experience were more likely to show novelty preferences than infants for whom this method was new. We modeled results of all infants ($N=90$) who participated in these three studies. Linear mixed-effects analyses show a significant interaction between Test item (familiar vs. novel) and number of HPP Visits ($F(1,88)=8.136$, $p=.005$), indicating that looking time differences were influenced by infants' HPP experience (Table 1, Fig. 2). The same pattern



holds when reducing the data to infants with 3 or fewer HPP visits ($F(1,83)=4.361$, $p=.04$). During their first visit, infants have to simultaneously learn the structure of the HPP task (i.e. visual-auditory contingency) and solve the learning problem (i.e., tracking word sequences). One possibility is that such double-processing of information increases the overall difficulty of the study, leading to familiarity preference. Infants who are already familiar with the HPP task structure may be more able to focus on the learning problem, resulting in better learning as evidenced in novelty preferences. Importantly, this effect may extend beyond HPP experience to encompass many aspects of the first laboratory visit, during which infants encounter a great amount of new information. Additional evidence from other paradigms would be informative about how the lab experience modulates infants' performance in a given task, and allow to create an updated model of the factors inducing different patterns of preferences in infant studies.

P4-D-61: The dynamics of everyday life: Variation and stability in caregiver-child verbal engagement during everyday activities in English

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It is well-established that individual differences in the quantity and quality of caregivers' verbal engagement is linked to children's later learning outcomes. But, does the nature of caregiver-child interactions change as a function of activity? Prior studies using standardized settings have demonstrated that, for example, book sharing is associated with increased verbal engagement compared to other everyday activities, such as play (Hoff-Ginsberg, 1991). At the same time, analyses of spontaneous all-day recordings find that book sharing is relatively infrequent and does not occur every day in all families (Gilkerson et al., 2017; Soderstrom & Wittebolle, 2013). More research is needed to understand what caregivers are doing when they engage with their children and how the dynamics of everyday life changes the nature of those interactions. Moreover, few studies have directly compared talk across activities in the same caregivers, i.e., to what extent is verbal engagement stable across caregivers? Here, we investigated naturalistic and spontaneous caregiver-child interactions with 2-year-olds in English- ($n=41$) and Spanish-speaking ($n=41$) families from diverse SES backgrounds. We explored variation in quantity (adult word counts, AWC) and quality (conversational turns, CTC) of verbal engagement (1) across activities and (2) across caregivers. For each family, we sampled interactions from day-long LENA recordings, selecting 6 10-minute segments of primarily child-directed speech with the highest AWCs. Coders identified child-centered (books, play, food, routines, unstructured conversation) and adult-centered activities (caregivers engage in their own activities while talking to their child; e.g., chores). We found that the densest hour of talk can occur in several different types of everyday activities in both English- and Spanish-speaking families (Figure 1). In both groups, child-centered activities accounted for approximately 50% of the AWCs in the densest hour, on average, whereas adult-centered activities accounted for 13% in English-speaking families and 18% in Spanish-speaking families. The remaining portion in both groups was comprised of overheard speech. Comparing speech across different activities, AWCs and CTCs per minute were higher during book sharing (English AWC $M=63.76$, CTC $M=3.26$; Spanish AWC $M=67.49$, CTC $M=3.87$) than all other activities (English AWC $M_s = 41.46-46.03$; CTC $M_s = 2.21-2.76$; Spanish AWC



Ms = 44.4-49.63, CTC Ms = 2.31-30.01). Finally, we found strikingly high stability in the rank orders of caregivers (Figure 2). That is, caregivers who engaged relatively more in one activity also engaged more during other activities (AWC: English mean $r=.65$ ($r_s = .30-.93$); Spanish: mean $r=.75$ ($r_s = .13-.96$); CTC: English mean $r=.78$ ($r_s = .49-.94$); Spanish: mean $r=.61$ ($r_s = .42-.88$)). Using day-long recordings, these results provide further evidence that the dynamics of everyday life alters the specific features of learning environments across activities. At the same time, everyday life provides caregivers with many different opportunities to engage in language-rich interactions with their children. Additionally, intra-individual variation is highly stable across caregivers, suggesting that variability is driven by differences across caregivers, rather than activity. In ongoing work, we are transcribing interactions to provide precise estimates of tokens, types, and utterance complexity and relations to child outcomes.

P4-D-62: 5-month-olds are sensitive to native language phonotactics

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A prevalent view is that infants learn phonotactic distributions from a proto-lexicon derived via domain-general statistical learning. Supporting evidence comes from studies showing that 5-month-olds can segment words using transitional probabilities between syllables (Johnson & Tyler, 2010), but only at 9 months are infants sensitive to native language phonotactics (Jusczyk et al., 1994; Mattys et al., 1999; Mattys & Jusczyk, 2001). We present data from two infant and one adult experiment challenging this developmental trajectory. In Jusczyk et al.'s classic experiments on phonotactics, infants were presented lists of words that differed simultaneously on two metrics, positional probability of a segment within a word (unigram) and co-occurrence probabilities of two phonemes within a word (bigram). In Experiment 1, we asked adults to assign numerical ratings to nonce sequences based on the likelihood that they could be adopted as new words of English (using a magnitude estimation task, following Hayes & White, 2013). Adults in the lab ($n = 85$) and in an online Amazon Mechanical Turk experiment ($n = 168$) experiment were tested with 480 stimuli from Jusczyk et al., as well as novel stimuli. Our results (Figure 1) confirmed that low values on each of these metrics is associated with decreased phonotactic acceptability in adults (Daland et al., 2011, Albright, 2009). Crucially, our results demonstrated that unigram and bigram probabilities independently predict adult native English speakers phonotactic judgments with the effects of each metric being clearest among items with low-probability values on the other metric (Figure 1). Based on the adult experiments, we identified 4 sets of CVC sequences: (a) two had items with low bigram probabilities that differed only on unigram probabilities, and (b) two had items with low unigram probabilities that differed only on bigram probabilities. In Experiment 2 ($n = 30$), using an infant-controlled version of the Headturn Preference Procedure (Jusczyk et al., 1994) we compared monolingual English learning 5-month-olds's listening times to 7 lists of words each with high and low unigram probabilities. Listening times were log-transformed then analyzed using Bayesian hierarchical linear regression with a maximally specified random effects structure; 5-month-olds listened significantly longer to lists with high compared to low unigram probability items (Figure 2, left panel). We are currently testing monolingual English learning 5-month-olds ($n = 12$) using the same methods on lists with high and low bigram probability items (Figure 2, right panel); 8 listened longer to lists with high compared to low bigram probability items. Together, our results show that we can isolate the contribution of individual lexical



statistics to phonotactic acceptability. Once we do so, we show that infants are sensitive to language-specific unigram (and possibly bigram) probabilities at the earliest age at which they have been shown to segment words using transitional probabilities. Our results cannot be reconciled with accounts where sensitivity to language-specific phonotactics is learned over a proto-lexicon segmented using domain-general transitional probabilities. Instead, we argue for models in which infants use language-specific phonotactic probabilities themselves to find proto-words (Brent & Cartwright, 1996; Daland & Pierrehumbert, 2011).

P4-D-63: Relating the prosody of infant-directed speech to children's vocabulary growth between 18 and 24 months

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The most salient feature of infant-directed speech (IDS) is its exaggerated prosody compared to adult-directed speech (ADS) (Soderstrom, 2007). While there is robust evidence to suggest that the prosody of IDS attracts infants' attention and regulates infants' emotion, whether it has specifically linguistic functions is still debatable (see a meta-analysis by Spinelli et al., 2017). Specifically, results are mixed regarding whether there are correlations between IDS prosody and children's vocabulary (Kalashnikova & Burnham, 2018; Porritt, Zinser, Bachorowski, & Kaplan, 2014; Song, Demuth, & Morgan, 2018). Previous correlational studies have invariably measured prosody at a global level without comparing the prosody of IDS when mothers talk about familiar words and unfamiliar words. The main research question of the current study is whether the prosody of IDS addressed to 18-month-old children predicts their vocabulary growth from 18 to 24 months. First, we asked whether the prosody of familiar words and/or unfamiliar words in IDS is correlated with children's vocabulary size. Second, we examined whether the degree of prosodic exaggeration in IDS or the IDS prosody children hears predicts children's vocabulary. We used a storybook-telling task to elicit semi-spontaneous speech from Dutch mothers when their children were 18 and 24 months old (longitudinal design; N = 27) and we measured children's receptive vocabulary using Dutch CDI at both ages. The storybook contained target words that were familiar or unfamiliar to children. Each mother told the story twice, once to an adult (ADS) and once to their child (IDS). The prosodic measures were articulation rate, mean F0 (Hz), and F0 range (Semitone) of the target words and the utterances with target words. Multiple regression analyses were conducted to examine the correlations between the prosodic predictors at 18 months and children's vocabulary growth from 18 to 24 months. We had two types of prosodic predictors for each mother: (1) The raw prosodic values which indicate the prosodic input children hear; and (2) The "hyper-scores" by dividing the IDS values by the corresponding ADS values (Kalashnikova & Burnham, 2018), indicating the degree of prosodic exaggeration of individual mothers. We compared the analyses when the prosodic predictors were taken on familiar versus unfamiliar words. We had two main findings (see Table 1 for a summary of results). First, utterance mean F0 (regardless of the familiarity of words) in IDS at 18 months significantly predicted children's vocabulary growth between 18 and 24 months. Second, the degree of F0 range expansion specifically when mothers introduce unfamiliar words to children significantly predicted children's vocabulary growth. These findings support the view that the function of IDS prosody is more than attentional or affective. Instead, the prosody of IDS may serve specific linguistic purposes. Crucially, the specific cues that may account for children's vocabulary growth seem to differ



between IDS in word-learning contexts (in which mothers introduce unfamiliar words to children) and global IDS.

P4-D-64: Using eye tracking to examine toddlers' verb learning in the midst of distractions

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To learn a verb, children must attend to objects and relations, often within dynamic scenes. Children benefit from comparing events linked to a verb (e.g., Childers, 2011; Scott & Fisher, 2012), but most prior studies have included only events relevant to a new verb while intervening irrelevant events are common in everyday life. This study uses eye tracking to ask whether children visually attend more to relevant events than irrelevant ones (adjusting their visual attention appropriately), and whether this helps them learn a verb. Two-year-old ($n=11$ to date) and three-year-old ($n=24$) children sat in front of a monitor connected to a Tobii x3-120 eye tracker. In the learning phase, they were shown three relevant events and two distractor events in three different orders. During the relevant events (similar to each other), an experimenter produced sentences containing a novel verb (e.g., Look! She's going to gorp it.); during the distractor events (differed from other events), the experimenter produced nonlabelling speech (e.g., Do you see what she's doing?). The eye tracker recorded the total duration of fixations to each event. At test, a split screen video was shown and children pointed to one of two events in two test trials to extend the verb; this process was repeated for a second verb. If children can focus their attention appropriately, then they should look longer at the relevant events linked to the target verb than they look to the distractors. A repeated measures ANOVA computed with Age (2, 3 years) as a between-subjects factor, and trial type (target, distractor) as a within-subjects factor (dv =total fixation duration) showed a main effect of trial type, $F(1,33)=122.42$, $p<0.001$, $\eta^2=0.79$. Across age, children did look longer at relevant events ($M=5.65$, $SE=.30$) than irrelevant ones ($M=4.39$, $SE=.26$). To examine whether children were successful at test, a univariate ANOVA computed with Age as a factor, dv :proportion correct ($=total\ correct/total\ responses$) showed no overall difference by age, but one sample t-tests examining whether children at each age exceeded chance ($prop=.50$) showed 2-year-olds were at chance ($M=.61$, $SE=.09$), while 3-year-olds exceeded chance ($M=.74$, $SE=.06$), $t(20)= 4.48$, $p<.001$. A final analysis asked whether looking during the learning phase could predict success at test. In a multiple regression analysis, the overall model was non-significant, $F(2, 30)=1.17$, $p=.32$, however, the looking time variables had large standardized beta coefficients such that increased looking at the distractor was associated with worse performance at test ($\beta=-.74$, $t=-1.46$, $p=.15$) and increased looking at the target was associated with better performance at test ($\beta=-.61$, $t=-1.21$, $p=.24$). Overall, these results show that children can adjust their visual attention to relevant events, they can extend new verbs by 3 years, and that looking patterns during learning are associated with children's success in learning and extending new verbs. These results are important to better understand the processes that underlie verb learning, and language development as a whole.

P4-D-65: Speech processing measured with MEG in 7 and 11-month-olds



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The 'sensitive period' for phonetic learning between 6 to 12 months of age has been well-established by decades of research (see reviews Kuhl, 2010, Werker & Hensch, 2015). Infants' discrimination of native speech contrasts increases while discrimination of nonnative speech contrasts decreases (Werker & Tees, 1984, Kuhl et al., 2006). Native and nonnative speech discrimination differentially predict later language skills (Kuhl et al, 2008). So far, most existing data are cross-sectional in nature and very few examined relations between native and nonnative speech processing within each individual (Kuhl, Conboy, Padden, Nelson & Pruitt, 2005). In the current study, we collected a large longitudinal dataset from infants at 7 and 11 months of age, measuring their native and nonnative speech processing using Magnetoencephalography (MEG). We used a double-oddball paradigm (70% Standard, 15% Deviant 1 and 15% Deviant 2) using synthesized speech sounds varying on the voice-onset-time continuum. The Standard is a bilabial stop consonant with +10 VOT (i.e. /ba/) whereas the nonnative deviant has -40 VOT (i.e./mba/) and the native deviant has +40 VOT (i.e./pa/). In this case, both deviants are equal in duration allowing direct comparison between responses to deviants within individuals. The longitudinal sample (N=50 at 7 months and N=39 at 11 months) also allows examination of change within individuals. Preliminary whole brain analyses suggest that, when comparing between responses to native and nonnative deviants at the group level, differences emerged in an early window (0-100ms) at 7 months of age while differences emerged in a later window (300-400ms) at 11 months of age. Individual whole brain responses to native and nonnative deviants were highly correlated within each time point at 7 and 11 months. When comparing across age groups (7 vs. 11 months), the magnitude of the difference between native and nonnative response increased with age in the later window (Fig1, 300-500ms window). This is in line with previous studies, supporting the idea that the processing of native and nonnative sounds are diverging towards the end of the 'sensitive period'. However, no evidence at the whole brain level was found that the difference in response to deviants at 7 months was predictive of difference in response to deviants at 11 months. Ongoing analysis is further examining the spatial-temporal patterns of the neural responses to native vs. nonnative deviants, with focus on temporal and prefrontal regions of the brain. Future research will examine the relations between the functional change in speech processing with structural changes in grey and white matters in these infants.

P4-D-66: Developmental changes in acoustic features of infant-directed speech to infants with hearing loss

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When addressing infants adults use a speech register known as infant-directed speech (IDS). Two of the most distinctive components of IDS are elevated pitch and vowel hyperarticulation, the expansion of acoustic space between the corner vowels /i,u,a/. These two components have been proposed to undergo adjustments as a function of infants' age and linguistic needs. For example, regarding age, mothers increase pitch height in IDS to six- and 12-month-olds to comfort the infant or to encourage attention, but decrease it in IDS to nine-month-olds in order to direct infants' behaviour (Kitamura & Burnham, 2003). Regarding infants' linguistic



and processing needs, compared to their adult-directed speech (ADS) mothers hyperarticulate vowels in IDS, but do not do so when infants are at-risk for dyslexia (Kalashnikova et al., 2016) or cannot hear them (Lam & Kitamura, 2012). In contrast to these findings with normal hearing (NH) infants, evidence on IDS to infants with hearing loss (HL) is scarce. Cross-sectional evidence does suggest that mothers adjust their IDS to infants with HL according to infants' hearing experience rather than their chronological age (Bergeson et al., 2006; Kondaurova & Bergeson, 2011), but further longitudinal studies are required to clarify the role of infants' developmental and linguistic needs and the role that these may play in infants' language development. This study investigated mothers' adjustments, over infant age, to their vowel and pitch production in IDS to infants with HL compared to hearing-age matched normal hearing (NH) infants. Two groups of mother-infant dyads participated: HL infants (n=11; First session: M age = 10.52 months; Second session: M age= 17.64) and NH infants (First session: n=11, M age = 8.09; Second session: n = 9, M age = 14.68). Mothers were recorded during a play session with their infant while using a toy sheep, shoe, and shark (to elicit productions of /i,u,a/) (IDS) and in a semi-structured interview with an adult experimenter (ADS). Formant dispersion and between-category differences were calculated as measures of vowel variability and clarity respectively. The results showed that over infant age there was a decrease in formant variability for /i/ and /a/ and an increase in F1-F2 distances for /i/ in IDS to NH infants, but no developmental differences in IDS to HL infants. Additionally, there was a positive correlation between F1-F2 distances for /i/ and /u/, and infants' receptive vocabulary size ($r=.57$, $n=17$, $p=.01$). In contrast, pitch exaggeration was stable over development and equivalent between HL and NH infants. These results show that vowels become clearer over development, i.e., less variability and more precise realisation in IDS to NH but not HL infants (Bradlow et al., 1996). Furthermore, the positive relation between F1-F2 distances for /i/ and /u/ and infants' receptive vocabulary supports the importance of IDS vowel production in infants' lexical development (Kalashnikova & Burnham, 2018). As pitch remained unaffected by hearing status or age, the results indicate selective modification of vowel production as a product of infant hearing status, and the importance of these modifications in language development.

P4-D-67: Relating neural entrainment to speech to later development of language and autism symptoms in infants with high likelihood of ASD

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Infants are exceptionally good at tuning in to their first language and acquire it with a rapid speed. Recent work in adults has shown that neural oscillations synchronize with the incoming speech envelope during speech processing (Luo & Poeppel, 2007). This is referred to as neural entrainment. It has been proposed that neural entrainment is valuable for language acquisition as it makes neurons especially excitable at informative points of the speech signal, e.g. at stressed syllables (Goswami, 2019). Reduced neural entrainment to speech has been related to several developmental disorders, including autism spectrum disorder (ASD) (Jochaut et al., 2015). ASD is characterized by atypicalities in multiple cognitive domains with



an onset in early development, including changes in social communication and language use (Howlin, 2013). Our study investigated whether reduced neural entrainment to speech signals during infancy relates to development of ASD and later language skills. Data were collected as part of a longitudinal study which followed 52 Dutch infants with high likelihood (HL) for developing ASD because of an older diagnosed sibling, as well as 46 low-likelihood children (LL), from 5 months to 36 months of age. We used EEG data (32 actiCAP electrodes) to videos of 5 Dutch nursery rhymes collected at both 10 and 14 months. Data was analyzed regarding phase coherence between the speech amplitude envelope and brain activity (speech-brain coherence). Our results showed significant speech-brain coherence for all frequencies tested (1-15 Hz), with no differences between risk or age groups. Standardized speech-brain coherence at the stressed syllable rate (1-3 Hz) and the phonological rate (5-15 Hz) were then linked to parental reports of vocabulary (Communication Development Inventory/CDI) taken at 24 months and to the final autism diagnosis given at 36 months (ADOS-2) using linear mixed-effects models. No relationship was found between speech-brain coherence in infancy and later autism symptoms. Importantly, speech-brain coherence in both the stressed syllable rate (1-3 Hz) and the phonological rate (5-15 Hz) predicted later vocabulary knowledge. This effect was specific to these two frequency rates, as there was no relationship between vocabulary knowledge and speech-brain coherence in the 3-5 Hz frequency range. This effect was stronger for 10-month-old infants than for 14-month-olds. Thus, we show that early entrainment to speech is related to language development. Results suggest that especially around 10 months of age the cortical tracking of speech at the stressed syllable and phonological rate is important for vocabulary acquisition. While the larger spread of vocabulary scores in the tested population might have been crucial in identifying the above association, we do not find a relationship between entrainment to speech during infancy and autism symptoms in childhood.

P4-D-68: The development of amplitude rise time detection in the first year

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In infant-directed speech, we exaggerate rhythmic features, such as syllabic stress. These features are represented acoustically in the amplitude envelope - a nested series of energy modulations carrying speech rhythm. In adults, speech comprehension may be related to the "locking on" or entrainment of neural rhythms to these modulations (Ding et al., 2016). The 'BabyRhythm' project studies 113 infants over 2.5 years to examine the development of neural entrainment and relations to language acquisition. For adults, "locking on" of brain rhythms is triggered automatically by detection of rise times in the amplitude envelope (Gross et al., 2013). Here we measure neurally whether infants can detect changes in rise time, the time taken for an energy modulation to reach its peak value (Figure 1). We use tone-based stimuli previously used with infants at risk for dyslexia (Kalashnikova et al., 2018) and in EEG with children with dyslexia (Stefanics et al. 2011). We tested infants at 7 and 11 months using an oddball ERP paradigm comprising a repeated standard tone with a short rise time (15ms), and oddballs with longer rise times (161-293ms). 108 infants participated, of whom 75 contributed measurements at both 7- and 11-months. Based on previous literature and an exploratory sub-



sample (24 infants), we focused on responses over frontal and temporal electrodes, 220 to 380ms post-stimulus (Figure 2). To compute the mismatch response (MMR), the response to the standard stimulus immediately preceding an oddball was subtracted from the oddball response. The literature posits a shift from a positive MMR component to the more adult-like mismatch negativity (MMN) during infancy (Maurer et al. 2003). Consequently, we used response magnitude as our outcome variable, but included a variable for response valence. Results were analysed using a linear mixed effects model with a random effect on participant. The response in the target time window was significantly larger than baseline whether it was a positive MMR ($\beta = 18.71$, $SE = 0.6$, $p < 0.001$) or an MMN ($\beta = 18.73$, $SE = 0.62$, $p < 0.001$), indicating that rise time changes were robustly detected. The MMR increased with age ($\beta = 1.71$, $SE = 0.85$, $p < 0.05$); the MMN increase was comparable but non-significant ($\beta = 1.44$, $SE = 0.87$, $p = 0.1$). This suggests that some older infants were better at detecting rise time differences. There was no difference in response to longer (234-293ms) vs. shorter (161-220ms) rise time oddballs, but one marginal interaction warrants re-investigation in the full sample. Among babies showing the MMN at 11 months, the response to the more difficult-to-detect (shorter) oddballs potentially increased ($\beta = 2.13$, $SE = 1.235$, $p = 0.084$). This suggests a possible relationship between exhibiting the more mature MMN morphology at 11 months, and increased sensitivity to rise time differences. The significant results show that infants detect differences in rise time and response magnitude may change over development. Next, we will replicate these analyses with the full sample, and investigate whether this perceptual ability relates to individual differences in neural entrainment and to language acquisition.

P4-D-69: 2- and 3-yr-olds do not always disambiguate contrasting words

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BACKGROUND: When children hear a novel word, they prefer to assign it to a novel, unlabeled object over a previously labeled object (i.e., the "disambiguation effect", Merriman, 1989). One explanation for this preference is that children honor the principle of contrast, the pragmatic assumption that a speaker uses different words with the intent to refer to different things (Clark 1987; 1990). The current study uses a standard version of the disambiguation task to test whether this preference varies by the number and position of the contrasts between two words. **METHOD:** 2- ($n=12$) to 3-year-olds ($n=11$) completed a disambiguation task on a touchscreen computer. For each trial, a lone object appeared on screen and was labeled with a novel, three-phoneme word ("This is a val.") Next, this first object disappeared and then reappeared alongside a second, novel object. Finally, children were asked to "point to" the object that corresponded to a second, three-phoneme novel word ("Point to the vaz.") The two words in a trial could differ by the number of contrasting phonemes and by the position of those contrasts (Table 1). Object selection (choosing the novel object) and reaction time were the primary outcome variables. **RESULTS:** Overall, both 2- ($M = .77$) and 3-yr-olds ($M = .73$) selected the novel object at above chance levels ($ps > .01$), indicating their preference to map the novel word to the novel object. This overall preference was not affected by the number of contrasting phonemes (1, 2, or 3) ($p = .23$). It was, however, affected by the position of contrasting phonemes ($p = .032$). Contrasts located at the third phoneme position (as in "val" and "vaz") resulted in fewer novel object selections ($M = .59$) compared to contrasts located at any other position ($Ms > .75$, $ps \leq .033$) (Figure 1). There were no age effects on object



selection. For reaction time, there was a non-significant trend for the number of contrasting phonemes to affect how rapidly children made their selection ($p = .087$) - three-phoneme contrasts ($M = 1499$ ms) yielded marginally faster response times than one-phoneme contrasts ($M = 2147$ ms). Conversely, the position of contrasting phonemes did not affect how rapidly children made their object selection ($p = .792$). CONCLUSIONS: Overall, findings suggest that not all contrasts are created equal. For reaction time, children were sensitive to the number of contrasting phonemes. Words that differed by three phonemes were judged nearly 650 ms faster than words that differed by one phoneme. For object selection, children were sensitive to the position of contrasting phonemes. Words that contrasted at the third phoneme position (as in "val" and "vaz") were harder for children to accurately differentiate. Finally, there were no age differences, suggesting that 2-yr-olds and 3-yr-olds make similar assumptions when differentiating two contrasting words. Overall, findings suggest that the number and position of phonemic contrasts can affect whether and how quickly children assume that different words refer to different things.

P4-D-70: 12-month-olds acquired distinctiveness bolsters coda contrasts

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Soon after birth, infants can detect most speech sound contrasts of the world's languages. A few months later, infants' perceptual abilities begin to focus on the language surrounding them. Around 8- to 10-months, infants lose interest in non-native speech sound contrasts while their perception of native contrasts becomes more acute (Kuhl et al., 2006; Werker & Tees, 1984). However, it seems that this ability is positionally constrained. Though onset contrasts at the beginning of words (onsets) are discriminated early on in infancy, contrasts at the end of words (codas) are discriminated between 16- to 20-months (Zamuner, 2006). It is only around the age of 12-months that they detect contrasts between voiced stops word finally (Archer et al., 2016). All other contrasts in final (VC) and medial (VC.CV) positions between voiced and voiceless stops are not detected at this age. That is, infants do not discriminate voiceless stops in final or medial positions, nor do they discriminate voiced stops in medial positions. Infants' inability to detect contrasting voiceless stops in coda position that occur in their native language may be inhibited by task demands. It might be the case that 12-month-olds are capable of identifying native contrasts in less salient positions if an additional cue can enhance discrimination. Acquired distinctiveness is a phenomenon in which differentiation between stimuli is intensified by a prior associative link, in this case, visual and audio stimuli (Hall, 1991). English-learning infants at 9-months when presented with the Hindi speech contrasts dental [da] and retroflex [ɖa] paired with a novel object (e.g., dental [da] paired with Object A and retroflex [ɖa] with Object B) are able to detect this non-native contrast (Yeung & Werker, 2009). In the current study, infants of 9- and 12-months were randomly selected into two conditions: Familiarization and Baseline. Infants in the Familiarization condition were presented with a pair of voiceless stops in coda position ([ap] and [ak]). In the Familiarization phase, infants were familiarized to the VC syllables speakers (e.g., [ap]) paired with a moving object on a screen (e.g., Object A). A Test phase followed immediately with only audio stimuli. Infants were presented with two types of trials (16 tokens each): alternating (ap-ak-ap-ak or ak-ap-ak-ap), non-alternating (ap-ap-ap-ap or ak-ak-ak-ak). If 12-month-olds are unable to detect native language codas using audio stimuli only, we predict that acquired distinctiveness



will intensify the perception of the contrast. A preliminary analysis shows that infants in the Baseline condition ($n = 17$) do not detect differences between test trials (n.s.), while infants in the Familiarization condition ($n = 20$) are marginally significant, $p = .078$. Nine-month-olds do not detect differences in the Baseline ($n = 32$; n.s.) nor in the Familiarization condition ($n = 36$; n.s.). These preliminary results suggest that 12-month-olds are, indeed, capable of detecting consonants in coda position. The short duration of pairing visual cues with the ap-ak contrast appears to prime infants' discrimination of consonants in coda.

P4-D-71: Phonetic discrimination in bilingual and monolingual infancy: A heart rate study

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Monolinguals in the first year of life can perceive native and non-native phonemes. As the infant specializes to his/her native language, this broad perceptual ability narrows, with vowels narrowing to native categories around 6 months (Tsao, et al, 2006). Bilingual infants may have a different perception development. While they appear to discriminate acoustically distinct vowel pairings equally well as monolinguals, they have difficulty discriminating acoustically similar vowels around 8 months of age (Sebastián-Gallés & Bosch, 2009). This may be due to the increased input variability related to hearing two phonetic sources (Byers-Heinlein, et al., 2012). Another explanation relates to habituation as a measure of phoneme discrimination. This method may not be an optimal measure of bilingual ability, as it depends on a surprised reaction to a novel stimulus, as indicated by increased looking to a corresponding visual stimulus when an auditory stimulus changes. As bilinguals are accustomed to such phonetic variations, they may lack a salient surprise response to small changes. Appropriate language tasks and response measures are needed to accurately capture bilingual perceptual ability (see Albareda-Castellot, Pons, & Sebastián-Gallés, 2011). Heart rate (HR) may offer one such solution. It has been used in infant studies as a physiological proxy for infant attention toward a stimulus, where decreased HR corresponds to active cognitive processing (Moffitt, 1971). Furthermore, using a habituation design, Brez and Colombo (2012) demonstrated that HR changes indicate infants' ability to discriminate visual stimuli, even when their visual responses do not differ. Infants had greater deceleration to a novel stimulus than to a familiar one, but had equivalent looking. HR changes may therefore reveal differences between bilingual and monolingual infants' attention to phoneme changes. This study assessed HR as a physiological proxy for phonetic discrimination between similar and distinct vowel sound pairings in monolingual and bilingual infants. Monolingual ($n = 12$) and bilingual ($n = 11$) infants of 8 months were tested in a familiarization-switch design, where the infant heard one of two vowel pairs: /ta:/-/tu:/ (distinct) and /ti:/-/tɛ:/ (similar) (counterbalanced for order). HR was recorded during baseline, familiarization trials (e.g., /ti:/), the familiar test trial (e.g., /ti:/), and the novel test trial (e.g., /tɛ'/). We then repeated the study with the other pairing. We conducted a 2 (test trial: novel vs. familiar) by 2 (contrast: distinct vs similar) by 2 (language group: monolingual vs. bilingual) ANOVA. There was a significant interaction between test trials and language group ($p < .01$), but no interaction with contrast type. Bilingual infants demonstrated a heart rate reduction to a novel phoneme and monolingual infants showed a heart rate increase. The significant interaction indicates that, while monolingual and bilingual infants may be equally



adept at noticing vowel changes, the underlying attentional processes may fundamentally differ between the groups. Bilingual infants are showing an HR change associated with sustained attention to a vowel change, perhaps revealing additional processing due to the variation present in their everyday environment. Meanwhile, monolinguals are perhaps showing a startle response to a change without sustained attention.

P4-D-72: Neural responses to repetition-based regularities in French-learning 8-month-olds: Comparing vowels and consonants using fNIRS

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Syllable repetitions in the speech stream are salient and the newborn brain already automatically detects them. Using functional Near-InfraRed Spectroscopy (fNIRS), more neural activation was found for sequences containing syllabic repetition (e.g., ABB: mubaba, talulu... or AAB: babamu, luluta) than for random sequences (e.g., ABC: mubage, talupi...) (Gervain, Macagno, Cogoi, Pena & Mehler, 2008; Gervain, Berent & Werker, 2012). Again using fNIRS, the present study explores whether the infants' brain also detects repetitions carried by segments instead of syllables and whether consonants and vowels are differentially processed in this respect. According to the "division of labor" hypothesis (Nespor, Pena & Mehler, 2003), vowels are more important than consonants for (morpho-)syntactic processing (V-bias) and should therefore be preferentially used for detecting structural regularities such as repetition-based patterns. Two behavioral rule-learning studies showed a V-bias in 6-month-old Italian-learning (Hochmann, Benavides-Varela, Fló, Nespor & Mehler; 2018) and 11-month-old Spanish-learning infants (Pons & Toro, 2010). Here we test French-learning 8-month-olds to gather neural evidence for processing differences between consonants and vowels, and identify the neural bases of these processes. Following Gervain et al. (2008), French-learning infants were presented with blocks of trisyllabic ABC sequences (e.g., bukato, kidopa...) and either ABBC sequences (consonant repetition, e.g., bukaki, kidode..., Exp. 1) or ABBv sequences (vowel repetition, e.g., bukata, kidopo..., Exp. 2). Each block contained 10 sequences, constructed with 6 different consonants and 6 different vowels and synthesized with MBROLA with equal-duration consonants and vowels (120ms). No sequence was ever repeated. There were 6 blocks per sequence type, presented in interleaved order. Infants were tested with NIRx NIRScout 816 machine (source-detector separation: 3 cm; two wavelengths of 760 nm and 850 nm; sampling rate: 15.625Hz). The optodes were placed bilaterally over the temporal, frontal and parietal areas (10 channels per hemisphere, see Fig. 1). Changes in the concentration of oxygenated hemoglobin (oxyHb) and deoxygenated hemoglobin (deoxyHb) were analyzed. A preliminary analysis of 28 infants suggested overall neural activation in both the ABC and ABB conditions compared to the silent baseline in temporal areas (Channels 3 and 17) with marginal effects of $0.05 < p < 0.10$, but no difference between the consonant (N=16) and vowel condition (N=12). These preliminary results suggest processing of the repetition-based pattern, but are currently without indication of differential processing of consonant and vowel repetitions versus non-repetitions, contrary to results found for syllable repetitions (Gervain et al., 2008). After completion of our samples (target: N=24 per experiment) we will be able to confirm whether segment-based repetitions are processed



differentially from syllable-based repetitions, and whether there is a difference between consonants and vowels in this respect.

P4-D-73: Psychometrics of a behavioral assessment of Spanish and English vocabulary across the third year

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Parent report of early vocabulary size is a widely employed assessment method. Yet, direct behavioral assessments can be just as efficient and predict more variance than parent report tools alone. One such measure that has been adapted in English and Spanish is the Computerized Comprehension Task (CCT) which was created for children up to 24 months of age as a touch-screen assessment of decontextualized receptive vocabulary size. The CCT predicts language outcomes and kindergarten readiness into the fourth year (Friend, Smolak, Liu, Poulin-Dubois, & Zesiger, 2018). The present study introduces an adaptation of the CCT, the CCT+, that extends the assessment to 30 and 36 months of age in Spanish and English learning children by describing preliminary psychometric results. A total of 26 toddlers of Latino mothers were tested at 30 months of age ($M=29;20$, $SD=1;29$). A subset of these children ($n = 8$) were also tested six months earlier, at 24 months of age. Data collection is ongoing and will include a third longitudinal visit at 36 months. As a group, children had 81% exposure to Spanish and 19% exposure to English. To assess expressive vocabulary in English and Spanish, the MacArthur-Bates Communicative Development Inventory (MCDI) and the Inventario de Desarrollo de Habilidades Comunicativas (IDHC) were administered to mothers. The questionnaire has strong psychometrics and is considered one of few gold standards for assessing early vocabulary. In addition, English and Spanish receptive vocabulary was assessed behaviorally using the CCT and CCT+ at 24 and 30 months age, respectively. The CCT+ was adapted following procedures from the original CCT and presents a subset of words from the MCDI and IDHC that range in difficulty and word class. For children tested longitudinally at 24 and 30 months of age, performance on the CCT and CCT+ appear related in English and in Spanish, suggesting that the original CCT and its new adaptation were positively associated. Because this preliminary sample is too small to permit significance testing, these findings are reported graphically in Figure 1. Next we asked whether children's performance on the CCT+ correlated with parent report. A positive correlation was evinced for vocabulary in Spanish ($r(26)=.64$, $p < .001$) and English ($r(26) = .45$, $p=.03$, Figure 2). Lastly, children correctly identified approximately 59% and 54% of easy-to-moderate words in Spanish and English respectively, with this proportion decreasing for difficult words. Together these preliminary findings are generally consistent with the psychometric data reported for the original CCT. Specifically, the extended CCT+ at 30 months of age correlates with performance on the original CCT at 24 months of age and with parent report. The CCT+ also showed differential performance as a function of word difficulty. These preliminary findings support adequate construct validity such that the CCT+ is indeed capturing decontextualized word knowledge. Data collection is ongoing. We anticipate presenting data on a final sample of 20 children at 24 months of age and 40 children at 30 and 36 months of age.



P4-D-74: Acoustic cues in naturalistic infant-directed speech: A replication study

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It is widely accepted that infant directed speech (IDS) attracts infants' attention by utilizing exaggerated prosodic contours and higher pitch, and that this in turn facilitates their language development (e.g., Fernald & Simon, 1984; Grieser & Kuhl, 1988). Fisher and Tokura (1996) have also shown that there are reliable acoustic patterns related to the internal structure of IDS sentences. These conclusions, however, are largely based on in-lab recordings from small samples. It remains unclear whether the same patterns are present in more naturalistic settings. Thus, in the present study, we recorded families across two days using LENA technology and tested whether these features are present in everyday interactions. Method. Fifty 12-month-old (48% female) infants and their families participated in our study; all the adult speakers in the recordings were monolingual native English speakers. For each infant, audio recordings were transcribed in CLAN and acoustically coded in PRAAT. Of particular interest are the sentences that contain at least one modifier before the subject-verb boundaries--their prosodic and syntactic structures align at the end of the first major phrase and can provide prosodic bracketing cues to signal the syntactic boundary (Fisher & Tokura, 1996). We therefore identified the first major phrase in each full sentence and measured Vowel Duration, Pause Duration, and Pitch Change at Utterance Final, Phrase-Final, and Non-Final positions. These measures were then standardized by speaker into z-score values. 1575 full sentences were coded across infants. For each sentence, further coding included speaker information and number of modifiers preceding a head noun in the first major phrase. Results. Three one-way ANOVAs testing whether Vowel Duration, Pause Duration, and Pitch Change differed as a function of syntactic positions at Utterance Final, Phrase-Final, and Non-Final positions were all significant ($p < .0001$). Post-hoc analyses indicated that all three measures differed when in Utterance Final vs. Non-Final positions ($p < .01$) and Phrase Final vs. Utterance Final positions ($p < .01$), but there were no differences between Non-Final and Phrase-Final positions. When considering only the sentences with at least one modifier, only Pause Duration differed in Phrase-Final vs. Non-Final positions, $t(38) = 3.11$, $p = .004$, while Pitch Change and Vowel Duration did not. This suggests that while phrase-final pauses are reliably longer than nonfinal pauses, there are no detectable differences for vowel duration or pitch change across these positions. These results are partially consistent with Fisher and Tokura (1996). We found that Pause Duration differed in phrase-final vs. non-final positions for utterances whose prosodic bracketing coincides with syntactic boundaries. In contrast, Fisher and Tokura (1996) reported differences for vowel duration, but not pause duration. Together, these patterns suggest that naturalistically produced utterances may exhibit distinctive characteristics from utterances captured in a lab setting and confirm that these features of IDS are not an artifact of short interactions in which caregivers are primarily motivated to engage their infants.

P4-D-174: Automatic, real-time coding of looking-while-listening children videos using neural networks

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Infants' looking behavior, typically recorded in low-resolution videos, is a common tool for assessing infants' attention and learning. Despite its ubiquity in developmental science, estimating infants' gaze still typically involves laborious coding, or expensive setups that require calibration and involve data loss (e.g., Vencker et al., in press.). As a solution, we propose employing state-of-the-art computer-vision methods through automatic gaze estimation from low-resolution videos. We demonstrate our method on data collected from the common Looking-While-Listening procedure, where infants are expected to look at one of two locations on a screen. At the core of our method lies an artificial neural network that classifies gaze directions of infants in real-time. Using a large dataset of manually-annotated videos, we demonstrate performance that is on-par with human annotators and even replicates published results that used manual coding. Methods: We used 266 video sessions of infants and children (18-72m) participating in different studies using the Looking-While-Listening procedure. Infants were positioned ~70cm from a large screen and were recorded as they viewed pairs of images and heard sentences labeling one object. Illumination varied between videos, and the background was mostly black. Trained research assistants had labeled each frame of each video for whether the infant was looking at one image ("left"), the other one ("right"), or neither ("away"). Reliability comparisons revealed that coders agree on gaze location of 98% of frames, yielding a complete dataset of ~500k frames. Using off-the-shelf computer vision technology, we obtain for every frame the infant's facial landmarks (Zhang et al., 2016) to extract the face location, orientation (Patacchiola et al., 2017) and gaze direction (RT-GENE, Fischer et al., 2018). Using a sliding window, we stack the features of every 5 consecutive frames and treat them as data points to train our neural network. Results: We trained the neural network on 186 sessions of manually-coded videos. We then tested on a sample of 40 held-out sessions and found 98% agreement with the manual coding of "left" or "right". Adding the "away" category reduced the network's performance, but still yielded 92% agreement with manual results. We also re-analyze the automatically-labeled data to compare to the original published paper (Potter et al., 2019). Discussion: Our method provides a real-time estimation of discrete on-screen gaze location of infants as accurately as trained human coders. Beside per-frame accuracy, we also demonstrate accurate downstream use of our annotation, in the form of replication of published results. Looking ahead, gaze-contingent paradigms can be developed using this method, enabled by our real-time, temporally precise response rates (25 frames/second). For example, trials in which the infant was inattentive could be repeated, providing a more complete dataset for each participant, or infants could be presented with harder or easier trials depending on their performance on earlier trials. In addition, our technique can be adjusted to produce continuous gaze directions (i.e. horizontal and vertical angles). Exploiting this feature could potentially induce more elaborate studies, such as those displaying evolving graphics or animations.

E-Communication 2 (syntax, pragmatics, signed, nonverbal, disorders)

P4-E-75: Australian-English fathers' and mothers' IDS: More breathy, less creaky, with a high and variable pitch



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Introduction: Adults spontaneously speak differently to infants, in Infant-Directed Speech (IDS), compared to Adult Directed Speech (ADS). Key acoustic characteristics of IDS are the increased Fundamental Frequency (F0) measures, specifically an increased Mean, Median, Minimum, Maximum and Range (Fernald et al., 1989). Lesser-studied characteristics of IDS include increased variability in utterance-level F0 across an interaction (Benders, Fletcher, & StGeorge, under revision; Lee, Kitamura, Burnham, & McAngus Todd, 2014) and a breathier voice quality (Miyazawa, Shinya, Martin, Kikuchi, & Mazuka, 2017). While there is an abundance of literature on mothers' IDS, there is still limited understanding of fathers' IDS. Past research suggests that fathers may increase some or all utterance-level pitch properties in IDS, compared to ADS, (Broesch & Bryant, 2017; Papousek et al., 1987) and may do so to the same or to a lesser extent compared to mothers (Gergely, Farago, Galambos, & Topal, 2017). Even less is known about how fathers change the lesser-studied acoustic characteristics when speaking to infants. The overarching aim of the present study, therefore, was to compare utterance-level pitch properties, across-conversation pitch variability and voice quality of Australian-English mothers' and fathers' IDS, compared to ADS. Method: The final study sample consisted of eight Australian-English mother-father dyads and their infant (6-12 months). IDS was elicited from parent-infant dyads during play with toys, and ADS was elicited from mother-father dyads during a play task that was closely matched to the IDS elicitation. IDS and ADS tasks were recorded audio-visually; seven minutes of each audio recording was segmented into utterances (2210 in IDS; 2409 in ADS) and coded for the presence of breathy and creaky voice. Utterance-level F0 measures were automatically extracted and analysed in mixed-effects linear regression models. The standard deviation of utterance-level F0 as a measure of across-conversation pitch variability was analysed with mixed-effects Anovas. The prevalence of the three annotated voice quality types was assessed in mixed-effect logistic regression models. Results: Both mothers and fathers increased all utterance-level pitch F0 measures as well as their across-conversation pitch variability in IDS, compared to ADS. Both parent genders, and especially mothers, decreased their creakiness and increased their breathiness in IDS, compared to ADS. Discussion: The present study has revealed that, Australian-English fathers, as well as mothers, increase utterance-level pitch properties and across-conversation pitch variability in IDS, compared to ADS. This study is also the first to report on a decrease in the prevalence of creakiness in IDS, compared to ADS and supports earlier reports on increased breathiness in IDS with perceptually coded data. These results raise questions about infants' discrimination between and reactions to the different voice quality types. Furthermore, this study provides a procedure to match IDS and ADS elicitation, maintaining consistency in interlocutor familiarity and the type of activity engaged in by dyads, thus isolating the effect of the infant's presence on both mothers' and fathers' speech.

P4-E-76: Reciprocal influences between parent input and child language in dyads involving high- and low-risk infants for autism spectrum disorder

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Introduction: Links between parent input and child language skills have been well established in the literature on typical development (e.g., Rowe, 2012). However, less is known about the role of parent input in language learning in infants who have an older sibling with autism spectrum disorder (ASD) and are considered at high familial risk for the disorder (hereafter, "high-risk"). Moreover, little work has considered bidirectional influences between infants and parents in their communication and language production in the ASD high-risk context. In the current study, we examined the linguistic environment of high-risk infants later diagnosed with ASD (HRA), unaffected high-risk infants (HRA-), and low-risk comparison (LRC) infants, and reciprocal associations between parent input and language development in HRA , HRA-, and LRC infants during the first two years of life. **Research Questions:** (a) Do parents of HRA , HRA-, and LRC infants provide comparable measures of input at 12, 18, and 24 months? (b) Do measures of parent input relate to later language skills of infants similarly across the groups? (c) Do infants' language skills relate to parents' subsequent input measures similarly across the group? **Study Population:** Participants were 86 parent-infant dyads (high-risk: n = 53; low-risk: n = 33), 19 of whom included an infant later diagnosed with ASD. **Methods:** Parent-infant dyads were videotaped during free play interactions using a standard set of toys at 12, 18, and 24 months. Multiple measures of parent input, including word tokens, word types, mean length of utterances (MLU), and contingent verbal responses, were derived from parent-infant interactions. Children's language skills were assessed using the Mullen Scales of Early Learning at 12, 18, and 24 months, and their ASD diagnostic outcomes were determined using the Autism Diagnostic Observation Schedule and best clinical judgments between 18 and 36 months. **Results:** Our key findings were that (a) parents of all three groups (HRA , HRA-, LRC) produced similar frequency of word tokens and word types, and proportions of contingent verbal responses, but parents of high-risk infants used significantly shorter MLU than parents of LRC infants at 18 and 24 months (Table 1); (b) parents' MLU was significantly positively associated with their infants' language at the subsequent visit after six months regardless of group; and (c) infants' language skill at 18 months was significantly associated with their parents' MLU six months later in the high-risk group, but not in the low-risk group (Figure 1). **Conclusions:** Together, our findings depict a comprehensive picture of parent input to ASD high- and low-risk infants across the first two years of life and demonstrate that parents and high-risk infants collectively cultivate the interactional language environment. A better understanding of risk and protective factors that shape language learning in ASD - the genes, brains, behaviors, environment, and interactions among these factors - will help facilitate timely identification of children with potential language delays and develop effective interventions that can help all children reach their full potential.

P4-E-77: The effect of sign-supported communication in inclusive day care groups: Evidence from longitudinal data

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Background: Communication is of paramount importance for language acquisition, cognitive and socio-emotional development and social integration and acceptance. However, spoken language is not fully accessible to all children. In order to support individual communication skills in natural settings, sign-supported communication was implemented in several inclusive day care groups. This study explores: a) whether the introduction of sign-supported communication affects the mode of communication of all children and b) whether children at risk benefit in a different way. Methods: Longitudinal data were obtained from 159 children (aged 1;0 to 6;8) from 28 inclusive day care groups, directly before the implementation and 6 and 18 months after it. Children's language and communicative behavior were measured using SBE-3-KT (Suchodoletz et al. 2010) and the "Pragmatische Profil" (Dohmen et al. 2009). Results: There was a highly significant growth in sign-vocabulary after 6 and 18 months with no differences concerning gender, age, multilingualism and special needs. After 6 month a significant correlation between the spoken language competencies and the sign-vocabulary emerged ($ES > 0,3$). The higher the results of the SBE-3-KT, the more signs were acquired. But this effect disappeared after 18 month. Instead, there was a significant correlation between the spoken language competencies and sign-supported interactions with the educators ($ES > 0.45$): The lower the results of the SBE-3-KT, the more sign-supported communication was used after 18 month. Conclusions: The findings show empirical evidence that especially over time all children in inclusive day care groups learn signs more or less equal. Secondly, the results highlight the benefit of a sign-supported communication for children with no or poor spoken language competencies to facilitate communication.

P4-E-78: Building bridges: Adapting home-based early language intervention for the Early Head Start classroom

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The U.S. shows a continuing and resistant academic achievement gap between children from lower- and middle-income environments. This gap begins early, widens over time, and spans learning domains (Duncan et al., 2007; Hart & Risley, 2003; Morgan, Farkas, Hillemeier, & Maczuga, 2016). A high-quality early learning environment can attenuate this gap (Buysse, Peisner-Feinberg, Páez, Hammer, & Knowles, 2014). Because early language skills are the best predictors of later academic achievement (Pace et al., 2019), promoting early communication supports children's long-term academic outcomes across domains (Bleses, Makransky, Dale, Højen, & Ari, 2016). Specifically, several factors build a strong early communication foundation within classroom settings, including: environment, opportunities, and interactions (Dockrell, Bakopoulou, Law, Spencer, & Lindsay, 2012). Classroom environments that are physically constructed to support early language interactions (i.e., organized, clearly defined learning areas) result in higher quantity and quality child language experiences (Justice, 2004). Providing children with structured opportunities to engage in high-quality interactions with adults promotes children's vocabulary and oral comprehension abilities (Dockrell, Stuart, & King, 2010) at home and school. The current study elicited feedback from Early Head Start teachers on an early language intervention that would affect teachers' support of language learning environment, opportunities, and interactions. Teachers



volunteered thoughts about the pedagogical approach designed for parents and we examined whether reviewing the materials would alter their subsequent behavior in the classroom. Method Twelve Early Head Start teachers from six classrooms were recruited for this study, of which, ten reported being female. On average teachers reported having 14.56 years of teaching experience (SD=12.61). Seven teachers participated in a focus group that took place over three full days. Focus group participants were invited to give feedback on how to modify a parent-focused early language intervention for use with teachers. See Table 1 for description of the parent language intervention modules. Teachers were observed in their classrooms using the Communication Supporting Classroom Observation Tool before and after the focus group (Dockrell et al., 2012). Results Repeated Measures ANOVAs were conducted to address the research questions. There was no difference between language learning environment scores for teachers in the focus group and comparison group, $F(1,9)=.126$, $p=.731$, $\eta^2=.014$. See Table 2 for means. There were no differences between focus group and comparison group teachers in language learning opportunities $F(1,9)=.058$, $p=.815$, $\eta^2=.006$. There was, however, an interaction between treatment group and timepoint such that teachers who participated in the focus group maintained higher quality language interactions with children at the end of the year than comparison group teachers, $F(1,9)=7.03$, $p=.026$, $\eta^2=.439$. Finally, there was no difference between language learning interactions for teachers in the focus group and teachers in the comparison group, $F(1,9)=.636$, $p=.446$, $\eta^2=.066$. Simply exposing teachers to early language intervention modules for the purposes of eliciting feedback may enable them to maintain high-quality language learning interactions with children. This light-touch approach holds promise for enhancing language interactions.

P4-E-79: Adult response to the rhythmic movements of children at 9 months of age

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During the first years of life, rhythm helps to structure the interaction between adults and infants, contributing to the emergence of intentional communication. While infants are often considered to exclusively engage in dyadic interactions until the end of their first year, recent studies propose that triadic interactions (adult-infant-object) gradually develop even before children become able to intentionally communicate (Moreno-Núñez, Rodríguez, Del Olmo, 2015, 2017). Both adults and children tend to use objects when performing rhythmic movements, often together with other communicative resources such as vocalizations or social gaze. These rhythmic multimodal behaviors seem to be related to early proximal deictic gestures at the end of the first year (Murillo, Montero & Casla, 2019). As Iverson and Thelen (1999) proposed, rhythmic movements tend to be progressively replaced by more controlled communicative mediators, as children acquire a better autonomy and develop communicative intention. We propose that the relationship between rhythmic movements with objects and subsequent communicative gestures could be mediated by the adult's contingent response to such rhythmic movements. Adult's response could facilitate children's learning about how to establish shared references (to attend to, and to act upon) with others. This study explores how adults respond to the rhythmic movements of 9 months old children, focusing on the multimodal features of the interactions that arise from these behaviors. Following previous research, we observed 18 infants at 9 months of age (6 male, 12 female) in a free play situation



with their mother or father and in a familiar setting. We video-taped the sessions for 10-15 minutes. We used ELAN software for coding the rhythmic movements produced by children with or without an object in their hands, and children vocalizations. We also coded adult's response to children rhythmic behaviors, considering whether they followed the child's focus of attention as well as the type of response based on adapted categories from Ger, Altınok, Liszkowski, & Küntay (2018). Results showed that adults often responded to children's rhythmic movements, especially when they were produced with an object in the hand (Figure 1). They did so through a wide range of communicative mediators that offered different possibilities of action. Rhythmic movements with an object in the hands were the most frequently performed by children, while rhythmic movements without an object were rather infrequent. Most of the adult responses followed the communicative focus of the original action that the child performed, contributing to maintain the joint attention towards the referent. However, while vocalizations are typically part of early multimodal communicative behaviors as they contribute to draw other's attention towards a shared focus, we found no significant differences that pointed to an effect of vocalizations in adult responses as we initially expected. We conclude that children rhythmic movements performed with objects are systematically responded by adults, which fosters the interaction and the establishment of shared reference. Adults tend to accompany children's communicative development with adjusted mediators, promoting spaces for children active participation in the interaction, and helping to increase the complexity of their behaviors.

P4-E-80: A comparison of automated methods for quantifying daily infant crying from naturalistic audio recordings

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Background: A wearable audio recorder, the LENA (Language EnviroNment Analysis) allows researchers to measure infant crying unobtrusively and objectively in naturalistic settings. This is important because to date, most estimates of infant crying have been subjective parent or observer reports based on live observation. Although LENA software automatically quantifies the onset and offset of infant crying, no published work to date has systematically compared this estimate against human annotations of infant crying in 24-hour recordings. Given the profound clinical and research applications of an automated tool for identification of infant crying in the home, examining the accuracy of LENA-detected crying is a critical research step; especially as studies publish using LENA's automated crying output (Fields-Olivieri & Cole, 2019; Yoo, Bowman & Oller, 2019). Furthermore, with the advent of such a device, we may now begin to compare objective vs. subjective reports of infant crying in the home. Objectives: In the present study, we aim to (a) compare the accuracy of human and LENA annotations of infant crying in 24-hour recordings and (b) compare such objective estimates to subjective estimates of crying reported in the literature. Methods: Participants were drawn from an ongoing study leveraging wearable sensors to study the behavioral mechanisms of transmission of depression from mother to infant. Inclusion criteria were a continuous 24-hour LENA recording annotated for infant crying by trained RAs. N=10 infants (240 hrs) were included (1.5-4.2 months, M=2.9, SD=1.1). First, recordings were processed via LENA software to obtain cry annotations, which included fusses and cries. Next, trained RAs



(interrater reliability=.83) annotated raw audio for crying, also including fusses and cries. Consistent with existing coding schemes, cries had a minimum duration of 3 secs and were combined if within 5 secs. Results: LENA and human estimates of daily crying time were strongly correlated ($r=.85$). Human-annotated crying significantly predicted LENA crying, $b=.17$, $p=.002$ (Figure 1A); however, LENA consistently underestimated crying time relative to human annotations (range=15-105 mins, $M=53$, $SD=30$). The amount LENA underestimated crying was significantly higher for younger infants ($b=-4.6$, $p=.01$), but the ratio at which LENA underestimated did not differ by age (range=.02-.29, $M=.14$, $SD=.08$). Next, we compared moment-by-moment accuracy: LENA and human estimates had an average kappa of .21 (range=.02-.30; Figure 1B). Lastly, although our human-annotated crying showed a similar age trend compared to parent report (Figure 2), our objective cry estimates were approximately 30 mins less per day than parent reports. Discussion: Results suggest that LENA underestimates daylong crying time relative to human annotations. This was particularly noticeable for younger infants; as they cry more, LENA had more opportunities to miss episodes. However, the ratio at which LENA underestimated crying--highly variable from 1/60 to 1/3--did not vary by age. Relative to human annotations, LENA also showed poor moment-by-moment accuracy, suggesting time-locked analyses may be particularly inaccurate using LENA. Lastly, results suggest that parents report more infant crying than objective reports. These findings are critical for developmental researchers to consider, particularly given the clear promise of an automated tool for quantifying infant crying in the home.

P4-E-81: Individual differences in mothers' initiating joint attention relate to the input quality supporting word learning

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Parents display individual differences in using the available social and visual context to effectively convey the meanings of words to their young learners, known as input quality, and such differences in input quality predicted children's later vocabulary growth above and beyond socioeconomic status of the family (Cartmill et al., 2013). A recent study Jeong et al. (2019) showed that mothers with higher maternal mind-mindedness (Meins et al., 2001) were also likely to provide higher input quality whereas how sensitive mothers are to others' emotional changes (measured as empathic accuracy, Zaki et al., 2008) was not related to individual differences in input quality. The present study aimed to further examine whether individual differences in mothers' and infants' initiating joint attention (IJA) relate to maternal differences in input quality. We video-recorded 65 dyads of mother-infant naturalistic interactions, when infants were from 14 to 20 months, in their homes. We provided the mothers with identical sets of toys, materials, and books to use them during their interactions so that we can apply Early Social Communication Scales (Mundy et al., 2007) to coding IJA. We coded IJA of both mothers and infants from the entire 30-minute interaction, in terms of eye contact, alternating gaze between object and the partner, pointing, and showing. Mothers were also given MacArthur-Bates CDI checklists to report on their infants' receptive and expressive vocabulary. We then examined how these IJA scores related to maternal input quality, together with maternal mind-mindedness and empathic accuracy measures from Jeong et al. (2019). Between the mothers' and infants' IJA, alternate was the only component that showed a positive association (Figure 1), suggesting that mothers and infants shared similar tendencies



in alternating their gaze between objects and the partner. Similar to prior reports, infants' eye contact and alternate were related to their expressive vocabulary. Interestingly, the infants' word comprehension was also linked with maternal pointing behavior. In addition to maternal mind-mindedness, individual differences in maternal IJA was linked to differences in input quality, suggesting that the input quality of the mothers who have higher tendency in initiating joint attention tended to be higher in conveying word meanings clearly to their learners. We also observed that maternal empathic accuracy was linked to both maternal and infant IJAs, raising interesting possibilities in light of the association between joint attention and socio-emotional development (Vaughan Van Hecke et al., 2007). The present study adds important data to the field by providing both maternal and infant IJA from 30-minute long semi-structured naturalistic interactions and linking individual differences in IJA to maternal input quality as well as the infant's vocabulary.

F-Attention, Memory and Learning

P4-F-82: Infants' and mothers' pointing predicts infants' word knowledge and language processing speed

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Toward the end of their first year, infants begin to produce and to follow the pointing gesture in their interaction with other people. Infant pointing predicts both concurrent and prospective language development (Colonnese, 2010). For example, children's gesture production at 18 months predicts their vocabulary size and sentence complexity at 42 months (Rowe & Goldin-Meadow, 2009). Parental pointing is also related to infants' verbal production and vocabulary size (Iverson et al., 1999; Rowe, 2000). However, parents' and infants' point production have not been extensively studied in relation to infants' language processing speed, especially by separately considering whole-hand and indexical pointing forms. The present study examined whether parents and infants' use of whole-hand and indexical pointing at 14 months were associated with infants' word knowledge and language processing speed at 18 months. We expected that the pointing frequency of mothers and infants would both be related to infants' word knowledge and language processing speed. We further predicted infants' indexical pointing to be a better predictor of their later language abilities than whole-hand pointing (Lüke et al., 2017). We longitudinally examined 26 mother-infant dyads when the infants were 14 and 18 months old. To measure pointing frequency, we used the decorated room paradigm (Liszkowski et al., 2012). We coded both infants' and mothers' whole-hand and index-finger points and calculated the frequency of all points as well as of each hand form for both infants and mothers. At 18 months, we measured word knowledge and language processing speed via Looking While Listening task (LWL) using an eye tracker (Fernald et al., 2008). In 32 trials, infants were presented two objects (one distracter and one target) while they heard the name of the target object. We calculated i) the proportion of trials in which the infant correctly shifted to the target object within distracter-initial trials, ii) average reaction time to shift the gaze to



the target object from the distractor object among the distractor-initial trials and, iii) proportion of looking time at the target object relative to the total time they looked at both objects. We found that the overall pointing frequency of both infants ($\beta = .009$, $p < .05$) and mothers ($\beta = .008$, $p < .05$) as well as the index-finger pointing frequency of infants ($\beta = .005$, $p = .05$) predicted the proportion of infants' looking time to target objects at 18 months. Further, infants' index-finger pointing frequency predicted the proportion of correct shifting to target object ($\beta = .009$, $p < .05$) and reaction time to look at the target object ($\beta = -8.52$, $p < .05$). Our findings corroborate the existing evidence that both parental and infant pointing predicts infants' word knowledge. More remarkably, only infants' frequency of index-finger pointing predicted their language processing speed. That is, infants using specifically the index finger to point at 14 months were faster in language processing later on, emphasizing the importance of the index finger form as an indicator for more advanced language skills.

P4-F-83: Does polyphasic sleep benefit memory in infancy? Assessing early nap patterns via polysomnography

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Across their first 15 months, infants' sleep patterns undergo considerable change as they transition from a polyphasic sleep pattern (2 or more naps per day + overnight sleep) into a biphasic sleep pattern characterized by one nap and one overnight sleep bout (Galland et al., 2012; Weissbluth, 1995). Though prior work suggests that naps aid infant memory and learning (Gómez et al., 2006; Seehagen et al., 2015), no studies thus far have compared the relative physiological characteristics and benefits of morning and afternoon naps on infants' memory performance. In the present analyses, we investigate the sleep architecture and memory effects of infants' morning and afternoon naps at 9 months, an age during which triphasic sleep is typical. Infants participate in two study conditions, with conditions counterbalanced and spaced 1-2 weeks apart. In the Nap condition, infants engage in both their morning and afternoon naps in our sleep laboratory, with nap architecture recorded using 32-channel polysomnography. In the Wake condition, infants are kept awake during their typical morning nap, but are permitted to nap in the afternoon. Prior to all nap/wake periods, infants participate in a deferred imitation task adapted from prior studies (McDonough et al. 1995; Seehagen et al. 2015), in which an experimenter models novel actions with different objects (4 new objects per nap/wake period). Shortly after encoding, infants' memory for the actions is assessed, and memory is probed again following each nap/wake interval. Within our current behavioral sample ($n=9$, 2 female), analyses suggest that when infants are deprived of their morning nap, they show significant memory decay following their afternoon nap for items learned immediately prior to the afternoon nap ($t(8)=2.63$, $p=.03$; Fig. 1D). Intriguingly however, infants do not show significant memory decay in the morning immediately after the wake period ($t(8)=1.79$, $p=.11$; Fig. 1C). Additionally, when infants engage in both naps as usual, no memory decay is observed on average after either nap interval (both $ps>.24$; Figs. 1A-1B). Regarding infants' nap physiology (Fig. 2), repeated-measures analyses of an overlapping sample of infants ($n=9$, 3 female) suggest that regardless of whether infants are deprived of their morning nap, afternoon naps contain high percentages of N2 and SWS compared to REM (Main effect of sleep stage, Greenhouse-Geisser corrected: $F(1.1,8.8)=11.06$, $p=.008$; Bonferroni-adjusted $ps\leq.006$). No other main effects or interactions approached significance for the PM naps,



suggesting that despite their differential effectiveness in aiding memory, the architecture of PM naps following morning napping or wake may be relatively similar. Our findings provide a first step in suggesting that polyphasic sleep may be important for memory and learning at 9 months of age. Specifically, our results indicate that morning nap deprivation reduces subsequent recall in the afternoon, even following an afternoon nap. We are currently analyzing additional physiological characteristics of infants' nap bouts in our sample, and we will discuss how individual differences in infants' naps might correspond to differences in memory performance across test intervals.

P4-F-84: How is the impact of naturalistic noise on infant attention moderated by experience with in-home noise levels?

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Background. A large body of research has been produced on the development of infant attention, and while there is a clear indicator that the addition of noise in experimental tasks affects infant attention, it is still unclear how these specific experimental findings relate to the stimulating and complex learning environments that infants often find themselves in. Some important questions that remain are: What aspects of naturalistic noise are the most 'distracting' for infants? How does experience with noise outside of the lab moderate the measured effects of noise on attention, and more specifically, on attention to information with varying levels of complexity? How might other important factors that influence attentional ability, such as sensory processing and sleep, be affected by exposure to noise? Method. We tested 10- to- 12-month-old infants to see how varying naturalistic auditory distractors affect attentional patterns in an established statistical learning paradigm. Infants observed three visual shape pairs, each with a different statistical probability of where the second shape was due to appear (.5, .75, 1). Using an eye-tracker, we measured saccadic latencies to the most probable location of each shape pair, and infants were randomly allocated to three noise conditions in which there was either no noise, acute noise (i.e. phone buzzing), or chronic noise (i.e. muffled tv, traffic, doorbell). Furthermore, in order to capture the environment that the infants are regularly exposed to outside of the lab, we had parents record 9 hours of sound levels from their home. Lastly, we also measured the infants' sensory processing and sleep quality using the Sensory Profile 2 questionnaire and a 7-day sleep diary, respectively. Results. Preliminary results show that similarly to the findings from the previous research using the same paradigm, infant saccadic latencies towards the 3 shape pairs that are varying in complexity is influenced by the presence of noise. Interestingly, infants in the acute noise condition showed faster saccadic latencies to the most complex stimulus, whereas infants in the chronic noise condition showed faster saccadic latencies to the less complex stimuli. Furthermore, when taking into account experience with in-home noise levels, infants from noisier homes had slower saccadic latencies to the more complex shapes compared to infants from quieter homes, whereas infants showed similar saccadic latencies to the least complex stimulus regardless of experience with noise. When looking at the effect of exposure to noise on sensory processing, we found that both higher average in-home sound levels (L(A)eq) and more intense acute loud noises (L(A)10) correlate with lower scores on the registration/bystander and the avoiding/avoider sensory profile categories. Additionally, infants from noisier homes are trending towards requiring more night-time sleep compared to infants



from quieter homes. Discussion. From these preliminary results, we can posit that everyday experience with noise impacts on infant attentional behaviour in varying environmental contexts of different complexity. Furthermore, in-home noise levels affect sensory processing and sleep early in development, both of which are important when learning how to focus one's attention in highly stimulating learning environments.

P4-F-85: Curiosity-based learning: The brain bases of the Goldilocks effect

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Infants actively drive their cognitive development through curiosity-based exploration. Curiosity, an intrinsic need to seek information, is thought to drive learning and decision-making. According to curiosity-based models, maximal learning occurs at intermediate levels of novelty, relative to existing mental representations. Low-level novelty does not stimulate significant learning, as similar information is already mentally represented, whereas overly novel information is difficult to integrate into existing representations. The aim of this study was to investigate processes underlying the preference for intermediate novelty using EEG in 9-month-old infants. In this exploratory research we expected to find an event-related potential (ERP) signature specifically reflecting differential processing of information at intermediate novelty. The stimulus set consisted of nineteen colour images of novel animals on a morphed continuum. Images were presented successively to infants while EEG was recorded. The presented image was either one, three or seven positions away from the previously presented image on the morphed continuum, corresponding to small, intermediate or large levels of novelty, respectively. Seventeen infants contributed at least 8 artifact-free EEG segments for each level of novelty. EEG was analysed with a data driven approach using permutation based statistics. First, we examined which electrodes showed significant differences at given time points between the small, intermediate and large novelty ERPs between 50 and 600 ms. We found early differences (~100 ms) on the posterior electrodes and later differences (~ between 350-550 ms) on fronto-central electrodes. Second, we averaged the ERPs on the fronto-central electrodes (including Cz) and the visual ERPs on the occipital electrodes (including Oz). Visual ERPs between 80-120 ms post-stimulus showed differential processing for small novelty compared with intermediate and large novelty, while differential processing for large compared to intermediate and small novelty was found on the fronto-central electrodes between 450-600 ms post-stimulus. Importantly, the fronto-central ERPs were larger for intermediate compared to large and small novelty between 300-400 ms indicating differential processing for moderate novelty. We also compared the ERPs between the first and second half of the study to examine how the effect of novelty changed with the stimuli being more familiar for participants. The above described intermediate and large novelty effects on the fronto-central ERPs were significant only in the first half of the study; ERPs from the second half did not differ between conditions. The visual ERPs, on the other hand, were similar in both halves of the study. These results suggest that the early visual ERP differences reflect an automatic, stimulus driven process for images that are similar to the previously presented ones. The fronto-central ERP reflecting differential processing for intermediate novelty, on the other hand, corresponds to the Pb component that can be modulated by attentional and memory-related processes. This implicates learning from information of intermediate novelty. Moreover, this Pb effect decreased with increasing familiarity with the stimulus set, indicating



that moderate novelty is relative to existing knowledge. Overall, this is the first study to identify an ERP candidate that specifically reflects the processing of intermediate novelty.

P4-F-86: The influence of category interest on novel word retention at 24 and 38 months

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Children are seemingly effortless word learners: During the second year of life, typical vocabularies grow from just a handful of words to an average of 300 words (Frank, Braginsky, Yurovsky, & Markman, 2016). However, word learning is a complex process that operates on several time scales (McMurray, 2016). Furthermore, not all word-object-associations that a child forms initially are retained over a longer period of time. What determines whether a word will be retained and eventually enter the child's lexicon? Horst and Samuelson (2008) show that increased object salience facilitates novel word retention in 24-month-olds. At the same time, children's learning outcomes are boosted for information they are interested in (Begus, Gliga, & Southgate, 2014; Partridge, McGovern, Yung, & Kidd, 2015). Ackermann, Hepach and Mani (2019) found that this effect of interest also extends to the category level: 30-months-old children showed better recognition for novel word-object-associations from categories they were more interested in. Here we ask whether category interest may also modulate novel word retention by highlighting referents from high-interest categories such that children's intrinsic interests have a similar influence on learning as Horst and Samuelson's (2008) experimental manipulation of salience. In the present study, we therefore investigated whether interest in a natural category - e.g. animals or vehicles - helps children retain newly-acquired word-object-associations. In an eyetracking experiment, 24-months-olds (N = 44) and 38-month-olds (N = 46) were presented with pictures of 16 familiar objects from four early-acquired semantic categories while their pupil dilation was measured as an index of their interest in the different categories. In a next step, children were exposed to one novel member from each of the four categories. Novel word recognition was assessed immediately after exposure as well as five minutes and 24 hours later, using the intermodal preferential looking paradigm. Analyses indicate that 24-months-olds do not reliably recognize new word-object-associations above chance level. However, target looking is boosted for words from broad semantic categories after five minutes, in keeping with the findings of Borovsky, Ellis, Evans and Elman (2015). After 24 hours, recognition is modulated by category interest, suggesting a beneficial, but not sufficient, influence. A different pattern emerges for the older age group: At 38 months, children readily recognize novel words at all time points. After five minutes, interest in the category and interest in the object itself both have a positive impact on target recognition (see Figure 1). These results point at a developmental trajectory in the influence of interest on word learning and retention: For younger children, category size seems to be the driving force. As children get older and differences in category size across children level off (Frank et al., 2016, Szagun, Stumper, & Schramm, 2009), the role of individual interests becomes more important.

P4-F-87: An attentional blink in infancy



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The attentional blink (AB) is a phenomenon, in which the second of two target stimuli is not consciously perceived if it appears shortly after the first target stimulus. This phenomenon is well explained by a model, in which higher-level areas are busy processing the first target (T1) when the second target (T2) occurs. In adults, an AB is observed when the two targets are separated by less than 450 ms. Our first aim is to investigate the presence of an AB in young infants. Our second aim is to trace the development of the AB, especially its temporal dynamics. Based on recent neuroimaging studies (Kouider et al., 2013), we hypothesized that the temporal dynamics are at least three times slower in young infants (5-month-olds). The AB should peak around 900 ms instead of 300 ms in adults. We designed an AB task that requires no instruction whatsoever and can be employed with very young infants, capitalizing on their propensity to look at faces (Figure 1). In each trial, three streams of pictures were presented in parallel in three locations on the screen: left, middle and right. Most pictures were masks (scrambled faces). Among those masks, two faces appeared. The first face (T1) appeared in the middle. The second face (T2) could appear left or right at various delays. We measured infants' tendency to gaze in direction to T2. In Experiment 1, each picture was presented for 300 ms. As predicted, 5-month-olds (N=24) exhibited an AB around 900 ms; i.e., they missed T2 more often when it was presented 900 ms after T1 than when it was presented later (i.e., 2100 ms). Furthermore, 5-month-olds exhibited a phenomenon known in adults as lag-1 sparing: they detected T2 when it was presented immediately (300 ms) after T1. In contrast, both 8- and 12-month-olds did not show an AB, detecting T2 at 300, 900 and 2100 ms after T1 (Figure 2A). In Experiment 2, pictures were presented faster, in order to probe for an earlier AB in 8- and 12-month-olds. Each picture was presented for 200 ms in Experiment 2a and 100 ms in Experiment 2b. Eight- and 12-month-olds were analysed as one group. In Experiment 2a, infants (N=13, incomplete) detected T2 at 200, 600 and 1400 ms. In Experiment 2b, infants (N=20) exhibited an AB, detecting T2 at 700 ms but not at 100 or 300 ms (Figure 2B). These results suggest that the core structure of attention is already functional at 5 months of age (Experiment 1), but that the neural dynamics that are responsible for the AB are at least three times slower than in adults, lasting between 900 and 2100 ms. In 8- and 12-month-olds, an AB was observed lasting between 300 and 700 ms (Experiment 2), much closer to the AB duration classically observed in adults. In sum, these results suggest a formidable acceleration of visual information processing, possibly linked to myelination of the brain, effectively reducing the duration of the AB between 5 and 8 months of age.

P4-F-88: ERP correlates of infants' orienting of visual-spatial attention induced by numbers

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It is well known that human adults represent numbers as embedded into represented space, where numerical magnitudes are spatially organized along a horizontal continuum, which, in Western readers, is oriented from left (small number) to right (large number). An evidence of this phenomenon comes from the so-called Spatial-Numerical Association of Response Codes (SNARC) effect (Dehaene et al., 1993), by which smaller numbers are responded faster with



the left hand and large numbers with the right hand. Even more compelling, the perception of centrally presented numbers speeds up the detection of left/right lateralized targets depending upon the number's magnitude (Fischer et al., 2003). These findings suggest that, in adults, the automatically triggered covert shift of selective attention over the internal representation of numbers influences the allocation of selective attention in the external space. In spite of the wealth of evidence supporting the role of reading and writing practices in shaping the directionality of the spatial representation of number (e.g., Göbel et al., 2011) developmental research is providing accumulating evidence that number-space mappings are present in preverbal infants (e.g., de Hevia et al., 2010). Specifically, it has been shown that in infants, like in adults, the processing of numerical information brings about the activation of spatial attention (Bulf et al., 2016). Here, we investigated the neural correlates of the number-induced attentional cueing effect in 9-month-old infants using a Posner-like task. We measured ERP responses to the onset of peripheral targets flashing right after the offset of a centered small or large (i.e., 2 or 9) numerical cue. Infants were presented with both congruent trials -i.e., left-sided target cued by small number and right-sided target cued by large number- and incongruent trials -i.e., left-sided target cued by large number and right-sided target cued by small number. We reasoned that, if the numerical cue trigger covert shifts of spatial attention towards the left or right side of the visual space according to its magnitude, infants will experience sensory facilitation in processing visual information at the cued location, resulting in a larger P100 to the target in congruent compared to incongruent trials. The sample included 19 infants (9 females, mean age = 285 days). A 2 x 2 ANOVA was performed on the mean amplitude of the P100 with Trial Congruency (congruent vs. incongruent) and Electrode Cluster (occipital 1 vs. occipital 2) as within-subject factors. The main effect of Congruency proved significant, $F(1,18) = 4.70$, $p = .044$, as the P100 was larger on trials where the target appeared at a spatial location that was congruent with the magnitude of the numerical cue ($M = -.38 \mu V$) compared to incongruent ($M = -2.19 \mu V$). No other effect was significant ($ps > .095$). These results support and extend earlier evidence from eye-tracking studies (Bulf et al., 2016), showing that the previously reported cueing effect induced by numbers on infants' orienting of eye gaze brings about sensory facilitation in processing visual information at the cued location.

P4-F-89: Biobehavioral indices of sustained attention in infants with Down Syndrome, Fragile X Syndrome, and Typically Developing Infants

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Sustained attention provides a critical developmental foundation for cognitive development beyond infancy (Marciszko et al., 2019). Characterizing attentional impairments in developmentally delayed populations can inform our understanding of atypical developmental cascades and targeted intervention. Down syndrome (DS) and fragile X syndrome (FXS) are two neurogenetic conditions associated intellectual disability and atypical sustained attention (Fidler et al., 2019; Roberts et al., 2012). Little is known regarding aberrant patterns of sustained attention in DS and FXS during infancy relative to typical development, particularly across multiple behavioral and physiological indices. As such, the present study aims to identify etiologically specific patterns of sustained object, social attention, and heart-rate defined sustained attention (HDSA) in infants with DS or FXS, compared to typically



developing (TD) infants. Participants included 15 infants with DS (mean chronological age (CA)=12.15 months), 18 infants with FXS (M CA=13.00 months), and 29 TD infants (M CA) =12.40 months). Sustained attention was measured in three ways: 1) a three-minute keys task coded for proportion of time spent in social attention (i.e., towards examiner or parent); 2) the keys task coded for the proportion of time spent in object attention (i.e., towards a set of toy keys); and 3) through concurrent heart-rate variability measured during the keys task. Groups were compared across all three indices of sustained attention and associations between biobehavioral indices of sustained attention were tested across groups. The Mullen Scales of Early Learning provided a measure of fine and gross motor for post hoc analyses. Results indicated that groups significantly differed on proportion of social attention ($p=.005$), proportion of object attention ($p=.017$), and duration of orienting ($p=.027$), but not HDSA ($p=.205$). Infants with FXS showed a higher proportion of object sustained attention but a much lower proportion of sustained social attention than both the DS and TD groups, whereas the DS group showed much more within-group variability than FXS and TD groups. A priori bivariate correlations showed significant associations between heart-rate defined sustained attention and sustained object attention in the FXS ($r=.51$; $p=.033$) and TD ($r=.41$; $p=.028$) but not the DS group. HDSA was not significantly associated with proportion of sustained social attention in any group. It was hypothesized that significant motor delays characteristic to DS may influence attentional associations or lack thereof. Post hoc correlations were then tested to determine possible links between motor skills and sustained attention across groups. Differential patterns of association between fine and gross motor and sustained attention were identified across the DS and FXS groups (see Table 1). Findings demonstrate etiologically defined patterns in sustained social and object attention across DS, FXS, and TD infants. Further, results suggest important patterns of specificity in physiologically defined sustained attention between these groups and also highlight impaired motor development as a contributor to the etiological specificity of these atypical developmental patterns. While results are preliminary and further investigation with larger samples is necessary, collective findings offer potential for early targeted motor-based interventions for infants with DS and FXS.

P4-F-90: The role of sustained attention in infants' real-time word learning

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Infants utilize many mechanisms to help them acquire new vocabulary. Joint attention, the shared attention between two people and an entity of interest (Tomasello & Todd, 1983) has been found to play a large role in infants' language development. Researchers have also found that visual attention to an object for longer durations, or sustained attention, predicts later language learning (Kannass & Oakes, 2008). Recent work examined the separate roles of joint and sustained attention in infants on later vocabulary development (Yu, Suanda, & Smith, 2019). This study measured 9-month-old infants' joint and sustained attention to labeled objects in a free play session with a caregiver. Infants' vocabulary was later assessed at 12 and 15 months using the MCDI. The researchers concluded that sustained attention to objects in the free play session predicted later vocabulary outcomes more than did joint attention. The current study aims to investigate the relation between 12- to 15-month-old infants' real-time word learning and sustained attention. The study involves using both a live training task and an eye-tracking task. During the live task, an experimenter shows the infant six novel items.



Three of the items are labeled three times with a novel label (e.g., Look at this flurp!). The other three items are labeled with a neutral label (e.g., Look at this one!). Infants are given 20 seconds to hold and play with the object before a new object is introduced. Each object is presented twice, and presentation order and object labels are randomized across subjects. The live task is recorded from three different camera angles. Videos are aligned and coded for infants' direction of gaze. Sustained attention is defined as looking to the presented object for 3 or more uninterrupted seconds (Ruff & Lawson, 1990). After the live interaction, infants participate in an eye-tracking task in which the infant is shown counterbalanced, randomized pairs of unlabeled and labeled objects from the live task and asked to find the labeled object (e.g., Do you see the flurp?). Infants' proportion of looking to the objects is analyzed. We hypothesized a positive correlation between the duration and frequency of infants' sustained attention states to labeled objects during the live task and looking to the target object in the eye-tracking task, evidence for a relation between sustained attention and real-time word learning. Preliminary data (N = 4) show that three out of the four infants show a preference for the target object during the eye-tracking test. On average, infants are demonstrating 90 seconds of sustained attention across 15 sustained attention states in the live task. Upon further data collection we analyze for relations between sustained attention and looking times. Understanding how infants direct their attention in word learning tasks can inform us of the unique contributions from sustained attention to word learning, which ultimately may lead to more engaging and enriching environments to foster infants' vocabulary development.

P4-F-91: Noise in low-income communities disrupts mother-infant talk

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Children living in low-income communities are exposed to more noise, such as from television and transportation, than their middle-class peers (Evans, 2004; Haines, Stansfeld, Head, & Job, 2002). Moreover, high levels of noise relate inversely to child language development, child executive functioning, and maternal responsiveness (Evans, 2006; Stansfeld et al., 2005). However, substantive heterogeneity characterizes the noise and language environments of children from low-income homes, and thus inquiry into such variations and their implications for children's early development remain critical to science. We asked whether variation in environmental noise exposure relates to maternal language in families living in poverty. Specifically, we asked: (1) How frequently are infants exposed to sounds in their homes overall, and what types of sounds are most frequent (e.g., television/screen, communication device, music/radio, appliances, transportation/construction)? (2) Does sound exposure relate to mothers' speech in real-time? We video-recorded 70 mothers and their 10-to-19-month-old infants (half girls) engaging in their daily routines for one hour at home. Mothers were recruited from community agencies serving predominantly low-income, Spanish speaking (largely Mexican) Latinx families living in NYC. We coded each 10-second interval on the video for the presence of five common types of sound: screens (such as television), communication devices (such as phones), music/radio, appliances (such as vacuum cleaners), and transportation/construction sounds. Preliminary analyses reveal that infants are exposed to an extensive array of sounds, averaging 60% of intervals during visits (M=60.38% of intervals, SD=48.91%). The primary sources of sound were television/screens (M=31.18% of intervals, SD=46.33%), transportation/construction (M =16.50% of intervals, SD=37.12%), and



music/radio (M=13.71% of intervals, SD=34.40%). Communication devices (M=1.38% of intervals, SD=11.68%) and appliances (M=7.67% of intervals, SD=26.61%) were less frequent. Mothers varied greatly in word types and tokens; ranging from 107 to 567 types (M=306.8, SD=138.44), and 391 to 3,081 tokens (M=1629.33, SD=1046.39) across the visit. Mothers' utterances were generally short in length (M=1.99, SD=0.37), and mean length utterances (MLUs) ranged from 1.46 words to 2.26 words per utterance. During noisy bouts, mothers were less likely to vocalize to their infants than they were during bouts absent of noise, yule's $Q=-.051$, signed-rank test, $p<.001$. Results indicate striking variations in the noise and language environments of infants from Hispanic families, with the two areas of auditory inputs being inversely related. Thus, high exposure to noise relates to reduced maternal language quality in real-time. Because not all noise types are equivalent, we are currently exploring which features of noise most compromise the language experiences of Hispanic infants. Findings have practical implications for ameliorating language disparities in early life by addressing the challenges that arise from high exposure to everyday sounds.

P4-F-92: The impact of noisy environments on visual attention during infancy

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Environmental noise is considered to have a detrimental effect on cognitive skills such as speech perception, memory capacity, and problem-solving in primary school-aged children. Furthermore, chronic exposure to acoustic noise seems to affect children's visual and sustained attention capacities (Shield & Dockrell, 2003). If such effects are observed in childhood, how does noise exposure impact the ability to select and learn patterns of information during infancy, a critical period of brain development that will shape all learning to come? In an eye-tracking study adapted from Tummeltshammer & Kirkham (2013), 10-to-12-month-old infants viewed visual sequences of colourful shape pairs, where the first shape of each pair predicts the location of the second one with a different likelihood (1, 0.75, 0.5). Infants can thus learn the most probable upcoming shape location due to the varying co-occurrence of each shape pair. Across three between-subject conditions, the presentation of the visual stimuli is combined with the presence or absence of background auditory noise. The background noise - selected to simulate naturalistic environments infants are often exposed to during learning - is represented either by an acute distractor (i.e., buzzing cell phone) or by chronic noise (i.e., muffled T.V., cooking, traffic). Furthermore, sound levels in the infants' homes were measured to investigate whether infants' home experience with environmental noise influences their ability to select and attend to statistical events across multiple contexts. The preliminary results from 35 infants are in line with the literature. Infants exposed to noisy environments at home show slower saccadic latencies towards the less predictable and most complex events in the task than infants exposed to quiet environments (fig. 1), suggesting a negative impact of auditory noise on visual attention skills. Furthermore, infants' saccadic latencies are faster towards the less predictable events in the acute condition. However, this preference disappears in the presence of chronic background noise. This trend reflects the results of the previous study by Tummeltshammer & Kirkham (2013), in which the presence of visual distractors decreased the speed of infants' saccadic latencies towards complex events, favouring the exploration of the most predictable ones. These initial findings suggest that multiple factors, including the amount of information received, influence 1) how infants



explore their environment, and 2) their ability to process events of different degrees of complexity. Further data will enable us to reach a better understanding of how environmental noise impacts the early development of visual attention and learning.

P4-F-93: Television experience predicts infants' sensitivity to different face-looking cues when viewing videos

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How do developmental changes in attention and experiential differences in media experience predict age-related changes in looking at faces during video viewing? Previous research found age differences in the use of bottom-up cues for orienting to faces when viewing photographs (Amso et al., 2014). Whereas observers older than 12 months were more likely to fixate visually-salient faces compared to non-salient faces, younger infants' face looking was not influenced by visual salience. However, it is untested whether face salience influences face looking in dynamic videos, which contain motion cues that could facilitate bottom-up orienting in young infants. Thus, the first aim of the study was to investigate age differences in saliency effects on face looking to understand how general attention development influences video viewing. A second influence on face looking might be infants' knowledge about conventions used in creating television media. In particular, cinematographers purposefully frame the faces of important characters in the center of the scene. Accordingly, we asked whether there are age differences in orienting to faces based on their centering and whether use of centering as a cue is related to experience watching television. We recorded eye gaze in 93 participants (28 infants: 0.5-1.5 years; 19 toddlers: 1.5-3 years; 14 young children: 3-6 years; 12 older children: 6-11 years; 20 adults: 18-26 years) using an Eyelink 1000 Plus eye tracker while they watched five, 2-minute videos. In each video, face areas of interest (AOIs) were annotated on every video frame; up to 5 different faces were in view at any moment. Over time and across face exemplars, AOIs varied in how salient they were (calculated using the GBVS saliency toolbox) and how centered they were (calculated as the distance from the edge of the AOI to the center pixel) (Figure 1). We assessed whether saliency and centering models predicted when each participant looked at faces. Area-under-the-curve (AUC) values reflected model performance: AUCs of .5 indicated chance performance (face saliency/centering did not predict face looking) whereas AUCs closer to 1 indicated that saliency/centering positively predicted face looking. Figure 2A shows that both models predicted face looking better than chance at every age, revealing that both saliency and centering influence face-looking behavior when watching dynamic videos in observers as young as 6 months. Whereas the influence of saliency on face looking was stable from infancy to adulthood, centering became more influential with age (a linear mixed effects model indicated a significant age \times model interaction). Next, we tested whether caregiver reports of daily television viewing time predicted the influence of saliency and centering on face looking. Saliency AUCs were unrelated to television viewing in any age group (Figure 2B). In contrast, television viewing predicted centering AUCs in infants, $r(25) = .39$, $p = .044$, but no significant correlations were found for older participants. Thus, whereas bottom-up attention based on face saliency changes little (if at all) after 6 months of age, developmental changes in face looking are dependent on acquiring media-specific knowledge about how faces are framed in a scene.



P4-F-94: Feature-based attention in 7- to 8- month-old infants

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When searching for a target object, we can detect it by selectively attending to a specific target feature. Although the development of such feature-based attention has been studied in young children, little is known in infants. A recent study using a priming task showed that older infants aged around 10 months can prioritize an object than feature, demonstrating object-based attention (Werchan et al., 2019). Compared to relatively ample evidence for this kind of object-based attention in infants (Bulf & Valenza, 2013), feature-based attention has been unclear yet. The difficulty in examining feature-based attention in infants is mainly due to unavailability of verbal instructions to the population to inform them to direct their attention to specific feature while ignoring other competing features. However, it is reasonable to assume that even younger infants aged less than 10 months would demonstrate the feature-based attention functionally equivalent to adults based on the fact that the development of processing for low-level visual features precedes the development of processing for the whole objects (Yang et al., 2016), and they can attend to a whole object consisted of various features. In the present study, we examined whether feature-based attention has been developed in 7- to 8- month-old infants by introducing a new anticipation task. The task consisted of two phases. First, in the learning phase, infants observed a short movie clip that a yellow partly waned circle like "Pac-man" flanked by two rectangles. The Pac-man crawled toward either to the right or to the left to eat one of the rectangles eventually. In the color condition the Pac-man crawled consistently toward the predetermined colored rectangle (red or blue, depending on the infants) regardless of its orientations. The side of the color was determined randomly on every trial. In the orientation condition, the Pac-man crawled consistently toward the predetermined orientated rectangle (horizontal or vertical) regardless of its color. After eight trials of this learning phase, the anticipation looking phase followed. In this phase, infants viewed two different rectangles defined based on two feature conditions side by side. The Pac-man blinked repeatedly until infants fixated it and disappeared after infants' fixation on it. We recorded infants' eye movements, and examined whether infants showed an anticipation looking based on the learned color or orientation. As we expected, infants demonstrated the anticipatory looking in both conditions, indicating that infants in color condition looked anticipatorily at objects of the learned color while infants in orientation condition looked at objects based on the learned orientation. These results suggest that infants aged around 7 months can direct their attention to specific features, and anticipatorily behave using the attended feature while ignoring unattended features.

G-Cognitive Development

P4-G-95: Leveraging technological advances to bridge methodological limitation in low resource setting

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Visual exploration is a key tool for infants early learning. In the real world, this exploration often takes place in cluttered environments along with infants' social partner. From research in Western cultures, we know that such interactions are critical to infants' early learning such as word learning. For instance, when parents name objects in their surroundings, word learning is facilitated by dyadic joint attention. Additionally, interventions designed to increase joint attention by training parents to 'follow' their infants into their state of attention improve pre-term infant's performance in social, cognitive and linguistic domains (Landry et al., 2006). This is particularly important to understand in a global context where children face severe adversities such as poverty and poor nutrition that impact cognitive development. Recently, an Early Childhood Development review report (Rao, N., et al, 2014) stressed the need for parent-focused intervention for children's cognitive development in Low- and middle- income countries (LMIC). However, a lack of infrastructure in LMICs have limited research to either qualitative or observational methods. To bridge this methodological gap, the present study used an innovative technology -- low cost, mobile, head-mounted eye-trackers -- to capture parent-infant interaction in rural India and the UK. The aim of this study is to provide a reliable tool to assess parent-infant interaction in high and low resource settings. Additionally, we were interested in asking whether head-mounted eye-trackers could be used with automated processing in a large sample. We recorded data from ten-minute dyadic play sessions. Participants include 60 caregiver-infant dyads (six-month-olds) from the UK, as well as, Low and High SES dyads in India. Distribution of attention was measured via head-mounted eye-trackers. Measures included mean fixation duration, fixation switch rate, and dispersion on normalised x and y position. In addition, we used a deep neural network to recognize the type and number of objects that each dyad had in their view at each moment through time. These advanced technologies help us quantify dyadic interactions by measuring the visual experience of the caregiver and their infants from their own bodily perspective in real time. A preliminary analysis shows that parents in the UK tend to use a pedagogical-based interaction with their infants. This involves teaching the infant how to use the object. In contrast, in rural-India, we see that the parents observe their child and keep them entertained by making object sounds. This fits with previous anthropological research that shows that in non-western societies, children are expected to learn from their surrounding whereas in western society, it is expected that the parents shape the infant's learning by teaching them. Understanding parent-infant interact styles across cultures can be useful to understand the strategies of joint attention across cultures. This may have important implications for intervention studies seeking to harness parents as change agents to enhance cognitive outcomes.

P4-G-96: Hippocampal evidence of statistical learning from fMRI with awake infants

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The ability to extract regularities from the environment is essential for language acquisition and perceptual development (Romberg & Saffran, 2010; Werker et al., 2012; Erickson & Thiessen, 2015). Such statistical learning may be a building block of the mind, available in



newborns (Bulf et al., 2011) and throughout infancy (Saffran et al., 1996; Kirkham et al., 2002). Little is known about how the infant brain achieves this learning proficiency. The adult literature on statistical learning suggests that the hippocampal memory system plays an important role. fMRI studies consistently report activation and representational changes in the hippocampus during statistical learning (Turk-Browne et al., 2009; Schapiro et al., 2012), lesions to the hippocampus impair statistical learning (Schapiro et al., 2014; Covington et al., 2018), and computer simulations of the hippocampus exhibit robust statistical learning (Schapiro et al., 2017). However, it is widely assumed that the hippocampus is not functional during the first two years of life (Schacter & Moscovitch, 1984; Nelson, 1995; Gómez & Edgin, 2016). Indeed, the hippocampus has a protracted anatomical development extending into adolescence (Lavenex & Lavenex, 2013; Schlichting et al., 2017). How can statistical learning behavior be present in infants without the brain system that is required in adults? One possibility is that the infant hippocampus may be functional after all. Claims that it is not functional are often based on a lack of early episodic memory, but this is a different behavior than statistical learning. Indeed, the hippocampal pathway thought to support statistical learning (Schapiro et al., 2017) develops earlier in primates than the pathway supporting episodic memory (Lavenex & Lavenex, 2013). An alternative possibility is that infant statistical learning occurs entirely outside of the hippocampus. For example, inferior frontal and lateral temporal cortices support statistical learning in adults (McNealy et al., 2006; Karuza et al., 2013). These hypotheses can only be tested with fMRI, because of its unique ability to resolve deep-brain structures like the hippocampus. We collected fMRI data from 24 awake infants 3-24 months old during visual statistical learning. They viewed sequences of colorful stimuli that were organized into pairs (Structured) or appeared in a shuffled order (Random) across alternating blocks within participant. We analyzed neural differences between conditions separately for the first and second halves of exposure, expecting learning effects in the second half. Providing perhaps the first evidence of hippocampal function in human infants, fMRI activity was stronger for Structured than Random blocks in the second half, in both left and right hippocampus. This difference was uncorrelated with age and mirrors what has been seen in adults (Turk-Browne et al., 2009). Although our focus was on the hippocampus, we also found neural evidence for infant statistical learning outside of the hippocampus, for example with second-half differences between Structured and Random conditions in frontal cortex and the striatum. These findings not only begin to reveal the neural foundations of statistical learning, but also revise our understanding of the development of memory systems.

P4-G-97: Infant multisensory attention to social events predicts IQ in toddlers

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Multisensory attention skills, including attention duration, shift speed, and accuracy of intersensory matching, are considered foundations for language, social, and cognitive development (Bahrack & Lickliter, 2012). Prior studies have demonstrated that multisensory attention skills predict language and social functioning (e.g., Bahrack et al., 2018), however, few studies have focused on predicting cognitive outcomes. We propose that infant multisensory attention skills should predict cognitive outcomes in childhood. Enhanced multisensory attention skills reflect better attention control (i.e. selectively attending to relevant information and filtering out irrelevant information) and, in turn, should foster greater



engagement and better learning from social-communicative interactions (events that provide high levels of rapidly changing multisensory information). The Multisensory Attention Assessment Protocol (MAAP; Bahrick et al., 2018) assesses individual differences in multisensory attention skills and thus, can be used to index relations with cognitive outcomes. We predicted that longer attention maintenance, faster attentional shifting, and greater intersensory processing accuracy in infancy as assessed by the MAAP would predict greater Full-Scale IQ (FSIQ) on the WPPSI-IV (Wechsler, 2012) in toddlers. Children (N = 66) participating in an ongoing longitudinal study received the MAAP at 12- and 36-months. For the MAAP, each trial begins with a silent 3s central visual event (animated shapes) immediately followed by two lateral events (12s) of women speaking (social) or objects bouncing on a surface (nonsocial; see Figure 1). The visual movements of one lateral event are synchronous with its natural soundtrack while the other is asynchronous. For social and nonsocial events, we calculated measures of attention duration (proportion of available time looking to lateral events), shift speed (reaction time to look from the central to the lateral events), and intersensory accuracy (proportion of total looking time to the synchronous events, or intersensory matching). At 36-months, children received the WPPSI-IV and the FSIQ was calculated. Correlations revealed that 12-month intersensory accuracy for social (but not nonsocial) events predicted 36-month FSIQ, $p=.02$ (Table 1). However, 12-month attention duration and shift speed did not predict FSIQ. Also, at 36-months, intersensory accuracy, $p=.04$, and attention duration, $p=.01$ (but not shift speed), for social (but not nonsocial) events predicted FSIQ. Importantly, 12-month intersensory accuracy was a significant predictor of FSIQ, $p=.01$, (11% of variance) even after controlling for 36-month intersensory accuracy. The present findings provide novel evidence linking multisensory social attention with cognitive outcomes. Not only did we find concurrent relations between 36-month multisensory attention skills (duration, accuracy) and FSIQ, but multisensory attention skills (accuracy) in infancy (at 12-months) also predicted FSIQ at 36-months. These findings suggest that early assessments of multisensory attention skills may aid in identifying children at-risk for cognitive delays who could benefit from early interventions. Future research will explore the causal pathways between infant multisensory attention skills and child IQ (both verbal and nonverbal).

P4-G-98: Exploring the effect of familiarization on infants' visual search preferences

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Infants acquire an enormous amount of information from visually scanning the world, and efficient visual exploration involves both attention to relevant information and suppression of irrelevant information. Such attentional control is difficult for young infants who are more captured by physically salient stimuli than are older infants (Kwon et al., 2016; Frank et al., 2014). The goal of the present work was to understand factors that contribute to infants' developing attentional control when faced with multiple competing items. Specifically, we asked whether exposure to distractors would facilitate suppression, as is the case for adults given explicit distractor cues which allows them to utilize distractor templates (Won & Geng, 2018; Leber et al., 2016, Arita et al., 2012). We investigated how providing a distractor template and priming the target influenced six-month-old infants' (N=69) attention in visual search. We presented infants with a series of trials with the following sequence: first, a single item was



presented in isolation for 3000 ms, then an array of six items was presented for 5000 ms. In this second visual search array, there was a singleton "target" and five identical distractors. Infants were randomly assigned to one of two conditions. In each condition, half of the trials were control trials, in which the item presented in the initial familiarization trial did not appear in the visual search array (Fig 1, middle). These trials provide a baseline estimate of infants' attention to the singleton when the singleton and distractors are equally familiar. The remaining trials were the experimental trials: in the target-familiarized condition (Fig 1, top), the familiarized item was the singleton in the visual search array, and in the distractor-familiarized condition (Fig 1, bottom), the familiar item was the five identical distractors in the visual search array. We measured the proportion of time infants looked at the singleton (relative to the distractors), an indicator of attention-holding, and the proportion of trials in which infants looked first at the singleton, an indicator of attention-getting. Six-month-old infants familiarized with the distractor more effectively suppressed the distractors to attend to the singleton. Infants looked more at the singleton (attention-holding) when the distractor was familiar than when the target was familiar (i.e., comparison of the experimental trials in the two conditions), $t(67)=2.97$, $p=.004$, $d=.72$. In addition, infants in the target-familiarized condition did not differ in the proportion of time they looked at the singleton in experimental and control trials, $t(36)=0.29$, $p=.77$, whereas infants in distractor-familiarized trials looked longer at the singleton in the experimental trials, $t(31)=3.16$, $p=.003$, $d=.56$ (Figure 2). Infants directed more first looks to the target (attention-getting) when the distractor was familiar than when the target was familiar (i.e., comparison of the experimental trials of the two conditions), $t(40)=3.70$, $p=.0007$, $d=1.14$. In summary, familiarizing infants with the distractor, but not with the target, facilitated distractor suppression. As infants explore novel objects in their visual world, this mechanism could lead to rapid accumulation of knowledge.

P4-G-99: Understanding how early exposure to household noise affects cognitive and emotion development: Understanding the mediating role of autonomic reactivity

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INTRODUCTION: Previous research has suggested that early life stress confers increased risk of poor mental health outcomes (Businelle et al., 2013) and impaired cognitive performance (Blair, 2010) in later life. However, most research has concentrated on questionnaire-based assessments of life-long stressors (e.g. multiple parental figures in the home; Felitti et al., 1998). Virtually no previous research has directly investigated the role that environmental factors, such as noisy and chaotic home environments, play in causing stress responses, and investigated the impact of household noise on infants' cognitive and emotional development. **METHOD:** We examined for the first time infants' physiological responsiveness to noise in the home environment, using specially designed miniaturised wearable microphones and physiological arousal monitors (Electro-Cardiography, Heart Rate Variability, Actigraphy). The same infants also attended a lab testing battery where their physiological responsiveness to attention- and emotion-eliciting stimuli was assessed. The total sample was 82 12-month-old infants from mixed demographic backgrounds, recruited from the South-East region of the



United Kingdom. RESULTS: The average levels of microphone noise on the infants' microphones was found to be independent of other socio-economic variables, including maternal education and household income (all $p>.2$). Average sleeping microphone noise did, however, correlate with waking microphone noise ($p=.005$) and with the parent-rated Confusion Hubbub and Order Scale (CHAOS) ($p=.02$). Children exposed to high average noise levels at home displayed more unstable physiological arousal patterns overall, indexed by measuring the partial autocorrelation function of all arousal data obtained while infants were at home and the infant was awake ($p=.004$). Children exposed to noisier home environments also showed reduced physiological responsiveness to naturally occurring environmental noise in the home, indexed by measuring the cross-correlation between external (i.e. non-infant-generated) environmental noise and physiological arousal ($p<.001$). In the lab testing battery, we found that infants exposed to high noise levels at home also showed reduced physiological responsiveness to novel attention-eliciting stimuli ($p=.004$), along with reduced visual sustained attention ($p=.02$). In response to emotional stressors, they showed a trend towards increased reactivity ($p=.15$). Unexpectedly, they also showed faster recovery following the emotional stressor ($p=.049$). This finding of faster recovery times in the high noise group was also observed in response to naturally occurring environmental stressors in the home data. DISCUSSION: Our results suggest that environmental noise in home environments does evoke physiological stress responses in infants. They also suggest that children exposed to higher average levels of household noise become desensitized to environmental noise. In the lab, children exposed to higher levels of environmental noise at home also showed reduced responsiveness to novel attention-eliciting stimuli, along with reduced sustained attention. Children exposed to noisier home environments also showed more unstable patterns of arousal, including both greater reactivity and faster recovery to emotional stressors. These results offer new insights into the ways in which environmental noise can confer increased risk of adverse mental health and impaired cognitive outcomes.

P4-G-100: Strengths and difficulties in problem solving amongst two year olds with a familial history of autism and/or ADHD

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Background: Executive Functions (EFs) underpin our ability to solve problems. Autism Spectrum Disorder (ASD) and Attention Deficit Hyperactivity Disorder (ADHD) are both associated with difficulties with EFs, but with somewhat different profiles: ASD is associated with difficulties with cognitive flexibility and inhibition of pre-potent responses. ADHD is linked to impairment in inhibitory control, working memory and sustained attention. Similar, but less-pronounced, difficulties are observed amongst individuals with a familial history of autism or ADHD. To understand why EF difficulties occur in these populations, and how we might ameliorate them, it is useful to understand when and in what ways EF difficulties first emerge. Research into early EF difficulties has been hampered by a scarcity of tasks suitable for children under 3 years. Those available tend to have high social and language demands which may mask EF competencies, particularly amongst those with social-communication difficulties



(as are common in ASD). The Problem-Solving Box task is designed as an ecologically-valid measure of early EFs with low language and social demands. The task requires the retrieval of 3 visible rewards from a transparent box with built-in physical constraints. To succeed on the task by retrieving all 3 rewards in 5 minutes, participants must generate multiple strategies (i.e. show cognitive flexibility), overcome perseveration on a visually-cued or previously-successful strategy (i.e. exercise inhibitory control), and persist in the face of set-backs (i.e. sustain attention and effort). Aim: To explore whether familial history of autism (FH-ASD) or ADHD (FH-ADHD) is associated with dissociable strengths and difficulties in EF in toddlerhood. Methods: As part of a large longitudinal study, 180 two-year-olds were invited to an assessment session where they completed the Problem-Solving Box task. Preliminary data are reported from 127 two-year-olds (24 no FH-ASD/ADHD, 56 FH-ASD, 32 FH-ADHD, 15 FH-ASD&ADHD). Behaviour was coded offline by 3 students trained to research reliability, and variables computed for: problem-solving performance (latency to retrieve the rewards), generativity (number of unique strategies attempted), perseveration (proportion of goal-directed manipulation spent on the dominant strategy for that participant, excluding participants who spent less than 10 seconds on goal-directed manipulation) and persistence (proportion of time spent on goal-directed manipulation). To test for the effect of family history on problem-solving performance, presence of FH-ASD, FH-ADHD and an interaction term for FH-ASD and FH-ADHD were inputted as fixed factors in a univariate ANOVA. Results: FH-ADHD is associated with better problem-solving performance $F(1,112)=9.47, p=.003$ and increased generativity $F(1,105)=8.06, p=.005$. FH-ADHD is not significantly associated with perseveration $F(1,82)=0.38, p=.540$ or persistence $F(1,105)=1.54, p=.22$. Neither FH-ASD, nor the interaction between FH-ASD and FH-ADHD are significantly associated with problem-solving performance. Conclusions: Toddlers with a familial history of ASD and/or ADHD do not show difficulties with EF during a problem-solving task. Instead, familial history of ADHD is associated with more generative behaviour, and better overall problem-solving. We will discuss these findings in the context of previous studies indicating more-exploratory behaviour amongst infants with a familial history of ADHD.

P4-G-101: The relationship between socioeconomic status and false-belief understanding: New evidence from a low-demand elicited-response task

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Considerable evidence suggests that children begin to pass traditional elicited-response false-belief tasks at around age 4 (e.g., Wellman et al., 2001). However, performance on these tasks is positively correlated with socioeconomic status (SES; Devine & Hughes, 2018), with some studies reporting that low-SES children pass elicited-response tasks up to a year later than their more advantaged counterparts (Hughes et al., 2000). These findings could indicate that the development of the ability to represent beliefs is delayed in low-SES children. Alternatively, low-SES children's failure on elicited-response false-belief tasks might stem from factors other than an inability to represent beliefs. Several researchers have argued that elicited-response tasks impose significant processing demands on children and thus might underestimate their false-belief understanding (Helming et al., 2016; Scott & Baillargeon, 2017; Wang & Leslie, 2016; Westra & Carruthers, 2017). Consistent with this view, Setoh, Scott, and Baillargeon (2016) recently showed that when processing demands were sufficiently reduced, children

from higher-SES backgrounds can pass elicited-response tasks as early as 2.5 years of age (see also Grosso et al., 2019). These findings raise the possibility that if tested with a low-demand elicited-response task, low-SES children might also demonstrate false-belief understanding earlier - perhaps at the same age as higher-SES children. To test this possibility, we recruited a socioeconomically diverse sample of 47 2.5-year-olds ($M = 33$ months). SES was assessed via the highest reported level of parental education: 21 children had parents with a high-school education or less, 13 had a 2- or 4-year college degree, and 13 had an advanced degree (MA, PhD, etc.). Children completed the low-demand elicited-response task devised by Setoh et al. (2016), in which they heard a change-of-location false-belief story accompanied by a picture book. In the story, Emma placed an apple in one of two containers (box/bowl) and then left. In her absence, her brother Ethan found the apple and took it away. In the final test trial, children saw the two containers and were asked the standard test question, "Where will Emma look for her apple?" The task included two modifications intended to reduce processing demands: Ethan took the apple away to an undisclosed location (reducing inhibitory demands) and children received two practice trials that required them answer a "Where" question by pointing to one of two locations (reducing response-generation demands). Replicating Setoh et al.'s findings, children performed reliability above chance in the test trial, with 74% responding correctly, $P = .001$ (cumulative binomial probability). A binomial logistic regression revealed no relationship between parental education and children's performance, $p = .94$. Performance was equivalent for children in the lowest SES group (high-school education or less) and children in the highest SES group (advanced degree), with 76% of children in each group responding correctly. These results suggest that low-SES toddlers are capable of representing false beliefs, but they have difficulty coping with the processing demands imposed by traditional elicited-response tasks. When these demands are sufficiently reduced, they can succeed on elicited-response tasks and their performance does not differ from higher SES children.

P4-G-102: 2.5-year-olds pass an explicit unexpected-transfer false-belief task when processing demands are reduced

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Prior to about age 4, children typically fail at traditional false-belief tasks. While some researchers have taken this failure to indicate that young children lack false-belief understanding, others have suggested that young children's difficulties may be due to the tasks' high processing demands. Support for this second account comes in part from reports by Setoh et al. (2016) and Grosso et al. (2019) showing that 2.5-year-olds pass an explicit undisclosed-location false-belief task with reduced processing demands. Toddlers heard a story accompanied by a picture book: Emma hid an apple in one of two containers and then went outside to play; in her absence, her brother Ethan found the apple and took it away. Emma then returned, and children were shown pictures of the two containers and were asked where Emma would look for her apple. The task included two modifications designed to reduce processing demands: Inhibitory-control demands were reduced by having Ethan remove the apple from the scene, and response-generation demands were reduced by giving toddlers, as the story unfolded, two practice "where" questions that required them to point to one of two pictures. In both reports, performance was above chance, suggesting that children

represented Emma's false belief. Building on these results, we asked whether 2.5-year-olds would also pass a more typical unexpected-transfer false-belief task if processing demands could be sufficiently reduced. In this version of the task, Ethan moved the apple to the other container, instead of taking it away. To reduce processing demands, we instituted two changes. First, inhibitory-control demands were reduced by not showing the transfer of location: Children were told that Ethan moved the apple to the other container, but they were not shown this event. They simply saw pictures of the two containers side by side, and as the experimenter narrated the story, she pointed first to the container where Emma hid the apple and then to the container where Ethan moved the apple. Second, response-generation demands were again reduced by giving children two practice "where" questions. To learn more about the conditions under which such questions can be effective, we administered them at the start of the session, using objects unrelated to the story (e.g., muffin/sandwich). Toddlers were assigned to one of three conditions. In the no-practice false-belief condition, they simply heard the false-belief story. When asked where Emma would look for her apple, they pointed randomly to the apple's original or current container. In the practice false-belief condition, toddlers received the two practice questions before hearing the story, and they were significantly more likely to point to the apple's original container. Finally, the practice true-belief condition was similar except that Emma saw her brother move the apple, and toddlers were now significantly more likely to point to the apple's current container. Our results thus extend those of Setoh, Grosso and colleagues by showing that 2.5-year-olds can pass an explicit unexpected-transfer false-belief task when (a) inhibitory-control demands are reduced by not showing the object's transfer and (b) response-generation demands are reduced via practice trials.

P4-G-103: The integration of face and speech cues in 3 month old Caucasian infants

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The high degree of ecological co-occurrence of speech and face stimuli make the development of the mutual influences between these modalities during infancy an important topic of investigation. Of particular interest is the degree to which these modalities share mechanisms that drive perceptual narrowing in these domains, a process through which infants increase their sensitivity for frequently encountered stimuli such as same-race faces and native speech, at the cost of a decrease in sensitivity towards rarely encountered stimuli such as other-race faces non-native speech. Previous research has already demonstrated that perceptual narrowing in these domains occurs in a similar timeframe, suggesting that perceptual narrowing may indeed be driven by common mechanisms shared between these domains. Because perceptual narrowing is thought to emerge as a product of the natural frequency with which infants encounter specific types of stimuli, another crucial aspect of this process is its dependence on the degree of variation among the faces and speech surrounding infants. Therefore, infants from bilingual families present a valuable opportunity to study the dynamics of perceptual narrowing in face- and speech-perception by comparing them to infants from monolingual families, since a bilingual environment would result in infants



encountering a far greater variety of speech. Our study therefore examined both monolingual and bilingual infants, and tested the degree to which bilingualism/monolingualism influenced their attention for matches and mismatches between the familiarity of a speaker's ethnicity, and the language being spoken. We tested 53 3-month old Caucasian infants (data collection ongoing), of which 17 were raised in bilingual families, on their ability to integrate speech and face cues. We used a modified Infant Race Association Test (Xiao et al, 2017) using photos of female same- and other-race faces, and spoken sentences in a native or non-native language as stimuli. Each infant was exposed to 6 face trials sequentially paired with 6 speech trials (Fig.1). Each trial lasted for 10 seconds. Infants were randomly assigned to one of four conditions combining same-race or other-race faces with native or non-native speech: same-race faces and native speech (congruent), other-race faces and non-native speech (congruent), same-race faces and non-native speech (incongruent), other-race faces and native speech (incongruent). To examine differences in infants' looking patterns during the face trials, we used a Tobii Pro X3-120 eye-tacker. For our analysis we considered infants' total fixation time for the AOI encompassing the entire head in each face trial, with the exclusion of the very first trial, as it was not preceded by a speech trial. We then used a one-way 2x2x2 ANOVA with total fixation time for the head AOI as the dependent measure. The three fixed factors were the language group (monolingual/bilingual infants), face ethnicity (same-race/other-race), and speech type (native/non-native). Preliminary results indicate that monolingual infants looked at faces longer in the congruent conditions. By contrast, bilingual infants looked at faces significantly longer in the incongruent conditions. Our results therefore suggest that bilingualism seems to impact an infant's ability to perceive incongruences between familiar and unfamiliar classes of faces and languages.

P4-G-104: The impact of salient action effects on 6-, 7-, and 11-month-olds' goal-predictive gaze shifts for a human grasping action

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When infants observe actions that are in their own motor repertoire, they look at the action goal ahead of time and therefore predict the action goal (e.g., Falck-Ytter, Gredebäck, & von Hofsten, 2006; Kanakogi & Itakura, 2011). However, when they observe unfamiliar actions or actions by unfamiliar agents, infants tend to track the action reactively (e.g., Adam et al., 2016; Kanakogi & Itakura, 2011) and are only able to predict the goal of these actions when additional cues of agency are added (Adam, Reitenbach, & Elsner, 2017). A possible explanation might be that with increasing conceptual knowledge about certain actions, infants automatically associate agents with agency cues to predict the action goal of these agents (Bíró & Leslie, 2007; Southgate, 2013). Following this idea, on one hand, young infants with only little conceptual knowledge about grasping actions should need to draw on agency cues to predict the goal of a manual grasping action. On the other hand, older infants with more conceptual knowledge about grasping actions should be able to predict the goal of a highly familiar manual grasping action without the need of additional cues. To investigate this hypothesis, we tested 6- (n = 52), 7- (n = 52), and 11-month-old (n = 52) infants with an eye tracker in one of two conditions: We showed them a manual grasping action where the hand either approached a toy and lifted it up with a sound (salient action effect; effect-condition), or where the hand approached the toy and froze in place upon arrival (no-effect condition). The results revealed



that first, the 6-month-olds showed reactive gaze behavior in both conditions. Second, the 7-month-olds showed reactive gaze behavior in the no-effect condition, but predictive gaze behavior in the effect-condition. Last, the 11-month-olds showed predictive gaze behavior in both conditions. In an additional control group, 7-month-olds (n = 26) were presented with alternate versions of the action-effect condition: This time, a mechanical claw performed the action instead of a human hand. In this condition, the infants showed reactive gaze, suggesting that mere cognitive maturation or attentional mechanisms can not explain our data from the human hand conditions. Thus, our study provides evidence that the impact of agency cues, such as salient action effects, changes across development and with increasing age. More specifically, these results are in line with the idea that infants over time automatically associate observed agents and actions with agency cues, which eventually helps them to predict action goals even in the absence of agency cues. Furthermore, our results also suggest that at this age and for grasping actions, the process of the association between agency cues and agents is selective for human hands and does not transfer to a non-human mechanical claw. In the light of these results, future studies should investigate the influence of action experience and the effect of agency cues on goal prediction during the observation of human and non-human agents in more detail.

P4-G-105: Examining the social and contextual cues of mother-infant interactions in the home

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Object play presents opportune times for infants to learn words for the objects and actions capturing their attention. Lab-based studies of structured play reveal that mothers provide contingent language to describe and ask about objects under joint engagement. However, structured tasks are void of distractions, potentially increasing infants' attention and compelling mothers' talk. Here we examine infants' social engagements during home routines--the context where learning actually occurs, examining the role that spaces in which interactions occur influence language. We describe the frequencies and kinds of objects infants explore and the amount and semantics of language that mothers direct to infants. Participants were 40, 13-month-olds and their English-speaking mothers. Dyads were video-recorded in home during naturalistic routines for 45 minutes and later transcribed. First, we tested the degree to which visual and/or tactile object cues accompany "naming events." In order to detail the multiple physical cues that accompany the words mothers' direct to their infants, we limited our scope common concrete nouns infants learn first using the MCDI. Our final list included 59 target nouns spoken by at least 25% of mothers, identifying 3,219 naming events, coded for object presence, mother and infants' visual (social and object gaze) and tactile cues (gestures and touching object), and location (room and place within the room; e.g. living room, couch). Nearly all (92%) naming events referred to visually present objects, and 90% were accompanied by a manual or visual gaze. Infants looked at 68% of named objects and touched 45.6%; mothers looked at 82% and touched 53% of named objects. Deeper investigation into locational cues revealed that room (Figure 1A) and place (Figure 1B) systematically organized mothers' language. For example, food-naming events (e.g., apple, milk) occurred while infants were in the kitchen (especially at the table), and were infrequent in the bedroom, living-room, and bathroom. Next, we tested whether language inputs to infants are reliably organized around

infant "activity contexts." We coded the contextual cues that surround word use across 11,000 instances of concrete nouns and action verbs categorized into 20 semantic categories (e.g., animals, clothing, foods, etc.). Infants' engagement in routines (e.g., mealtime, grooming, literacy, and object play) was coded in temporal alignment with transcriptions of mothers' speech. The words mothers directed to infants reliably clustered around the objects and actions of infants' activities (e.g., body parts and clothing during grooming, foods during mealtime). Infants spend much time engaged with objects at home. Mothers' responses to infant object engagement fluctuate between dense and sparse bouts of contingency. Nonetheless, visual and/or manual cues to word meaning accompany the majority of spontaneous naming events at home. Further, language input is bound to the spaces in which it occurs: Infants encounter words that match the activities of their everyday lives. Together, data reveals that infants' everyday experiences and interactions in their everyday spaces are replete with regularities that shape infant-directed speech; providing infants systematic and structural cues to word meaning, scaffolding language development.

P4-G-106: Individual differences in children's spatial abilities: Role of parent-child spatial language and parent spatial ability

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Spatial skills are necessary for common tasks including fitting a carry-on suitcase in airplane overhead storage and organizing groceries in a cabinet. Spatial skills also predict entry and success in Science, Technology, Engineering, and Mathematics (Wai et al., 2009). Robust evidence links spatial language use by children with individual differences in children's non-verbal spatial skills (Miller et al., 2017; Polinsky et al., 2017; Pruden et al., 2011). Pruden and colleagues found that children's own spatial language use mediated the relation between parent spatial language and children's spatial skills, including mental rotation. Similarly, Polinsky and colleagues found that children's spatial language, not parents, predicted how rapidly they completed a puzzle requiring rotation. Questions remain about whether reported relations between children's spatial language and spatial ability can be explained by parent spatial language and ability. No studies have controlled for parent mental rotation ability when examining the relation between children's spatial language and mental rotation. Yet, parents who have better mental rotation abilities may be more likely to use increased spatial language with their children because they are more confident in their own spatial abilities and are more likely to engage their children with spatial activities/toys that invite spatial language. Does child spatial language production explain individual differences in child mental rotation ability, even after controlling for parent spatial language, parent mental rotation ability, and parent and child overall language? Participants were 40 preschool-aged children ($M = 4.26$; $SD = 0.45$; Range=4-7; 19 females; 21 males) and their parents. Dyads completed a 10-minute building task, where they constructed a Lego house from instructions, and a 10-minute drawing task, where they drew a picture of their family. Sessions were transcribed for spatial language (Pruden et al., 2011) including: shape terms (e.g., square), dimensional adjectives (e.g., little), and spatial features/properties (e.g., edge). Total number of spatial tokens and overall tokens were calculated for parent and child. Children's mental rotation/transformation abilities were assessed using an abbreviated version of the Children's Mental Transformation Task (CMTT;



Levine et al., 1999) in which they mentally rotated and translated 2-D shapes. Parent's mental rotation abilities were assessed using a redrawn version of the Vandenberg and Kuse Mental Rotation Test (MRT-A; Peters et al., 1995) in which they mentally rotated 3-D geometric figures. Parent and child spatial tokens, parent MRT-A and parent and child overall tokens were entered into a regression predicting children's CMTT. This model significantly predicted CMTT scores, accounting for 20% of the variance in performance, $F(5,39)=2.91$, $p=.027$, $R^2_{adjusted}=.20$. Controlling for parent and child overall tokens and parent spatial tokens, parent MRT-A significantly predicted child CMTT ($\beta=.377$, $t=2.45$, $p=.020$). Importantly, child spatial tokens ($\beta=.404$, $t=1.98$, $p=.056$) was trending towards significance, controlling for parent spatial tokens and parent MRT-A (Figure 1). These findings suggest children's own use of spatial language may still be important for children's non-verbal spatial ability, though there also appears to be a role that parent spatial ability plays in the development of children's spatial ability.

P4-G-107: Do infants and toddlers have an implicit Theory of Mind?

Systematic replication studies with various interactive measures

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Traditionally, research with explicit verbal task suggests that Theory of Mind (ToM) develops in protracted form before children acquire a meta-representational concept of belief around age 4. In the last 15 years, however, ToM research has been revolutionized by new studies with implicit tasks using looking or spontaneous interaction measures (e.g., Onishi & Baillargeon, 2005; Southgate et al., 2007, 2010). Findings from these studies suggest that even infants master ToM tasks once they are suitably simplified. These findings have been the basis for far-reaching theoretical claims arguing for an early (possibly innate) onset of ToM abilities. However, recent attempts to replicate and validate implicit paradigms have produced mixed findings. By far the biggest body of evidence comes from direct and conceptual replication studies with anticipatory looking measures, the vast majority of which have failed to reproduce original effects (e.g., Grosse Wiesmann et al., 2016, 2018; Kulke et al., 2017, 2018a,b; Schuwert et al., 2018). Against this background, we systematically tested, in a large-scale project involving two labs and three sets of studies, the replicability of another class of implicit ToM tasks, those that use spontaneous interaction as dependent measures. Study 1 implemented a conceptual replication of Rubio-Fernandez & Geurts (2013) with 3-year-olds ($N=72$). Results revealed that children did not perform more proficiently in a less explicit FB task compared to a closely matched standard FB tasks and thus failed to replicate the original findings. Study 2 implemented direct and conceptual replications of a communicative-interactive FB task by Southgate et al. (2010). Across five experiments with children at 17 months (original age group), 24 months, 48 months ($N=124$ in total) and with adults ($N=48$) we investigated whether children reveal any FB competence in interactive tasks before they do so on explicit tasks or whether (for older children and adults) subjects perform more proficiently in the former than the latter. Results revealed, first, no evidence for FB tracking in the interactive task in any age group of children and second, that 4-year-olds performed actually less proficiently in the interactive compared to a standard explicit FB task. Third, only



adults performed at comparable levels in interactive and standard FB tasks. Taken together, these results question the sensitivity of this interactive task for tapping early implicit ToM. Study 3 (ongoing) implements a conceptual replication and extension of a spontaneous helping FB task by Garnham & Perner (2001). Results with 3-year-olds (N=51) so far reveal, first, that children behave differently in FB and True Belief (TB) conditions - potentially indicating belief-tracking. Second, however, the results of a novel ignorance control condition in which children behaved exactly like in the FB condition suggest the possibility that children merely track knowledge vs. ignorance rather than belief per se - a result highly consistent with the patterns of (non-)replications in another recent study (Powell et al., 2018). Taken together, these sets of studies converge with recent replication attempt with anticipatory looking measures in failing to find stringent evidence for implicit ToM competence in children younger than age 4.

P4-G-108: Testing the maturity of infants' concept of false belief with inanimate and naive agents

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The mentalistic view of early theory of mind posits that infants possess a robust and sophisticated understanding of false belief that is masked by the demands of traditional explicit tasks. Much of the evidence supporting this mentalistic view comes from infants' looking time at events that violate their expectations about the beliefs of a human agent. In this talk, we report a series of experiments with the violation of expectation paradigm (VOE) that suggests that infants' concept of false belief is not as sophisticated as older children and adults. In the first experiment, 16-month-old infants (N= 53) were administered the original VOE task except that a remote- controlled mechanical crane performed the actions of the human agent in the original task (Onishi & Baillargeon, 2005). Infants viewed three familiarization trials, one belief-induction trial, and one test trial. Each trial was followed by an infant-directed pause, which ended when the infants either 1) looked away from the scene for 2 consecutive seconds after looking at it for a minimum of 2 cumulative seconds, or 2) looked at the scene for 30 cumulative seconds. The goal of the familiarization trials was to show that the crane, like the human actor in the original experiment, reached for a cup in a box. During the induction trial, the object changed location in the absence of the crane. During the test trial, the crane was rotated toward the empty box (congruent condition) or was rotated toward the box that contained the toy (incongruent condition). Infants in the incongruent group looked longer than those in the congruent group. This longer looking indicates that the infants were surprised when the crane turned to the box where the toy cup was actually located compared to when the crane turned to the empty box. A group of adults (N=30) who watched the video predicted that the crane would turn toward the box that it was associated with during the familiarization trials. In the second experiment, a switch agent paradigm as used with the classic false belief violation-of-expectation task. Infants aged 16 months (N= 48) watched an agent interact with an object followed by a belief-induction trial that induced a true or false belief to this agent. At test, a naïve agent, never exposed to the location of the toy, reached in one of the two boxes. Infants' looking patterns replicated those found with a single agent (i.e., longer looking in the incongruent group compared to the congruent group), indicating that infants overattribute beliefs to naïve agent. Adults predicted that the agent was equally likely to reach for the empty



box ($n = 16$) than for the full box ($n = 14$). These predictions are not different than what would be expected from chance (binomial $p = .86$). Taken together, these findings suggest that, unlike adults and older children, infants overattribute false beliefs to inanimate objects and do not believe that mental states are person-specific.

P4-G-109: How do infants process sociomoral scenarios? An eye-tracking pupillometry study

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Past research shows that infants are sensitive to third-party sociomoral events. After watching puppet shows depicting prosocial and antisocial actions, infants preferred to touch (Hamlin et al., 2007) and looked longer at (Hamlin et al., 2010) prosocial over antisocial characters, suggesting that they more positively evaluate the prosocial (vs antisocial) characters. At a mechanistic level, however, it remains unclear how infants process these scenarios and whether emotional mechanisms are implicated. Although a recent study found that infants and toddlers showed more positive facial expressions to prosocial versus antisocial scenarios, providing preliminary evidence for the links between emotions and infants' processing of sociomoral scenarios (Steckler et al., 2018), the effects in the study were small and inconclusive. The current study used eye-tracking and pupillometry to explore the roles of cognitive and emotional mechanisms in infants' processing of sociomoral scenarios. The use of eye-tracking and pupillometry allows for moment-to-moment analysis of infants' looking behaviors and sympathetic activities (Hepach et al., 2016), which sheds light on the relations between sociomoral evaluations and affective processes. Using pupillometry, past research has found links between children's empathic concerns for others and their own prosocial behaviors (Hepach, 2017). The current research applied pupillometry to exploring infants' third-party sociomoral evaluations. We presented infants ($N = 34$; mean age = 5.13 months) with the "Hill" scenario (Hamlin et al., 2007) in which a protagonist repeatedly tried but failed to reach the top of a steep hill. On his third attempt, the protagonist was assisted (pushed up the hill) or hindered (pushed down the hill) by other characters. Infants viewed 3 prosocial scenarios and 3 antisocial scenarios in alternation, followed by a still image depicting the helper and hinderer placed side by side against a white background. Afterwards, the same set of stimuli was presented again (except that the position of the helper and hinderer was reversed in the still image). Throughout the study, infants' eye-movements and pupil diameter were measured using an SMI REDm250 eye-tracker. Pupillometry data analyses focused on 1) whether prosocial/antisocial events elicited different levels of sympathetic arousal and 2) whether individual differences in arousal responses to prosocial/antisocial events predicted infants' looking behaviors in the still image viewing activity. Results found an overall increase in infants' pupil diameter as they watched antisocial and prosocial events unfold. Crucially, infants showed smaller pupil dilation to antisocial (than to prosocial) scenarios after antisocial/prosocial actions occurred, but no pupil diameter differences were observed before or during prosocial/antisocial events. These findings provide evidence that infants' sympathetic nervous system responds differently to negative and positive sociomoral events. In addition, correlational analyses revealed that infants who showed less pupil diameter increase after viewing antisocial events spent less time looking at the antisocial character during the still image viewing activity, suggesting a link between infants' emotional responses to the scenes



and their social preferences. Taken together, these results support the idea that emotional processes are involved in infants' evaluation of sociomoral scenarios.

P4-G-110: Pupil size synchrony: A new measure of attention and learning in infancy research

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Measuring how attention and processing unfold on a subsecond timescale in infancy is challenging, leaving gaps in our understanding of real-time-processing. In two case studies, we illustrate how inter-subject pupil size synchrony (Kang and Wheatley 2017) can reveal how stimulus dynamics and prior experience shape infants' moment-to-moment attention, learning, and processing. Pupil responses in adults are time-locked to task-relevant stimuli during moments of attention (Kahneman & Beatty, 1966, Smallwood et al., 2011, Kang et al., 2014), suggesting that moments in a continuous stimulus that elicit heightened attention would elicit similar time-locked responses across participants. In line with these findings, the most engaging moments in naturalistic stories elicit higher alignment in pupil responses across adult participants compared to less engaging moments (Kang & Wheatley, 2017). Can pupil size synchrony offer insights about infants' processing of environmental input? To answer this question, we evaluated processing of two distinct domains of communicative input in infancy: infant-directed speech, and emotion. In Study 1, we used inter-subject pupil size synchrony as a marker of shared attention to explore the effects of subsecond pitch changes on toddlers' learning from child-directed speech. Thirty 24-30-month-olds were presented with four novel words embedded in identical sentence frames and paired with novel isoluminant objects. Two of the words followed a "hill"-shaped contour, previously associated with emphasis in child-directed speech (Aslin 1993; Fernald and Mazzie 1991), and two with a contour that caregivers do not use for emphasis: the inverse "valley"-shaped contour. Synchrony was computed as pairwise dynamic time-warping distance (Tormene et al. 2009) between the pupil size time series spanning the duration of each word for each participant. During training, toddlers showed higher synchrony during novel words presented with a hill contour vs. a valley contour (Figure 1a; $\chi^2(3)=228.78$, $p<0.001$). At test, when toddlers were tested on their discrimination of two novel word-object mappings, they showed higher accuracy in looking to target objects whose names had been presented with the hill (vs. valley) contour (Figure 1b; $\chi^2(1)=4.68$, $p<0.05$). Controlling for contour type, higher pupil size synchrony during individual word exposure predicted better learning at test (Figure 1c; $\chi^2(1)=3.96$, $p<0.05$). In Study 2, we used inter-subject pupil size synchrony to explore how prior experience with caregivers' emotion expressions shapes infants' real-time processing of emotion dynamics. Ten 7-10-month-old infants watched isoluminant videos of an actor displaying emotion transitions, for example, from happy to sad. To assess infants' experience with emotion transitions, we asked parents to rate how common different transitions between emotions are in the household. Infants whose parents reported similar patterns of emotion transitions were significantly more coupled in their pupil responses to videos of emotion transitions in the lab (Figure 2; Welch's t-test: $t(503.23)=-3.09$, $p<0.005$). This suggests that infants' real-time processing of social information was shaped by their prior emotion-related experiences. Together these studies highlight pupillometry as a highly promising means of understanding infants' real-time processing of input that is sensitive to subsecond stimulus dynamics and prior experience.



P4-G-111: Prior locomotor experience and sleep quality predict newly walking infants' learning trajectories

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The quality of night sleep predicts preparedness to learn and, reciprocally, can reflect consolidation of recently-learned information. However, little is known about the relation between sleep and problem solving in infancy. This study aims to address this dearth of knowledge by investigating 1) whether and how sleep interacts with other factors implicated in infants' problem solving, such as prior experience and information gathering, 2) whether there is an optimal level of sleep efficiency for successful learning, and 3) whether sleep metrics can reflect information processing. Over 2 days, experimenters trained and tested 17 newly-walking infants on a novel locomotor problem--navigating a tunnel to reach a caregiver on the other side (see Figure 1 for procedure). Switching between walking and crawling, which is necessary for solving the tunnel problem, is challenging for novice walkers. Training consisted of a strict 15-step protocol comprising a series of task-relevant prompts. Testing occurred immediately after training or after a 2-hr delay. A follow-up test and generalization to a new tunnel occurred the next morning. Coders documented exploratory behavior and number of training prompts required. Infants wore an actigraph (Ambulatory Monitoring, Ardsley, NY, USA), a wristwatch-like activity monitor, the night between test days to measure sleep quality. To capture an accurate picture of infant problem solving, hierarchical exploratory cluster analysis based on infants' exploratory behaviors and extent of training yielded problem-solving profiles for each session (training, test, follow-up, generalization): efficient (minimal exploration and training needed to successfully navigate the tunnel); inefficient (high rates of exploration and full training needed before success); and never solved (never figured out how to go through the tunnel, despite high rates of exploration and full training). A second hierarchical cluster analysis based on cluster membership at each session yielded four trajectory profiles: efficient at every session ($n = 7$), improved consistently across sessions ($n = 5$), improved across sessions until generalization ($n = 3$), never solved ($n = 2$). A multinomial logistic regression revealed that number of wake episodes (Figure 2a) and prior tunnel experience (Figure 2b), but not whether there was a delay between training and test, predicted membership in the four trajectory clusters, $\chi^2(12, N = 17) = 26.36$, Nagelkerke $R^2 = .84$, $p = .01$. Infants without tunnel experience and few night wakings never solved the problem. Infants with tunnel experience and moderate-to-many wake episodes solved the task efficiently at each session or continuously improved over each session. Infants without tunnel experience and many wake episodes improved on the task, but could not generalize to a novel task. Learning trajectory varied as a function of the combination of night wakings and tunnel experience. There was a "goldilocks effect" of sleep quality where both too few and too many wake episodes were associated with less successful learning. Few wake episodes may reflect a lack of information processing, whereas too many may reflect active acquisition of new motor skill and, as a result, increased task difficulty. Thus, sleep quality and prior experience interact to impact the consolidation of new knowledge and its application to new contexts.

P4-G-112: Neighborhood talk: Linguistic composition of neighborhoods and their relations to mother and infant language in the home

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Infants learn language through everyday interactions with caregivers and other adults and children in their communities. Although infants' daily interactions take place in a variety of settings--such as homes, center-based care, parks, stores, restaurants, and other settings where the family spends time--the focus of research on language development has been almost exclusively on infants' home language experiences. The home setting however, is nested in and shaped by neighborhoods, broader contexts of development that are powerful organizers of family life. Yet, no research to date has documented the types of languages spoken in infants' neighborhoods, nor examined the relation between language spoken in neighborhoods and infants' language interactions in the home. To address this gap, we examined the linguistic composition of neighborhoods Latinx infants reside in, and tested the relations between neighborhood English and Spanish and 1) mothers' use of Spanish and English; 2) infants' use of Spanish and English; and 3) infant Spanish and English vocabulary. We interviewed Mexican and Dominican mothers residing in a large metropolitan city in the United States, and observed them interacting with their 24-month-old infants during a wordless book-sharing task and a play task with beads. Neighborhood language was drawn from the U.S. Census, which contains zip-code level information on language spoken in the home, categorized as: 1) Spanish; 2) English; 3) Asian/Pacific Islander; 4) Indo-European; and 5) Other. Mother-infant interactions were transcribed and all words spoken by the dyad were categorized as either Spanish or English. Finally, mothers were administered the MCDI, and asked which words infants knew in English and/or Spanish. Scores were generated for each language. Preliminary findings suggest that Latinx infants in this sample live in predominantly Spanish speaking neighborhoods, followed by English, Indo-European, Asian/Pacific Islander, and Other (ps ranged from .018 to .001) (Figure1). However, enormous variability was observed among infants from both ethnic groups (Figures2a-b). neighborhood Spanish ranged from 4.44% to 72.49%, suggesting that some infants lived in neighborhoods where Spanish was barely spoken, while others lived in neighborhoods where over 70% of the population spoke Spanish as their main language. Similar variability was observed for English (range: 12.39-81.16), Indo-European (range: .79-33.18), Asian/Pacific Island (range: .31-53.24) and Other (range: .16-7.94). Pearson correlations between neighborhood English and Spanish and mothers' English word types and tokens indicated that neighborhood Spanish did not relate to mothers' English or Spanish word types and tokens. Neighborhood English, however, related to mothers' English word types ($r=.22$, $p=.025$) and English word tokens ($r=.21$, $p=.031$). For infants, neighborhood English and Spanish and infants' English word types and tokens did not reveal any significant relations, although two correlations were marginal: infants' English word tokens marginally correlated with neighborhood English ($r=.17$, $p=.07$) and neighborhood Spanish ($r=-.19$, $p=.05$). When controlling for mothers' education and income, relations between neighborhood talk and mother and infant language attenuated, suggesting the importance of human and economic capital in shaping infant's language interactions. Findings have implications for understanding how neighborhoods shape infant learning.



P4-G-113: Investigating children's early learning about social categories: Evidence from 36-month-olds

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By age 4, the tendency to use social categories to make inductive inferences about novel category members is well established (Baron et al., 2014; Waxman, 2010). When and how does this tendency emerge? The present study began to address these questions by investigating toddlers' understanding of novel social categories. Specifically, we asked (1) whether 36-month-olds could learn about the characteristics of a novel social category through a brief, naturalistic interaction with their parents and (2) whether they then used this newly acquired knowledge to make inductive inferences about novel category members. To address these questions, we tested 63 36-month-olds and one of their parents. All parents first read a paragraph about a novel social category, Zarpies. The paragraph was designed to induce the essentialist belief that Zarpies were a distinct kind of people that shared inherent characteristics. Next, parent-child dyads completed a picture-book task adapted from Rhodes et al. (2012). Dyads were assigned to either a generic or no-label condition. The picture-book contained pictures of individuals displaying behaviors or properties. Each picture was preceded by a description. In the generic condition, the description included a generic statement about the novel social category. In the no-label condition, the description did not include a generic statement and did not refer to the social category (Fig-1). Parents were instructed to read the sentences aloud and describe the pictures to their child. Children then completed a violation-of-expectation task consisting of six test trials involving agents dressed like Zarpies. In each pair of test trials, one agent performed an action that was consistent with a characteristic in the book, and the other performed an action that was inconsistent with a characteristic in the book (order counterbalanced across children; Fig-2). A difference-score for each test pair was calculated by subtracting children's looking time to the consistent event from their looking time to the inconsistent event. The difference scores were then averaged for each participant. Children's looking-time difference scores differed across conditions, $t(62) = 2.11$, $p = .04$. Children's difference scores were significantly above chance in the generic condition ($M = 3.49$, $SD = 5.24$), $t(31) = 3.08$, $p = .004$, but did not differ from chance in the no-label condition, $t < 1$. Examination of parent talk during the picture-book task indicated that relative to parents in the no-label condition, parents in the generic condition produced more sentences containing generic statements (beyond those already printed in the book), $t(61) = 3.27$, $p = .002$. Together, these results suggest that children in the generic condition learned about Zarpies based on a brief parental interaction, used this knowledge to make inductive inferences about the behavior of novel category members, and hence looked longer when Zarpies displayed Zarpie-inconsistent, as opposed to consistent, behaviors. This did not occur in the no-label condition, suggesting that parents' use of generic statements was critical to children's learning and inductive inferences about the novel social category. These findings thus highlight the powerful influence of generic statements on children's early learning about social categories.

P4-G-114: What are you looking at? Using eye tracking glasses to monitor toddlers' attention in natural learning situations



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Eye movements are thought to reflect (automatic) cognitive processes. Because eye tracking is non-invasive and does not require an overt behavioural response, it is a suitable method to use with infants and toddlers. Most eye tracking studies to date use screen-based eye trackers, presenting stimulus material such as pictures and videos on screen and monitoring infants' eye movements and/or pupil dilation to assess their perception and understanding of these stimuli. This research provides important insights, but it often uses very controlled and - compared to the real world - reduced stimuli. However, given the increasing interest in embodied cognition and the role of social interaction for cognitive processing and learning, the need arises to investigate infants' processing in more naturalistic and complex settings. Head-mounted cameras (e.g. Smith et al., 2014) or eye tracking glasses might provide a useful mean to study infant cognition in natural interactions. Yet, systems that fit infants or toddlers are difficult to find. Tobii and Eyelink - whose eye tracking systems are widely used in cognitive research with infants - offer eye tracking glasses for adults and a smaller sized version for school-aged children. Next to being quite expensive, these systems are not advised for use with younger children and also do not fit very well on an infant or toddler head. In this poster, we present a prototype of eye tracking glasses suitable for toddlers, based on the components of a Pupil Labs eye tracker built into the frame of standard children's sunglasses. The eye tracker consists of three cameras: a world view camera, which is fixated centrally and records the toddler's view; and two cameras which each record one of the toddler's eyes. Calibration, recording and analysis is performed based on the Pupil Labs software and R. The software is freely available and open source, giving researchers the opportunity to make adjustments according to their specific needs. Analysis of scene data is, however, not as straight-forward as analysis of data from screen-based eye trackers. In particular, there is a mapping problem: how do we know the size and position of areas of interest when the field of view constantly changes due to movement of the participant (or movement of objects/people in the scene)? This problem is solved through the use of QR-codes which can be fixated on relevant items in the scene, and which serve as reference points for data analysis. The poster will present the components and set-up of the eye tracking glasses, as well as the basic principles and routines of data acquisition and analysis. Data from an example experiment will be used to illustrate data quality and potential pitfalls in data collection.

P4-G-115: Nine-to-ten-month-olds do not discriminate between expected and unexpected events in four different core knowledge domains

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Developmental psychology often relies on looking times to measure infant cognitive processes. For instance, longer looking times to unexpected physical or social events were interpreted as evidence for underlying basic concepts infants hold about the world. It was suggested that already young infants possess an understanding of physical laws (Spelke, Breinlinger, Macomber, & Jacobsen, 1992), numbers (Wynn, 1992), and human actions (Reid et al., 2009). Another measure presumably reflecting violation-of-expectation reactions is pupil



dilation (Jackson & Sirois, 2009). However, it remains an open question whether infants equally discriminate between expected and unexpected events in different domains and whether looking times and pupil dilation equivalently measure violation-of-expectation. In an eye tracking study, we therefore presented 33 9-to-10-month-olds (18 female, mean age: 9 months 32 days) expected and unexpected events in the domains action, solidity, cohesion, and number. Infants saw a sequence of three pictures in which the first two pictures, the priors, (presentation duration: 1000ms) set the context for the final outcome picture (presentation duration: 5000ms) which either depicted an expected or an unexpected event (see Figure 1 for example stimuli for each domain). Infants' looking times and pupil dilation in response to the outcome pictures were measured. We performed a repeated-measures ANOVA with the within-subject factors domain (action, solidity, number, and cohesion) and outcome (expected vs. unexpected) to test the following hypothesis: (1) If infants equally discriminate between expected and unexpected outcomes in all domains, infants will show longer looking times to the unexpected as compared to the expected outcomes in all domains (action, solidity, cohesion, and number) which will result in a main effect of the factor outcome. The repeated-measures ANOVA showed only a significant main effect of domain, $F(3,30)=25.42$, $p<.001$. Post-hoc paired sample t-test (Bonferroni corrected) revealed that infants looked significantly longer to action (mean=3.75s, SD=0.71s) as compared to any other domain (cohesion: mean=3.06s, SD = 0.57s, $t(32)=5.22$, $p<.001$; solidity: mean=3.21s, SD=0.64s, $t(32)=3.80$, $p<.05$; number: mean=2.55s, SD=0.59s, $t(32)=8.51$, $p<.001$, see Figure 2). Furthermore, infants looked significantly less at the number outcome as compared to the solidity, $t(32)=5.93$, $p<.001$, and the cohesion outcome, $t(32)=5.06$, $p<.001$. Using looking times, we did not find any evidence that 9-to-10-month-olds discriminate between expected and unexpected outcomes in any of the four tested domains. Infants looked longest at the action domain which presumably is due to the fact that only pictures of this domain present humans. Potential reasons for the discrepancy of our results as compared previous studies may be the usage of eye tracking instead of manual coding, the timing (i.e. the presentation duration of 5000ms may have resulted in ceiling effects) or the usage of pictures instead of movies. We will further analyze pupil dilation as a marker of arousal. Analyzing the relation between looking times and pupil dilation to the same stimuli will give insights into the underlying processes of violation-of-expectation, that is enhanced attention vs. physiological arousal.

P4-G-116: 17-month-old infants' goal and movement imitation on different levels of goal saliency

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Prior research has shown that infants' imitation is goal-directed and hierarchically organized (Bekkering, Wohlschläger & Gattis, 2000). When presented with a clear action goal, infants imitate the goal to the detriment of the movement style; but when presented with no visible action goal, they preferentially imitate the movement over the goal (Carpenter, Call & Tomasello, 2005; Bekkering et al., 2000). A study with preschoolers (Elsner & Pfeifer, 2012) has found a possible interacting factor: 3- to 5-year-olds' imitation was influenced by verbal cues (highlighting the movement or the goal) in a condition with low goal saliency, but not in a high goal-saliency condition. In the present study, we first treated goal saliency as dimensional and established a new condition with medium goal saliency (in addition to the existing



conditions by Carpenter et al., 2005) and second investigated the influence of verbal highlighting of goal and movement aspects of the action on infants' imitation. For this purpose, we demonstrated 16- to 19-month-old infants (n=24 in each goal-saliency condition) a hopping or a sliding motion of a toy animal (a mouse) towards one out of two goal locations that were each marked by either a 3-D house that the mouse was put into (high goal saliency), a 2-D circle taped on the table that the mouse was put onto (medium goal saliency), or an empty space at which the movement stopped (low goal saliency). In addition, half of the infants in each goal-saliency condition heard the model verbally highlighting either the demonstrated movement ("hopping", "sliding") or goal ("red/blue house", "red/blue circle", "there"). After the demonstration, infants were invited to play with the toy animal (30 seconds). Infants participated in two identical trials. We expected to replicate findings by Carpenter et al. (2005) for the low and high goal saliency condition. Further, we expected that the medium saliency condition would create a situation of uncertainty as to which aspect of behavior (movement or goal) should be learned from the demonstration, and that infants would therefore preferentially imitate the verbally highlighted aspect. However, analyses did not yield any significant influence of verbal cues on infants' imitation behavior. Therefore, we collapsed data across verbal conditions. Concerning the factor goal saliency, we replicated Carpenter et al. (2005): Infants imitated more often the goal than the movement in the high goal saliency condition, and more often the movement than the goal in the low goal saliency condition. In addition, infants did not show a preference for movement or goal imitation in the medium goal saliency condition. We thus successfully created a learning situation where action goal and movement were equally salient. This offers new possibilities to investigate what drives infants to learn certain aspects from an action demonstration when confronted with uncertainty as to what to learn. In the future, we plan on further investigating potential interactive effects of goal saliency and verbal highlighting on infants' imitation, e.g., with more age-appropriate words.

P4-G-117: A stimulating home environment is associated with higher cognitive function in toddlers with Congenital Heart Disease

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Congenital Heart Disease (CHD) is associated with increased risk of developmental impairments including mild intellectual difficulties, poor motor skills, executive function impairments, and speech and language disorders (Latal, 2016). The extent to which perioperative clinical factors, type of cardiac defect, severity of brain injury, socioeconomic status or home environment influence early childhood development in this population is not clear. 56 children [31 male; gestational age at birth median (IQR)=38.43(0.57) weeks] with CHD were recruited from St Thomas' Hospital Neonatal Unit. Infants underwent presurgical MRI on a 3-Tesla scanner situated on the neonatal unit. At 22 months children completed the Bayley Scales of Infant and Child Development-3rd edition (Bayley-3; Bayley, 2006) and parents completed the Cognitively Stimulating Parenting Scale (Wolke et. al., 2013) to assess the level of cognitive stimulation in the home environment. Level of maternal education and total annual household income was also collected. Hospital records were reviewed to calculate

days on the intensive treatment unit (ITU) post-surgery, time on bypass during surgery and days to corrective or final palliative surgical intervention. Bayley-3 scores were compared to the standardised test mean (mean=100) using one-sample t-tests. Kruskal-Wallis, Mann-Whitney U and spearman-rank correlations were used to test the relationship between clinical, cardiac and environmental factors and Bayley-3 scores. Significant factors were entered into a multiple linear regression to predict Bayley-3 scores covarying for sex, gestational age at birth and maternal education level. Holm correction was used to control for multiple comparisons (reported as pFWE). Cognitive [mean(SD)=91.5(13.3); $t(55)=-4.76$, pFWE<0.0001], Language [mean(SD)=89.8(16.6); $t(52)=-4.45$, pFWE<0.0001] and Motor [mean(SD)=93.4(12.8); $t(54)=-3.84$, pFWE=0.0003] Composite scores were reduced in children with CHD. A cognitively stimulating home environment was associated with higher cognitive scores (Figure 1). This effect remained when correcting for gestational age at birth, sex and maternal education (Table 1; $F(6,41)=2.92$, pFWE=0.036, $R^2=0.30$). There were no significant relationships between clinical risk factors, cardiac physiology, socioeconomic status or brain injury severity and cognitive, language or motor scores. Environmental enrichment paradigms combining exercise, social interaction, and stimulating experiences improve performance on cognitive tasks in rodent models of neurological disorders with research pointing to a general mechanism of experience-dependent neural plasticity (Nithianantharajah & Hannan, 2006). We hypothesise that this effect may underlie the relationship between cognition and parenting reported in this study. Supporting parents to provide a stimulating home environment during infancy and early childhood may promote cognitive development in this population.

P4-G-118: Individual differences and neural correlates of prosociality in infancy

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In the past decade, studies have suggested that prosocial behaviors, defined as the actions that benefit others without requiring anything in return, may have early developmental roots as observed in preverbal infants who display a stronger preference for prosocial over antisocial individuals (Hamlin et al., 2007; Hamlin & Wynn, 2011). The present study addressed the role of individual differences in promoting and shaping the understanding of prosocial and antisocial events. Specifically, we assessed 5-6 month-old infants' ability to discriminate and prefer prosocial over antisocial individuals using neurophysiological (i.e., ERPs), behavioral (i.e., looking times) measures and we investigated whether temperamental (Rothbart, 1981) and attachment (Condon et al., 2008) styles (i.e., parent questionnaire) would affect the emergence of this competence. While 26 infants were tested and analyzed in the behavioral measures, 7 infants obtained the adequate number of trials per condition to be included in the ERP analysis. Infants watched 4 short familiarization films (20s each; 2 prosocial and 2 antisocial) and 60 short videos (1.9s each; 30 prosocial and 30 antisocial) depicting a prosocial (i.e., a puppet helping another puppet to open a box) or antisocial acts (i.e., a puppet hindering another puppet from opening a box) (Fig 1), at the end of which they were asked to manually choose between one of the two puppets presented in the videos. The familiarization films were presented at the beginning of the study, the data acquisition began during the presentation of the short videos. On a neural level, we found that infants differentiated between prosocial and



antisocial scenes in the P400 component (i.e., an index of early social information processing). A rmANOVA with condition (prosocial vs antisocial) x hemisphere (right vs left) x cluster (occipital vs temporal) revealed a significant main effect of condition, $F(1,6)=47.48$, $p=.0005$ (Fig 2). The Nc component (i.e., an index of attention), showed a change in amplitude between the two conditions and specifically showed higher amplitude in the prosocial condition, a rmANOVA with cluster (frontal central left vs frontal central right vs central) x condition (prosocial vs antisocial) also revealed a main effect of condition, $F(1,6)=30$, $p=.003$ (Fig 2). Suggesting that infants are able to discriminate between the two presented events and attuned more to the prosocial condition compared to antisocial condition. Analyses performed on looking times and manual choice did not reveal any overall preference across infants. However, when individual differences were taken into account this revealed that longer looking times towards the prosocial individual were associated with temperament and attachment; particularly, longer attention to prosocial events were positively correlated with higher temperament ($r=.506$, $n=24$, $p=.012$), specifically effortful control which is related to self-regulation, and higher attachment scores ($r=.443$, $n=24$, $p=.030$). This suggests that earlier preference to prosocial individuals could be promoted both by biological (i.e., temperament) and external and affective (i.e., attachment) factors. Overall, while our results are preliminary this study could shed new light on the factors characterizing prosocial development and the importance to observe individual differences in the early development of social cognition.

P4-G-119: Visual habituation in deaf and hearing infants

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Early cognitive development is driven by the sensory experiences that infants acquire as they explore their environment. Atypical experience in one sensory modality from birth has cascading effects across multiple developmental domains. For instance, research has shown that deaf children exhibit poorer performance, relative to their hearing peers, on a range of non-auditory cognitive skills such as working memory, sequence processing, attention, and even motor coordination. However, this work has been limited to studies with children. As a result, the underlying causes of these differences and when they emerge is still a matter of debate. To shed light on the effects of hearing loss on early cognitive development, we conducted a study to compare visual habituation in infants with profound hearing loss, prior to receiving cochlear implants (CIs), and age-matched infants with normal hearing. Method: Twenty-three deaf infants participated in this study (mean age = 13.4 months, SD = 4.4). Each deaf infant was matched to a typically-developing hearing infant based on chronological age (mean age = 13.4 months, SD = 4.5). All infants were diagnosed with bilateral severe-to-profound sensorineural hearing loss, and were tested prior to receiving cochlear implants. We used the visual habituation-oddity paradigm, a variation of a standard habituation procedure (Houston et al., 2007). During the habituation phase, infants observed a novel object presented on a screen until they looked away or a maximum of 20s. To test differences in habituation between deaf and hearing infants, we compared the number of trials to reach the habituation criterion (defined as three consecutive trials in which the mean looking time to the stimulus was less than or equal to 50% of the baseline), growth slopes during the habituation phase, and look-away rates. Results: Our findings revealed that the infants with hearing loss took



significantly longer to habituate to the visual stimulus and demonstrated a slower habituation rate than the hearing group (Figure 1). These findings were not explained by overall attention to the objects, as there were no differences in looking times between groups during the first habituation trial. They are also not due to general fatigue, as both groups showed renewed interest to a novel visual item following the habituation test. These findings indicate that infants with hearing loss encode or process visual information differently than infants with normal hearing. We suggest that early auditory experiences play an important role in general cognitive development, including the development of visual processing skills. Figure 1. Visual habituation in deaf and hearing infants. (A) Deaf infants required more trials to reach the habituation criterion and (B) demonstrated lower look-away rates across habituation trials than their age-matched hearing peers.

P4-G-120: The effects of eye gaze on infants' language learning: A systematic review

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Eye gaze is a ubiquitous cue in child-caregiver interactions. Infants are highly attentive to eye gaze from very early on. They prefer mutual gaze and look longer at faces with direct gaze from birth (Farroni, Menon, & Johnson, 2006), and can reliably follow others' gaze direction from six months (D'Entremont, 2000). However, the question of why infants show gaze-sensitive behaviour, and what role this sensitivity to gaze plays in their language development is not yet well-understood. Some have argued that mutual gaze between caregivers and infants is a signal of social engagement, which puts infants into a receptive state that optimizes information transfer (Csibra & Gergely, 2006). In contrast, others argue that gaze following simply allows infants to orient and attend to the relevant information in the naturally noisy environment. In the domain of language, for example, we know that there are links between infants' early gaze following skills and later vocabulary acquisition. However, these studies do not tell us anything about the mechanisms behind the effect; whether eye gaze brings about a general cognitive enhancement effect, in the sense that all learning is more likely or more effective in the presence of eye gaze, or whether it is simply helping children understand their interlocutor's referent; in which case it will be specific to tasks that require the child to identify the link between the speakers' actions/words and referent objects (e.g. object learning, word-referent mapping). To gain a better understanding of the role of eye gaze in infants' language learning, we conducted a broad systematic review of the developmental literature for all studies that investigate the role of eye gaze in infants' cognitive development. We screened four databases with the key terms "eye contact OR gaze following" and "attention OR learning", and identified peer-reviewed articles published between 1900-2019 that displayed data from typically developing human infants between 0-24 months of age in the domain of cognitive development. By systematically reviewing the 83 relevant studies, we identified four widely studied themes: (1) object learning, (2) word-object mapping, (3) vocabulary development, and (4) whether the role of eye gaze is special. Overall, there is strong evidence that infants learn more about objects, and are more likely to form word-object mappings in the presence of eye gaze cues, and there is good evidence for longitudinal relationships between infants' gaze following abilities and later receptive and expressive vocabulary. However, whether eye gaze is a highly specialised socio-cognitive cue, different from other low-level attentional cues,



cannot be determined as the evidence is mixed. In summary, there is robust evidence that infants learn better in the presence of eye gaze cues, but the origin of this effect is still not clear. In the language domain, further work on other aspects of language development, such as speech processing and phonetic learning, is needed to decide whether the mechanisms behind these observed effects are specific to certain tasks such as word-object mapping, or whether they reflect a general learning enhancement mechanism.

P4-G-121: The effect of visual uncertainty on information selection in 7-8-month-old infants

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Curiosity plays a role in creating motivation for learning (Engel, 2015; Kang et al., 2009). The information-gap theory (Loewenstein, 1994) suggests that the arousal of curiosity is linked to a knowledge gap between an agent's prior knowledge and the uncertain amount of knowledge that is needed for understanding. Previous studies showed that facing uncertain information induces subjective curiosity (Niki, 1970; Berlyne, 1966). The closing of the knowledge gap is rewarding, which motivates further explorations for knowledge gain (Gruber, Gelman & Ranganath, 2014; Jepma et al., 2012). The purpose of this study was to explore in 7-8-month-old infants whether the curiosity induced by uncertain information is specific to the resolution of the uncertain information itself. In a first study, a blurred image of a novel toy was first presented. Then, its corresponding clear image paired with a new, clear image of a novel toy was displayed side by side. Infants' looking time and eye gaze were recorded by a Tobii remote eye tracker. In a second study we investigated if the states of curiosity induced by an information gap affect infants' exploration and learning more broadly. There were two conditions: in a Curiosity Induction (CI) condition, blurred images followed by their corresponding clear images were used to induce and resolve infants' curiosity. For the Non-Curiosity Induction (Non-CI) condition, a clear image was shown twice. Incidental information (an image of a novel object) was presented in the gap between the first and second image. We were interested if incidental information presented in a state of curiosity (after a blurred image) would be processed differently than incidental information presented in a non-curious state (after a clear image). Processing of the incidental information was tested immediately afterwards using a looking preference paradigm by showing both incidental objects side-by-side. Results showed that in the first study, infants had no looking preference to the clear corresponding images, $t(34) = 0.77$, $p = 0.45$, suggesting that they had no preference for resolving the uncertainty induced by watching the blurred image. In the second study, there was no preference for looking at either image, $t(31) = -1.20$, $p = 0.24$, finding no evidence that incidental information encountered in a state of curiosity is processed differently from information encountered in a non-curious state.

P4-G-122: Combined representation of causal relations in infancy

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Human adults can combine concepts, allowing them to build a potentially infinite conceptual repertoire. Human language is also combinatorial, raising debates about the link between the conceptual repertoire and language. To investigate this link, we ask whether pre-verbal infants are already equipped with combinatorial mechanisms. So far only one study has directly investigated this issue, yielding negative results in 9-month-olds (Piantadosi, Palmeri, Aslin, 2018). Here, we investigated whether infants can combine mental representations that are readily available to young infants, relying on intuitive physics and causal relations. In Experiment 1, we show that pupillometry can be used to investigate 8-month-old infants' causal representations. Infants watched video clips of partially occluded Michottian causal launching events involving a causal agent and a patient (Figure 1.a). In interleaved infrequent test trials, two types of unoccluded events were shown: contact events (Figure 1.b), where the agent contacted the patient; and gap events (Figure 1.c), where a spatio-temporal discontinuity was introduced between the agent's and the patient's movements. Pupil dilation in response to gap relative to contact events (Figure 1.d) is taken to reflect infants' mental representation of the causal relation between the agent and patient. Such dilation is absent (Figure 1.e), when infants only watched the test trials, suggesting that no baseline pupil dilation difference exist for the mere visual differences of the events. In Experiment 2, we asked whether infants can represent and combine two different causal events occurring consecutively: a launching event and a state-change event. Previous studies indicate that 8-month-olds understand launching events even when they involve two inanimate objects, but they understand state-change events (such as color change), only when they are performed by intentional agents (e.g., a hand; Muentener and Carey, 2010). These findings suggest that infants attribute a wider causal power to intentional agents than to inanimate objects. Relying on these findings, we designed a chain of causal events, requiring infants to combine both events in order to understand the final causal effect. Infant watched video clips illustrating an intentional agent moving toward a ball, launching its movement (launching event). The ball then went behind an occluder and a partially visible box changed color and emitted sounds (Figure 2.a). In interleaved test trials, two possible scenarios were shown unoccluded: 1. The box changed color upon being contacted by the ball (contact event, Figure 2.b). 2. The box changed color after a short delay when the ball stopped before reaching the box (gap event, Figure 2.c). We hypothesized that infants could understand the box' change of color as causal, only if they combine the launching and color change events, so that the causal power of the agent is transferred to the ball, enabling it to act on the box and change its state. Pupil dilation for gap relative to contact events provides the first evidence in support of this hypothesis (Figure 2.d). In a follow-up study, we go further to test the hypothesis that by replacing the intentional agent with an inanimate object (a ball), infants would not represent the causal relation between the second ball and the box.

P4-G-123: Development of a bilingual advantage for executive functions: Replication across four years of undergraduate research projects

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Bilinguals outperform monolinguals on a range of executive function tasks across the lifespan. However, the replicability, and even the existence, of this bilingual advantage has been called



into question. Moreover, the mechanisms underlying the bilingual advantage are poorly understood and unlikely to be the same across development. The current study used a novel methodological approach to investigate the effect of exposure to two languages from birth on three aspects of executive function reportedly involved in the bilingual advantage: working memory, reduced distractibility, and cognitive flexibility. Executive function abilities in very young children can be examined using the deferred imitation paradigm. Here, monolingual and bilingual infants and toddlers were asked to imitate an ordered series of actions with familiar toys for three conditions associated with different aspects of executive functioning: 1) Working memory was evaluated by measuring the number of actions imitated and the number of pairs of actions performed in the correct order, relative to a baseline control condition. It was hypothesised that bilinguals would imitate more actions, and pairs of actions in the correct order, compared to same-age monolinguals. 2) Distractibility. Inhibiting one language while using the other is thought to lead to a bilingual advantage in inhibiting attention to irrelevant information, thus making bilinguals less distractible. It was hypothesised that the presence of a distractor toy would impair performance for monolingual but not bilinguals. 3) Cognitive flexibility. Exposure to two languages is thought to enhance cognitive flexibility in bilinguals. Cognitive flexibility was measured by introducing a non-canonical action (e.g. giving the train a drink) within the sequence. It was hypothesised that bilinguals would perform more of the non-canonical actions than monolinguals. Developmental differences were examined by comparing performance from infants (14-36 months) with toddlers (3-4 years). Replicability was addressed by comparing the results across four years of undergraduate research projects (currently n=80; year four data collection in progress). Demonstrating consistency across findings in spite of variability in stimuli and experimenters would provide evidence for robust effects. The results in all three years of data collection found that when a distractor stimulus was present, bilingual toddlers, but not infants, imitated significantly more actions, and more pairs of actions in the correct order, relative to monolinguals (Figure 1). No other experimental manipulations elicited a significant difference between monolinguals and bilinguals for either age group. Relative language exposure, socio-economic status, and percentile rankings for vocabulary size were also recorded but yielded no significant correlations with the two dependent measures in the larger sample. In conclusion, preliminary results revealed a bilingual advantage for reduced distractibility after 36-months. No bilingual advantage was observed in the group of infants. One possible interpretation is that long term exposure to two languages is needed to lead to enhance executive functions related to working memory. The results suggest that development of the bilingual advantage might stem from reduced distractibility and increased inhibition. The study has implications for methodological solutions to the replicability crisis in the field.

P4-G-124: The ontogeny of expectations about speakers' informativeness

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By preschool age, children interpret what is communicated to them relying on the assumption that speakers are appropriately informative (Frank & Goodman, 2014). Here, we investigate the nature and early development of this expectation. We tested preschoolers (n = 73, 3- to 5 year-olds) and toddlers (n = 40, 18-month-olds) in a word learning paradigm. After a familiarization phase, a speaker produced a novel label while pointing ambiguously towards a



set of unfamiliar objects: one unique exemplar of a first type of object and many identical exemplars of another type of object. Thus, participants could infer that the speaker was referring to the unique exemplar by assuming that she was informative enough to allow her audience to identify what she referred to. The results reveal that expectations about speakers' informativeness develop during the first years of life. Whereas preschoolers assumed that the novel label referred to the unique exemplar (thereby demonstrating that they expected the speaker to be informative), toddlers assumed that the novel label referred to the type present in multiple exemplars (a strategy that is consistent with simple associative or statistical learning strategies). In an additional condition, we also demonstrate that toddlers rely on the distribution of potential referents from the speaker's viewpoint, rather than from their own egocentric viewpoint. Altogether, the results suggest that expectations about speakers' informativeness change greatly during early childhood, and are based on social, not perceptual, salience from the outset.

H-Social Development

P4-H-125: Individual differences in prosocial behavior in 12-month old infants

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Infants have been found to use prosocial helping behaviors (i.e., helping an experimenter achieve a goal) as early as 14 months of age (Warneken & Tomasello, 2007). Yet, as most studies of children's helping examine children 18-months and older, very little is known about helping behaviors that may emerge even earlier in infancy. Moreover, although experiences of adversity have been associated with a lack of concern for others in childhood (Mills-Koonce et. al, 2016), few studies have examined associations between adversity and prosocial helping behaviors in early childhood. The purpose of this study was to examine early forms of helping behaviors in 12-month-old infants, and potential associations with early adversity. Infants (N= 48; Mage= 12mos 7days) completed two tasks designed to elicit helping behaviors. In one an experimenter demonstrated placing balls in a container; in the other she demonstrated stacking blocks. Following the demonstration, additional objects were placed (balls) or dropped (blocks) in front of the infant and out of reach of the experimenter. Infants then had the opportunity to 1) help the experimenter directly achieve her goal by placing the objects in the container or on the stack (Goal Helping) or 2) help via social means by placing the objects in the experimenter's hand (Social Helping). For each of three trials per task, infant behaviors were scored independently for goal and social helping on a scale from 0-2 (0 = no helping; 1 = partial helping; 2 = successful helping). Parents completed the STRAIN interview to assess the severity of adverse life events experienced by the family. Across both tasks, all but one infant exhibited one or more helping behaviors: 57.8% exhibited goal helping, and 72.3% exhibited social helping. Moreover, 35.7% of infants exhibited social helping on both tasks. Individual differences also emerged such that infants' overall goal helping scores were positively correlated across both tasks, $r = .550$, $p < .001$. Similarly, overall social helping scores were also positively correlated across tasks, $r = .40$ $p = .009$. Interestingly, goal helping was not significantly associated with social helping. These findings indicate that infants who helped in a particular manner on one task tended to help in that same manner on the other task.



Furthermore, compared to infants from families who did not experience severe adversity, those who experienced severe adversity engaged in significantly less social helping on the balls task, $F(1, 20) = 4.39, p = .02$. This finding controlled for infant's sex, age, and score on the Bayley cognitive assessment (i.e., proxy for IQ). Overall, these results demonstrate impressive rates of prosocial helping in infants younger than those typically studied, and raise the intriguing possibility that individual differences in prosocial behaviors are present by 12-months of age. The findings also provide preliminary evidence that adversity might impact emerging prosocial behaviors, and that this might be specific to more social forms of helping.

P4-H-126: I Spy caregivers and babies with books: Examining the quantity and quality of early book-reading interactions

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Children's language and literacy development benefits when adults engage with them in cognitively stimulating activities such as shared book-reading (Baker et al., 2015; Mol & Bus, 2011). Although a high frequency of shared book-reading is valuable, the interaction style is perhaps even more important (Reese et al., 2003). For children aged 26-61 months, book-reading periods yield higher adult word counts and conversational turns than non-reading periods (Gilkerson et al., 2017), with some evidence that boys receive greater adult word counts during reading than girls. However, potential gender differences in book choices may also have played a role in these word count differences. The vast majority of studies on shared book-reading have focused on young children, although many families begin reading together in the infancy period (DeBaryshe, 1993; Senechal et al., 1998). Recent evidence suggests that parental reports of shared reading at 8-months, but not 4-months, is associated with expressive language abilities at 12- and 16-months (Fulkerson et al., 2017). Given the links between book reading and positive educational outcomes, there is a need to better understand what caregivers say and do when engaging with infants in shared book-reading. In this cross-sectional study, dyads of mothers and their infants aged 6- (n = 13), 9- (n = 10), and 12-months old (n = 13) were asked to engage with a board book (I Spy Little Letters by Jean Marzollo) "as they would at home" for 5 minutes during a lab visit. Approximately half the infants were female. Infants were fitted with a Language Environmental Analysis (LENA) audio recording device and sessions were video-recorded. Mothers also completed a questionnaire on home reading frequency and duration. Within this sample of mostly middle socio-economic status families, book reading was a common activity. The majority of mothers (88.6%) reported it was most appropriate to begin reading to infants aged 0-6 months on a regular basis, while the remaining mothers reported age 6-12 months old as most appropriate. Most mothers (65.7 %) reported reading to their infant daily, with 85.7% of the sample reporting that a typical home shared reading session lasted 1-10 mins. During the book-reading session, mean adult word count was 426.54 words (SD = 160.06), considerably more than the 230 words contained in the book itself. However, there were no significant differences in adult word count as a function of infant age (M = 407.79 at 6 months, M=437.00 at 9 months, M= 435.80 at 12 months) or gender (M= 410.66 female, M = 447.71 male). Mean infant vocalisation count was 22.6 (SD = 15.8), with no significant differences as a function of infant age (M= 19.83 at 6 months, M=28.8 at 9 months, M= 20.38 at 12 months) or gender (M= 22.90 female, M = 22.20 male). Finally, there were no significant differences in conversational turns as a function of infant age (M=



9.92 at 6 months, M=13.40 at 9 months, M= 10.15 at 12 months) or gender (M= 11.25 female, M = 10.67 male). Video records are currently being analysed to further examine interaction quality. In summary, when provided with the same book to share, the quantity and quality of adult and infant verbalisations during reading appears consistent across the first year of life. Further research is needed to better understand the book choices caregivers make with their infants, and the impact this has on early language interactions.

P4-H-127: Mothers' utterances during toy play in English and Spanish contain recognizable prosody: Evidence for acoustic packaging

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In parent-child interactions, modifications of action enhance the understanding and learning of pre-verbal children (Brand, Baldwin, & Ashburn 2002; Williamson & Brand, 2013). Infant-directed action of this kind is usually accompanied by prosodic changes to language, such as: tone of voice, speed of speech, and melody (Fernald & Kuhl, 1987; Fernald, Taeschner, et al., 1989). In fact, research suggests that the timing of mothers' speech and action together may also provide support to infants' learning. This coordination of speech and action in infant-directed interactions has been called acoustic packaging (Brand & Tapscott, 2007; Shillingman, Wrede & Rohlfing, 2009). Meyer, Hard, Brand, McGarvey, & Baldwin (2011) found that during lab-based object demonstrations to their infants, mothers' utterances fell in to four main types: attention-getting, goal setting, action description, and celebration/completion, and among these, action descriptions were the most tightly linked to mothers' movements. Acoustic packaging therefore seems well-suited to assisting babies in learning about mothers' actions. This would be particularly true if these utterances in action-demonstration contexts had recognizable "messages" based on prosody, as has been found in the emotional realm (Fernald, 1989). Meyer et al. (2011) found that adults were able to differentiate and correctly identify mothers' lab-based utterances based on prosody alone. Steck and Brand (unpublished) replicated that effect with a larger sample of raters and more utterance tokens. For acoustic packaging to play the hypothesized role in infants' learning, it would have to appear in natural home environments (not just constrained in-lab demonstrations), and it would likely function similarly in languages other than English. In the current study, we attempt to replicate and extend previous work using home-based interactions in both English- and Spanish-speaking samples. We ask whether adults can identify these action-related utterance types based on prosody alone. Utterance types from English-speaking and Spanish-speaking mother-infant pairs were low-pass-filtered, obfuscating word meaning but retaining prosody. Ten English-speaking students, seven of whom are proficient in Spanish, rated 24 filtered utterances (3 of each type in each language). As predicted, raters familiar with the language reliably detected utterance types in both English (M = 53%), $t(9) = 5.70$, $p < 0.001$, and Spanish (M = 48%), $t(6) = 2.34$, $p = 0.05$. Despite our small sample (data collection ongoing), accuracy rates are similar to the prior study which raters judged lab-based English utterances. Raters accurately identified action description utterances in English, $t(9) = 2.44$, $p = 0.04$, and celebration/completion utterances in both languages, $t_s > 4.0$, $p_s < 0.01$. See Figure 1. Preliminary data ($n = 3$) examines whether raters unfamiliar with Spanish can detect utterance types in that language. If so, it would suggest that prosodic patterns in English are seen cross-



linguistically. To our knowledge, these data represent the first examination of acoustic packaging in infant-directed demonstrations across two languages.

P4-H-128: Measuring the developmental trajectory of relational reasoning from 1 to 7 years old

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Relational reasoning requires the reasoner to go beyond their specific experience, abstracting from items to make inferences about categories and kinds on the basis of structural or analogical similarities. One of the earliest emerging forms of abstract thought is the ability to distinguish the relations same and different, apparent in 3-month-old infants (Anderson, Chang, Hespos, & Gentner, 2018). At the same time, decades of research document difficulties with relational reasoning well into middle childhood (e.g., Gentner & Toupin, 1986), including a decline in same-different reasoning occurring around 3 years old (Walker, Bridgers, & Gopnik, 2016). One complication for understanding the early development of relational reasoning is the proliferation of experimental paradigms that are narrowly calibrated to target specific ages and abilities, and a corresponding lack of research documenting broad developmental trajectories within a single task. Here, we present a tablet paradigm for assessing relational reasoning, based on the causal Relational Match-to-Sample (cRMTS) task (Walker et al., 2016). We measured same-different reasoning in this task across a large cross-sectional sample from 18 months to 7 years ($n = 115$; data collection ongoing). In the task, participants see pairs of blocks placed on a box, which either activates and plays music, or does not, based on the relation of the blocks. In the same condition, only pairs of matching blocks activate the toy, while the converse is true in the different condition. After four training trials with two active and two inactive pairs interspersed, participants are asked to help the animated characters choose pairs of blocks that will activate the toy across four test trials. We assess performance in the same and different condition in two within-subjects blocks, with a short coloring task between blocks. Our preliminary findings in the different condition reproduce previous work by Walker et al. (2016), documenting early success on this task in infants between 18 and 30 months old ($t(20) = 2.26, p = .035$), followed by a decline to chance performance in preschoolers between 36 and 48 months ($t(20) = -0.46, p = .651$). However, in the same condition, performance does not differ from chance for either of these groups (18-30m: $t(20) = -0.37, p = .715$; 36-48m: $t(20) = -1.24, p = .229$), contrasting with previous work showing success in the youngest group. We also find a gradual recovery of performance between 4 and 7 years old (48-84m same: $t(51) = 2.86, p = .006$; 48-84m different: $t(51) = 2.86, p = .006$), providing the first empirical documentation of the upswing in accuracy proposed in Walker et al.'s account of a U-shaped curve for performance in this task. These findings establish a flexible paradigm for the measurement of relational reasoning across a wide range of ages, and document the developmental trajectory of same-different reasoning in one context (the U.S.), providing a foundation for future work examining the early development of abstract thought in other cultural and linguistic contexts.

P4-H-129: Mind the gap: Further explorations into mental rotation in human infants



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Mental rotation (MR) involves the cognitive process of rotating objects in the mind and predicting how they will look in their new orientation. Since the earliest explorations of MR (Shepard & Metzler, 1971), numerous researchers have investigated the mechanisms underlying this spatial cognitive ability. It is widely accepted that on average, men outperform women on MR tasks (Voyer, Voyer, & Bryden, 1995), and boys between 7-11 years typically outperform girls on MR-related tasks (Linn & Petersen, 1985). At what age do MR skills and sex differences in MR performance begin to emerge? To address this question, researchers have explored the developmental origins of MR competence in 3- to 6-month-old infants (Christodoulou, Johnson, Moore, & Moore, 2016; Constantinescu, Moore, Johnson, & Hines, 2017; Moore & Johnson, 2011). Several of these studies found that 5-month-old male infants, but not female infants, seem to recognize the previously unseen "back side" of an object--an ability that presumably requires MR (Moore & Johnson, 2008; cf. Quinn & Liben, 2008). These results suggested that a sex difference in MR may emerge in humans as young as 5 months old. Recently, infant researchers have begun exploring MR through increasingly larger angles of rotation (Shepard & Metzler, 1971). For example, crawling 9-month-old infants seem to find it easier to execute MR tasks when the angle of rotation, through which MR is performed, is small rather than large (Gerhard & Schwarzer, 2018). The current study seeks to extend this research with 24 female and 24 male 5-month-old infants. In this study, infants were habituated to a video of a modified Shepard-Metzler object rotating through a 210-degree arc. These infants subsequently saw two test videos simultaneously, presented side-by-side. Both of these videos showed a test object rotating through a previously unseen 90-degree arc, but whereas one video showed the "back side" of the habituation object, the other video showed the "back side" of a mirror-image object (see Figure 1). These stimuli left a 30-degree gap between the final frame of the habituation video and the initial frames of the test videos. Thus, infants would only be able to recognize the back of the habituation object if they were able to mentally rotate their representation of the habituation object through [the missing] 30 degrees of arc. Data collection is ongoing. Preliminary analysis revealed a significant interaction between sex and test stimulus (the mirror-image object versus the habituation object) in the first test trial following habituation, $F(1, 44) = 4.44$, $p = .041$, $\eta^2_p = .09$. Additionally, post-hoc analyses revealed a trend in which male infants preferred to fixate on the novel, mirror-image object in the first test trial, $t(21) = -1.94$, $p = .066$. Further, males' preference for the novel test stimulus was significantly greater than females' novelty preference, $t(44) = 2.14$, $p = .038$. These preliminary results may provide the first evidence of a sex difference in 5-month-old infants on an MR task involving a 30-degree rotational gap.

P4-H-130: Early developmental trajectories and loss of skills in infants at elevated likelihood for autism spectrum disorder: A prospective study

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Introduction. The concept of regression, characterized by a loss of previously established skills in the second year of life, remains a puzzling phenomenon in the early development of autism spectrum disorder (ASD). Prospective studies, in which infants at elevated likelihood (EL) for ASD are followed from very early onwards, may be more suitable to study developmental trajectories than retrospective methods. In these prospective studies, typical early development between 2 to 6 months has been reported, followed by a decline in social-communicative skills up to 36 months and onset of ASD symptoms around the first birthday (Ozonoff & Iosif, 2019; Pearson et al., 2018). Since these studies suggest that declining trajectories could be the norm in ASD development rather than an exceptional subtype, additional research on onset patterns in ASD is needed.

Hypotheses. The aims of the present study were therefore to examine 1) initial developmental levels at 10 and 14 months in infants with typical development (TD), non-typical development (non-TD) and ASD, 2) if infants with ASD show increasing diverging or atypical trajectories, and 3) levels of declining skills in ASD.

Study population. The sample included 50 infants with an older sibling with ASD (EL-sibs) and 37 infants with an older sibling with typical development (i.e., siblings with a typical likelihood for ASD or TL-sibs). Infants were grouped based on their best-estimate outcome at 36 months: TD (n=52), non-TD (n=22) and ASD (n=13).

Methods. A prospective, longitudinal study design was used in which non-verbal and language development (MSEL) and social-communicative development (Social Affect scale of ADOS-2) of EL-sibs and TL-sibs were measured at 10 (only MSEL), 14, 24 and 36 months. Differences in developmental trajectories were investigated using Multigroup Latent Growth Curve Analysis.

Results: At the age of 10 months, infants with ASD showed significantly lower levels of non-verbal (Mintercept=13.96, $p<.001$) and receptive language development (Mintercept=10.72, $p<.001$) compared to TD (Mintercept=15.29, $p<.001$ and Mintercept=12.39, $p<.001$) and non-TD infants (Mintercept=14.27, $p<.001$ and Mintercept=11.68, $p<.001$). As expected, infants with ASD showed increasing patterns of non-verbal and language development, however, their average growth over time was smaller (Range Mslope=.61-.87, $p<.001$) as compared to non-TD (Range Mslope=.73-.89, $p<.001$) and TD infants (Range Mslope=.85-.96, $p<.001$). With regard to social-communicative skills, slowly declining trajectories were found over groups but infants with ASD showed more difficulties across the ages, starting from 14 months (Mintercept=4.71, $p<.001$) as compared to TD (Mintercept= 1.74, $p<.001$) and non-TD infants (Mintercept=3.09, $p<.001$). Declining raw scores on the non-verbal and language scales of the MSEL between consecutive visits occurred in 30.77% of ASD, 22.73% of non-TD and 11.54% of TD infants. Although infants with ASD showed a higher number of declines, mainly in language domains and present over different visits, differences between groups were not significant ($X^2(2)=3.317, p=.190$). Overall, results show a progressive divergence of ASD trajectories from typical development in multiple domains starting at 10 months and continuing throughout the first 3 years of life (Figure 1). More research is needed on declining trajectories of specific early-appearing social-communicative behaviours.

P4-H-131: Triadic parent-child interactions in siblings at elevated likelihood of autism spectrum disorder in the first two years of life

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Introduction: Taking part in social interactions during the first years of life is the key aspect of infant social environment and is crucial for children long term developmental outcomes in language (Donellan et al., 2019; Romeo et al., 2018) and cognitive domains (Karmiloff-Smith et al., 2010). In the context of emerging autism spectrum disorders (ASD), research into parent-infant interactions might give insight into developmental course of social and communicative skills ahead of clinical diagnosis of ASD. Previous research with younger siblings at elevated likelihood of ASD (Sibs-A) showed differences in parent-infant interactions in the first year of life between them and siblings of typically developing children (Sibs-TD) in terms of mutuality or infants' communicative initiations (Wan et al., 2013, Pijl et al., 2019). Such studies might help in designing early interventions for Sibs-ASD, to create more optimal social environment and redirect developmental trajectories prior to symptom onset (Green et al., 2017; Jones et al., 2017). Research question: (1) Do groups of siblings differ in developmental trajectories of triadic object play and triadic attention between 10, 14 and 24 months? (2) Does the amount of triadic object play in the first year of life predict socio-communicative developmental outcomes at 36 months? Study population: We analyzed a sample of 43 participants who had an older sibling with diagnosis of ASD (Sibs-A, N=28) or typically developing (Sibs-TD, N=15). For analyses the Sibs-A group was divided into 2 groups according to diagnostic outcome at 36 months (infants that were diagnosed with ASD or had an increased ASD symptoms in ADOS-2 (above cut-off point for ASD, SibsA+ = 9) and those who did not get a diagnosis (SibsA- = 19). Methods: We analyzed episodes of parent-infant interactions when infants were 10, 14 and 24 months old. We coded visual attention using coding scheme validated in the previous study (Niedzwiecka et al., 2017). We concentrated on dyadic level behaviors: parallel attention (looking at the same object) and triadic object play (looking and acting on object together). At 36 months we collected socio-communicative outcome measures (Vineland Adaptive Behavior Scale [VABS]: Social and Communication Scales, SRS-2, Mullen Receptive and Expressive Language), symptom severity (ADOS-2) and diagnosis status. Results: 1) At 10 months Sibs with diagnosis or increased ASD symptoms spent less time engaged in triadic object play than SibsA- and Sibs-TD. Also, the slope of change between 10 and 14 months was more positive for SibsA+ than for two other groups. In regard to parallel attention, at 10 months SibsA+ spent less time in parallel attention than Sibs-TD and the slope of change between 10 and 14 months was less negative for them than for Sibs-TD. 2) More time spent in triadic object play at 10 months predicted higher scores in language (MSEL Receptive Language, VABS Communication Scale) and social skills (VABS Social Scale) at 36 months more strongly than individual child visual attention measures at 10 months (looking at parent with object) or amount of triadic object play at 24 months.

P4-H-132: Toddlers, but not apes connect through creating common ground in a shared experience

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Humans connect with one another through a variety of social activities, many of which are centered around creating shared experiences. Adult research shows that even in minimally interactive shared experiences such as watching a video together causes participants to feel closer to each other (Wolf, Launay, & Dunbar, 2015). Yet it remains unknown how fundamentally human this form of social bonding is. Our earlier comparative studies show that



both 2.5 year olds feel closer to an experimenter (i.e. approach quicker) after having watched a video with that experimenter than when the experimenter could not see the video and was reading a book (Wolf & Tomasello, 2020). Surprisingly, we found similar results with great apes, who approached an experimenter faster after the experimenter had watched the same video with them compared to when the screen was turned away from the experimenter who had been reading their own clipboard, and who spent more time in the same part of the room with a conspecific after having watched a video on the same screen as opposed to having watched a video on individual screens (Wolf & Tomasello, 2019). This is surprising, as many have argued that sharing experiences is a uniquely human phenomenon. The question remains, however, how similar human and great ape shared experiences are. Some theorists have argued that, in addition to just experiencing the same thing, a key part of humans sharing experiences is that participants know in common ground that they are experiencing something together. Thus, while visually attending to something together individuals establish common ground by, for example, a mutual look face-to-face, allowing both individuals to infer that they both are aware that they are attending to the same thing - and that the other is aware of this as well (Bakeman & Adamson, 1984). This common ground understanding is crucially important in many uniquely human cooperative activities, facilitating uniquely human forms of coordination in collaboration and shared reference in cooperative communication (Tomasello, 2010). We therefore conducted a study with both 2.5 year olds and great apes in which an experimenter and a participant were watching the same video in both conditions. The participant was sitting behind the experimenter, meaning that in both conditions the participant knew they were watching the same video as the experimenter. Crucially, however, in the shared attention condition the experimenter attempted to create common ground about watching the video together through a communicative look (i.e. allowing the participant to infer that both of them knew they were watching the video together). In the control condition the experimenter looked at the participant at a later time in the procedure but did not look at the participant at any point during the video, so that during the manipulation the participant was merely observing the experimenter watching the video without common ground being established. The results showed that human children, but not great apes approach the experimenter more quickly after the experimenter attempted to create common ground about the experience being shared through a communicative look. This suggests that although both humans and apes create social closeness by experiencing the same thing, only humans create additional closeness through establishing common ground about their experiences being shared.

P4-H-133: Latent profiles of maternal disrupted communication: Relations to infant affect and behavior

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Introduction: Mother-infant interactions in the first year of life set the foundation for the attachment relationship (Ainsworth et al., 1978), as well as many associated social-emotional outcomes (e.g., Sulik et al., 2015). Although prior research has shown both that sensitive maternal behavior during the Still-Face Paradigm (SFP; Tronick et al., 1978) is associated with optimal infant behavior and that disrupted maternal behavior is associated with cortisol



dysregulation in the SFP (Crockett et al, 2013), it remains unclear which maternal disrupted behaviors have greatest impact on infant affect and behavior early in life. Thus, there is a need for differentiated, fine-grained profiles of maternal disrupted behavior in relation to infant outcomes. The current study seeks to identify profiles of maternal disrupted behavior and to assess which profiles of disrupted behavior are associated with which aspects of concurrent infant affect and behavior. Methods: Mother-infant dyads (N=150), ranging in social risk characteristics, participated in the Harvard Mother-Infant Neurobiological Development (MIND) study. At infant age 4 months, dyads completed the SFP. Maternal disrupted behavior was rated using the Atypical Maternal Behavior Instrument for Assessment and Classification (AMBIANCE), which yields five subscales: affective communication errors, disorientation, negative intrusiveness, role confusion, and withdrawal (Lyons-Ruth et al., 1999). The MACY Infant-Parent Coding System (Earls, Musik, & Beeghly, 2009) was used to code infant positive, negative, and withdrawn affect, responsivity, social engagement, and soothability. Using Mplus Version 8 (Muthén & Muthén, 2017), latent profile analysis (LPA) was conducted to derive patterns of disrupted maternal behavior based on the AMBIANCE scales. Using the AUXILIARY DCH function, chi square tests were used to determine whether infant affect and behavior differed across the profiles of maternal behavior. Results: The LPA resulted in a three-profile solution (Figure 1). The first profile was characterized by Optimal Behavior (39% of mothers), the second by Inappropriate/Intrusive Behavior (51% of mothers), and the third by Withdrawing Behavior (10% of mothers). As shown in Table 1, infant negative affect, withdrawal, soothability, responsiveness, and social engagement all differed across the maternal behavior profiles. Specifically, maternal Withdrawing Behavior was differentially associated with lower infant social engagement and greater withdrawn/flat affect, and maternal Inappropriate/Intrusive Behavior was differentially associated with infant negative affect and lower soothability. Discussion: This study used new analytic tools for differentiating patterns of disrupted maternal interaction early in the first year of life and found that particular profiles of maternal disrupted behavior were associated with specific forms of infant behavior during the SFP. These results illustrate the importance of a nuanced and multi-dimensional understanding of profiles of maternal behavior for predicting different maladaptive infant responses. Future work should explore whether these early constellations of mother and infant behavior foreshadow longer-term differences in infant trajectories over time. Finally, these results aid in identifying problem profiles very early in the first year, so that interventions can be thoughtfully tailored to particular aspects of problematic mother-infant interaction.

P4-H-134: 18-month-old infants differentiate between moral and conventional violations

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Norms are integral to all human societies. Following Turiel (1983), many scholars and empirical findings suggest that humans from early in ontogeny categorically differentiate between non-arbitrary moral norms (e.g., against harming others) and more arbitrary conventional norms (e.g., game rules, dress code; e.g., Schmidt, Rakoczy, & Tomasello, 2012; Smetana, 1983; Smetana & Braeges, 1990; Turiel, 1978). The developmental origins of this distinction, however, remain a puzzle. In the present study, we used a novel paradigm using eye-tracking methodology and examining both anticipatory gaze and pupil dilation (as a measure of arousal;



Hepach et al., 2012, 2016) to investigate whether 18-month-old infants differentiate between prototypical moral (harm) and conventional (harmless) violations. We hypothesized that infants would show a larger relative increase in pupil dilation in response to a moral violation than to a conventional violation. Moreover, we expected infants to differentiate between two types of conventional norm situations in their anticipatory looking based on prescribed actions. Seventy-two 18-month-old infants ($M = 18$, $SD = 0.42$, girls = 34) participated in the study. In a between-subjects-design, children watched the same video clip in three different conditions, and we varied the actors' speech acts. In the first two conditions, an instructor explained to an actor to destroy a picture with an upper tool A (conventional violation condition) or with a lower tool B (no violation condition), whereas in the third (moral violation) condition, the instructor forbade the actor to destroy the picture at all. The actor then announced to destroy the picture, grasped the lower tool B, and destroyed the picture, resulting either in no norm violation, a conventional violation, or a moral violation. For both pupil dilation and anticipatory gaze, we found significant main effects of condition (both p 's < .05). Planned comparisons revealed that infants showed a larger relative increase in pupil size in the moral versus the conventional violation condition, Welch's t -test, $t(42) = -2.43, p = .018$ (see Figure 1), and that they showed anticipatory looks more towards tool A versus tool B in the conventional violation condition than in the no violation condition, $t(29) = 2.07, p = .047$ (see Figure 2). These findings suggest that 18-month-old infants differentiate between situations that are considered prototypical moral and conventional violations. Furthermore, higher relative increase in pupil dilation in a moral versus conventional violation suggests that the very same action (tearing apart a picture) leads to more arousal in infants, perhaps because moral violations are more severe and harmful than conventional violations.

P4-H-135: Maternal sensitivity and risk factors in rural Andean Peru

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Sensitive responsiveness of caregivers is one of the most widely studied aspects of parent-infant relations in the literature on early childhood development, as it has been related to a variety of positive aspects of child development. Although there is evidence that sensitivity can be observed in many different cultures, rural non-Western populations are underrepresented in observational studies of sensitivity. This research aims to describe sensitivity of mothers living in rural Andean Peru, and its association with risks variables. A total of 69 mother-child dyads participated. The average age of mothers was 28.43 years ($SD = 7.06$), and children's mean age was 16.22 months ($SD = 7.78$). The majority (88%) of dyads belong to the lowest SES levels (1 and 2, out of 8). Maternal sensitivity was assessed during a one-hour free interaction, using the Maternal Behavior Q-Sort 3.1 (MBQS, Pederson et al., 1999). MBQS scores range from -1 to 1, reflecting the degree of similarity with the ideal criterion sort of the sensitive mother. In addition, a composite risk variable was calculated based on the presence of low SES, higher number of children and daily life worries; and on the absence of additional caregivers and social support. Global maternal sensitivity levels were on average .46 ($SD = .36$, $Min = -.39$, $Max = .93$); while the mean for Sensitivity vs. Insensitivity, Disengaged, and Nonsynchronous profiles were .58, -.30, and -.40, respectively. Studies conducted in urban Peru found similar (.54) or lower average scores (.30) in the interaction with infants and



preschoolers (Nóblega, 2012; Nóblega et al., 2016). Additionally, mothers with high scores on the composite risk variable showed lower global sensitivity ($r = -.28$, $p < .05$). Reviewing risk factors separately showed that the presence of more additional caregivers was related to higher maternal sensitivity ($r = -.35$, $p < .01$).

P4-H-136: 13-month-old infants seek out third-party social interactions

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In the second half of the first year of life, typically developing infants orient to third-party interactions (Augusti, Melinder, & Gredebäck, 2010; Beier & Spelke, 2012; Galazka, Roché, Nyström, & Falck-Ytter, 2014). In the current study, we aimed to investigate whether this attentional bias goes beyond a preferential orienting in the here and now, in other words, whether infants seek opportunities to observe such social interactions. We presented 13- to 14.5-month-old infants ($N = 32$; 16 females; $M = 416.8$ days, $SD = 15.4$ days) with an associative visual learning task to examine whether they selectively learn cue-target associations guiding them to videos showing third-party interactions. During 24 trials, two geometrical shapes (circle or triangle) were presented in the center of a screen, repeatedly paired with two kinds of target videos appearing left or right of the cue: One video showed two adults turning toward one another and engaging in a social interaction (social interaction condition), whereas the other video showed the same agents performing the identical movements as in the social interaction video while standing back-to-back (non-interactive control condition). To assess infants' learning performance, we measured their saccadic latencies and anticipatory gaze shifts to the cued target region across trials. We hypothesized that if social interaction targets increase infants' learning performance in the visual learning task, they should perform faster saccadic latencies from the central cue to the corresponding target region over trials. To compare the change in saccadic latency to the cued target region between conditions, we conducted a general linear mixed model (GLMM) for saccadic latency, including the interaction between trial (24 trials) and condition (social interaction, non-interactive control) as fixed effect. We found that infants' saccadic latencies were faster during social interaction trials ($M = 1107.35$ ms, $SD = 331.68$) compared to non-interactive control trials ($M = 1284.79$ ms, $SD = 198.04$, $\chi^2(1) = 9.57$, $p = .002$, estimate = -172.57 , $SE = 52.48$). An additional GLMM for predictive and reactive gaze shifts (binomial error structure) revealed that infants performed more predictive gaze shifts in the social interaction condition (mean proportion = $.45$, $SD = .35$) compared to control trials (mean proportion = $.17$, $SD = .20$; $\chi^2(1) = 8.78$, $p = .003$, estimate = 1.90 , $SE = .62$). Our findings suggest that 13-month-old infants are skilled at recognizing and seeking others' interactions, indicating that they find it intrinsically valuable to observe such interactions (Tamir & Hughes, 2018). We will discuss this pattern as an adaptive mechanism in early child development to maximize the learning benefit from observing third-party interactions (Paradise & Rogoff, 2009; Tomasello, 2016).

P4-H-137: How to be amused together? The dynamics of toddler-parent humor expression

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Previous research investigated the toddlers' initiation of humorous events (Hoicka & Akhtar, 2011) and showed that toddlers by age of two years produce humorous acts. Toddler's smiling and laughing responses in this kind of setting might not only point to the expression of humor production and appreciation, but they might also reveal social processes such as mimicry of caregivers's actions or social smiles without humor appreciation. The current study aimed at distinguishing between positive emotional responses in playful encounters (amusement responses) and other social reactions to the context/person by coding the non-verbal spontaneously expressed smiles and laughs with the Facial Action Coding System (FACS; Ekman, Friesen, & Hager, 2002). As recent studies suggest that parental mood influences the humor production ability of young children (Mireault et al., 2015), we further expect that parental cheerfulness predicts shared amusement and humor production. Eighty 2.5-year-old toddlers played together with their main caregiver in a room with eight different toys. In the parent phase the task of the parent was to make the child laugh, in the child phase the task of the child was to show their parents how funny they can be. Both phases lasted for eight minutes. We coded smiles and laughter (social and Duchenne Displays) for both, parent and toddler, using the Facial Action Coding System. From this coded data we created a framewise times series of Duchenne smiles and laughter and analyzed them using Cross Recurrence Quantification Analysis. The main caregiver filled in the State-Trait-Cheerfulness-Inventory standard trait short form for themselves and peer-report form for their children (Ruch et al., 1996). In the first analysis, we compared the real timeseries to a randomized version of the timeseries to investigate whether synchronization in amusement was evident between dyads. The amount of shared amusement (recurrence rate) was higher in the real time series compared to the randomized baseline, $est = -0.022$, $SE < 0.001$, $p < .001$, Figure 1. This result shows that dyads shared instances of humor. In the second analysis, we investigated the lag of emotional contagion between the initiator's amusement action and the follower's amusement appreciation and predicted it by parental and child cheerfulness, phase (parent, child), initiator and length of parental social smiles. Results of the mixed linear regression revealed that parental cheerfulness and length of social smiles predicted the lag, Table 1. Higher levels of trait cheerfulness were associated with earlier contagion whereas a longer duration of parental social smiles was associated with later contagion. We found no difference between phases and no role of child cheerfulness or initiator. These results show that the lag of emotional contagion between the initiator and follower is critically modulated by parental cheerfulness but also conversational reactions such as social smiles. Taken together, the findings contribute to amusement as a central emotion in learning and social relationships, showing that 2-year-old toddlers show amusement synchronization with their parents. They further provide data to disentangle the roles of positive emotions and social reactions.

P4-H-138: The development of joint attention and communication from 6 to 10 months of age

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Joint attention is widely agreed to be a key skill in infants' social development. However, there is still a lack of consensus over what exactly joint attention is, and when it emerges in development (Siposova & Carpenter, 2019). Several researchers have argued that joint attention first emerges at around 9 months, with some suggesting that this is a sudden developmental transition (Stern, 1985; Tomasello, 1995; Trevarthen & Hubley, 1979). However, these views have been challenged, with other researchers questioning the view of a sudden and discrete cognitive change (de Barbaro et al., 2013; Reddy, 2003), as well as challenging previous claims about the age of emergence of joint attention (Rossmanith et al., 2014; Striano & Bertin, 2005). Our aim was to elucidate the nature of the changes occurring at this important but controversial developmental period. Twenty-six infants participated in a longitudinal study from 6 to 10 months of age. This involved five monthly lab visits. In the lab sessions, mother-infant dyads took part in a free-play period, before an experimenter ran a battery of short behavioural tasks that tested a variety of social and non-social skills. Social tasks focussed primarily on skills related to joint attention (e.g. gaze following, social referencing) and communication (e.g. request elicitation, show elicitation). Non-social tasks focussed on skills such as means-end understanding and object permanence, which have also previously been suggested to undergo important changes during this period (Bates et al., 1976). These were followed by a version of the "Decorated Room" task (Liszkowski & Tomasello, 2011), which examined how mother-infant dyads communicated about objects while the mother carried the infant. The sessions concluded with a maternal interview, with questions related to infants' social and physical developments. The same questions were also discussed through phone interviews that took place halfway between each monthly session. During test sessions, mothers also completed the Infant Behavior Questionnaire (Putnam et al., 2014) at 6 and 10 months, and the UK Communicative Development Inventories questionnaire (Alcock et al., forthcoming) at 8 months. The last 3 infants are still completing their final visits, but preliminary analyses from the behavioural tasks indicate consistent emergence of triadic skills (e.g. joint attention, triadic imitation, giving) at around 8 to 10 months, though with evidence of some earlier understanding (e.g. attempts to imitate, give, and show) found at younger ages. Similarly, we found that mothers reported joint attention and communicative gestures from around 6 months, though not consistently until around 9 months. The data suggest that some understanding of joint attention and related triadic skills can be identified prior to 9 months, but that these skills are only employed consistently after this time. Further analyses will explore the idea that the developmental transitions seen at around 9 months involve a newfound understanding of communication (Carpenter & Liebal, 2011), rather than a developmentally unprecedented understanding of triadic relations. By using a longitudinal design, a wide variety of tasks and a mixed-methods approach, we contribute new insights into this highly complex developmental period.

P4-H-139: Factors associated with separation-induced infant cortisol reactivity in a large sample study

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Infant cortisol levels have associations with their development, effecting prenatal stress and parent-child attachment. Yet, results from previous studies have been inconsistent; some results suggested that increased cortisol levels are associated with a higher risk for infant development, while others found that decreased cortisol is associated with a higher risk. Although various reasons have been suggested for the inconsistent results, such as different ages of participants, characteristics of the population studied, or differences in methodologies, resolving the questions related to the inconsistency has been difficult because previous infant studies involved a small sample size. Thus, the present study attempted to identify factors that contribute to infant cortisol levels by testing a large enough sample of infants. The study population consisted of 528 10-month old Japanese infants and their mothers who participated in a longitudinal infant study. We used modified "strange situation" procedures, in which the mother was separated from the infant for one minute. Infants' salivary cortisol levels were measured twice, once each pre- and post-separation, using an ELISA kit (Salimetrics, Hamburg, Germany). For each infant, the ratio of cortisol level between pre- and post-separation was calculated (post-separation cortisol/pre-separation cortisol) and converted to a logarithmic scale for further analysis. We also measured the mother's mental and physical status (stress, fatigue score, sleep status, depressive symptoms, and loss of motivation,) and infants' responses to the separation (cry or no-cry), their social, cognitive, and physical development (assessed by mothers using the Japanese version of the M-Chat (Kamio et al., 2008) and Kinder Infant Development Scale (KIDS(A)) (1989), and child care status. Infants' pre-separation cortisol level did not differ significantly based on whether they were tested in the morning or afternoon, or according to gender. It was also not associated with infants' age in days, M-chat score, KIDS(A) score, or child care score. However, infants who did not cry after separation had higher pre-separation cortisol levels than those who cried. Change in cortisol levels differed according to gender: female infants showed a smaller change than male infants. Infants who cried showed greater changes in cortisol levels than those who did not cry. However, no difference was found in terms of the time of day when testing (AM or PM). Although mother's mental and physical conditions (stress, fatigue score, sleep status, depressive symptoms, and loss of motivation) were not related to the infant's pre-separation cortisol levels, they were significantly related to the change in cortisol level in the infants. In other words, the mother's poor mental and physical condition correlated positively with a higher change in infant cortisol level compared with that in infants whose mothers were in good mental and physical condition. Our study found that gender and whether the infant cried or not after separation influenced the change in pre- and post-separation cortisol level, which is consistent with previous studies. In addition, mother's mental and physical condition is associated with changes in infant cortisol levels in response to separation, suggesting that the mother's condition has an effect on infant separation-induced cortisol reactivity.

P4-H-140: Automated measurement of responsive caregiving from video using machine learning

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Responsive caregiving is key to the WHO Nurturing Care Framework which was launched at the World Health Assembly in 2018. Responsive caregiving interventions have demonstrated positive impact on early childhood development in Low and Middle Income Countries (LMICs),



however existing metrics are unsuitable for specifically measuring the quality of the caregiver-child relationship. This poster describes a new objective measure of responsive caregiving by applying existing machine learning techniques to videos of caregiver-infant interactions. Extending work by Leclere et al (2016) we will build a new automatic measure of mother-infant interaction. A machine learning algorithm (OpenPose by Cao et al, 2018) was used to translate digital videos of two-person interactions into labeled and animated wireframes of all body and head positions (see Figure 1). Additionally audio was translated into power spectra. These sets of time series data will be analysed for cross recurrence quantification analysis (CRQA- Coco & Dale, 2014) to give a single synchrony score for each interaction (Figure 2). We validate this tool by comparing its outputs for videos that have already been collected which possess manually coded interaction scores and numerous other covariates and outcome measures. The first dataset consists of 80 videos of mother infant feeding from the Wellcome Trust SPRING cluster RCT which was carried out in collaboration with Sangath in India (<http://spring.lshtm.ac.uk>). The second dataset consists of 500 videos of mother-child interactions collected in rural Lesotho (Tomlinson et al. 2016). Results will be presented showing that a proportion of variance in maternal responsiveness can be explained by the CRQA scores. This demonstrates that our new measure can be a valuable predictor for use in interventions and monitoring in LMICs. All the code for these analyses is open-source and is being packaged, documented and shared to create a prototype tool usable by field researchers.

P4-H-141: Are our samples representative? Exploring the influence of temperament on dropout rate in a longitudinal study at 3 and 7 months

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Infants are precarious research participants. Experiments can be terminated because of excessive crying, falling asleep, or lack of attention, illustrating the unique challenges faced by researchers. Sometimes infant performance can be influenced by state factors, such as amount of sleep prior to testing, but there are also more stable factors to consider, such as infant temperament. If temperament contributes to whether infants complete an experiment or not, it is possible that the samples from which we are gathering data may be unrepresentative. Previous research on infant temperament and experiment dropout is riddled with mixed findings^{1,2,3}. Some studies report no relationship between infant temperament and task completion⁴. Others have found that infants who were rated by parents as high on "distress to limitations (D)" and "approach (A)" scales were less likely to complete tasks,⁵ whereas infants who were rated as high on falling reactivity/rate of recovery (FR)⁵, duration of orienting (DoO)⁷, and cuddliness (C)⁵ were more likely to complete tasks (as measured by the Infant Behavior Questionnaire, IBQ-R⁶). The aim of the current study is to measure whether infant temperament predicts dropout across multiple tasks. The current study is unique in two ways. First, infants were required to complete several tasks in a single lab visit as a part of a larger, longitudinal study. Previous research typically focuses on infant dropout for a single habituation looking task. Second, the longitudinal nature of the sample allows us to explore whether dropout is stable across ages. At 3 months, infants (n = 76) completed three tasks: 1) Event-Related Potential task (ERP), 2) still-face task, 3) interaction play task. At 7 months,



infants (n = 43) completed the same 3 tasks in addition to two eye-tracking tasks. Parents completed the IBQ-R6 at both time points and three researchers independently coded whether infants met pre-specified criteria for completing each task. Infants received a score of '0' if they completed some but not all of the tasks, and a '1' if they completed all of the tasks. We ran a regression analysis at both time points to determine whether five temperament scales (D, A, FR, DoO, C) predicted overall dropout. At 3 months, falling reactivity/rate of recovery was the only significant predictor in the model ($\beta = .67$, $SE = .33$, $p = .042$) and the model was able to predict dropout rate with 70% accuracy, $R^2 = 0.15$, Model $\chi^2(5) = 8.66$, $p = .12$ (Figure 1). At 7 months, none of the predictors were significant and the model was able to predict dropout rate with 58% accuracy, $R^2 = 0.12$, Model $\chi^2(5) = 3.85$, $p = .57$. Dropout rates were not correlated between the two time points (n = 60, $r = .22$, $p = .099$; Figure 2). These preliminary findings suggest that infant temperament does not systematically influence whether infants complete or do not complete a battery of lab tasks. This has positive implications for the representativeness of infant samples in developmental research, suggesting we may not be oversampling infants of a certain temperament. These findings suggest exploring other factors that may have influenced infants' dropout, such as task order, researcher expertise, and more.

P4-H-142: Brain signal entropy during social perception is associated with oxytocin receptor DNA methylation and social behavior in infancy

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Background: Humans display attentional biases for social stimuli that are apparent early in ontogeny and considered foundational for subsequent social and cognitive development. However, the degree to which different individuals show these attentional biases and successfully develop advanced social-cognitive abilities varies, and in extreme cases may be indicative of neurodevelopmental disorders such as autism spectrum disorder. Here, we tested the hypothesis that the oxytocinergic system may contribute to variability in these early attentional biases - potentially increasing the developing infant's experience with social information, facilitating neural specialization, and ultimately setting differential developmental trajectories - by increasing brain signal entropy during social perception. Brain signal entropy - a measure of moment-to-moment variability and complexity in neural signals (Garrett et al., 2013) - increases during development, is positively associated with behavior, and is aberrant in neurodevelopmental disorders like autism. Methods: Sixty 4-month-old infants (31 F) and 95 adults (64 F) aged 17 to 28 underwent EEG while viewing faces and objects and listening to human speech and water sounds. Infants provided a saliva sample and behavior was assessed via eye-tracking and the Revised Infant Behavior Questionnaire (IBQ-R, Gartstein & Rothbart, 2003). Longitudinal investigation of the infants at 8-, 12-, 16-, and 24-months is ongoing. Adults provided a blood sample and behavior was assessed via a social perceptual threshold task and self-report questionnaires. We extracted DNA from all saliva/blood samples and assayed an epigenetic modification to the oxytocin receptor, OXTR DNA methylation (Gregory et al., 2009). We extracted 1000 ms epochs time-locked to stimulus presentation from the EEG recording and computed multiscale entropy - a measure of temporal irregularity. Relationships between the epigenetic-brain-behavior data were modeled using partial least squares path modeling (Esposito et al., 2010). Results: We establish brain signal entropy as a



reliable, predictive, and specific marker of behavioral outcomes. We show brain signal entropy during social perception increases with development (Fig 1), accounts for individual differences in behavior, and is associated with early-life individual differences within the endogenous oxytocinergic system (Fig 2). These results appear to show some domain-specificity and may track with sensory system maturation (Gottlieb, 1971); in infancy, brain signal entropy evoked during social auditory perception specifically predicts infant vocalization behavior at 4 months of age (Fig 2). However, by adulthood, brain signal entropy evoked during social auditory perception specifically predicts adult communication abilities, and brain signal entropy evoked during social visual perception specifically predicts adult visual social perceptual threshold. Discussion: Our results suggest a mechanism by which early-life individual differences in the endogenous oxytocinergic system contribute to variability in brain signal complexity, impacting behavior. These results may have implications for identifying individuals at risk for atypical development before behavioral manifestations of disorder occur and suggest potential biomarkers with probable diagnostic, therapeutic, and prognostic value.

P4-H-143: Higher attention bias to fearful faces at 8 months is related to better social competence at 24 months

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Several studies have established that infants show an attention bias to faces and specifically to fearful faces during the second half of the first year (Leppänen et al., 2018; Libertus et al., 2017; Nakagawa & Sukigara, 2012; Yrttiaho et al., 2014). However, little is known about how individual variance in these attention biases is associated with children's social and emotional development. Results from a previous study suggest that higher levels of attention to faces in infancy is related to prosocial behavior in later childhood (Peltola et al., 2018). In addition, in children, the threat-related attention bias predicts behavioral problems when combined with temperamental risk-factors (Pérez-Edgar et al., 2010, 2011). Our study question was, how infant temperamental reactivity at 6 months and infant attention bias to faces and specifically to fearful faces at 8 months are related to socioemotional competence at 2 years. Methods Participants (n=209, 95 girls) belong to FinnBrain Birth Cohort Study that has been established to investigate effects of early life stress on child development. Infant temperament was measured using parental reports of Infant Behavior Questionnaire Revised (IBQ-R; Gartstein & Rothbart, 2003) at 6 months and socioemotional competence using a subscale of Brief Infant Toddler Social Emotional Assessment (BITSEA; Alakortes et al., 2015; Briggs-Gowan et al., 2004) at the child age of 24 months. Maternal depressive symptoms were measured with Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987) at 2 years postpartum. Attention to emotional faces was studied using eye tracking at the study visit at 8 months. We used overlap paradigm to assess infants' probability to disengage attention from the centrally presented face stimulus (neutral, happy and fearful face, non-face control stimulus) to a later appearing lateral distractor stimulus (Peltola et al., 2008). We used two attention bias variables in our analyses as indexed by the disengagement probabilities (DPs): face bias (a difference between the DPs for the control picture against the DPs for happy and neutral faces) and fear bias (a difference between the DPs for happy against the neutral faces and DPs for fearful



faces). A sequential regression analysis was used to investigate the predictors of social competence. Results The sequential regression analyses for face and fear biases, positive and negative reactivity and social competence are presented in Table 2. Significant covariates, infant sex and maternal depressive symptoms (Table 1) were also included in the model. The observed association between face bias at 8 months and social competence was in the expected direction but the result was not statistically significant ($\beta=.11$, $p=.10$). Higher fear bias at 8 months ($\beta=.18$, $p=.008$) as well as higher positive reactivity at 6 months ($\beta=.19$, $p=.004$) were significant predictors of better social competence at 24 months. Discussion In previous studies, higher attention to faces in infancy has been associated with prosocial behavior in later childhood (Peltola, et al 2018). In our study, higher attention specifically to fearful faces compared to neutral and happy faces in infancy was related to better social competence in toddlerhood after the adjustment for the significant covariates. The implications of these results will be discussed in the poster.

P4-H-144: I like you because you were right: Toddlers prefer accurate over inaccurate labelers

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Young humans are capable of learning independently through trial-and-error. However, the acquisition of certain information requires input from competent adults, and so the ability to selectively learn from knowledgeable others is imperative for successful learning. Indeed, past research shows that toddlers and preschoolers notice inaccuracies in people's speech, and use speakers' past accuracy to guide their subsequent learning of novel words (Clement, Koenig, & Harris, 2004; Koenig, Clement, & Harris, 2004; Koenig & Harris, 2005; Luchkina, Sobel, & Morgan, 2018). While these tendencies emerge as young as 16 months of age (Koenig & Echols, 2003), it remains unclear whether toddlers also use such information to positively/negatively evaluate social agents. Since human infants and toddlers select social partners based on diverse characteristics, including others' tendency to act prosocially (Hamlin, Wynn, & Bloom, 2007), group membership (Kinzler, Dupoux, & Spelke, 2007), and perceived competence (Jara-Ettinger, Tenenbaum, & Schulz, 2015), the present studies investigated whether competence specifically in the form of labeling accuracy is one of the characteristics that influence toddlers' social preferences. In Study 1, 18-month-olds watched videos of two female experimenters accurately or inaccurately labeling common items. Subsequently, each experimenter appeared to drop an identical toy into a box, and toddlers were encouraged to "choose a toy" (adapted from paradigm originally designed to examine the selective approach of fair versus unfair humans; see Lucca, Pospisil, & Sommerville, 2018). Following the choice task, one of the experimenters (either the accurate or inaccurate labeler) proceeded to teach two novel labels to the toddlers. In addition to social choices, toddlers' acquisition of the novel labels from accurate versus inaccurate labelers was assessed via a looking-while-listening task where toddlers were shown pairs of objects followed by audio prompts that referenced one of the objects (adapted from Luchkina et al, 2018). Overall, toddlers in Study 1 did not reliably prefer the accurate labeler (21 out of 34, binomial test, one-tailed $p=.115$), which may have been attenuated by a marginal right-side bias (22 out of 34). For the looking task, a 2 (object type: familiar/novel) by 2 (labeler accuracy: accurate/inaccurate) mixed-ANOVA with proportion looking to correct target as the dependent



variable revealed only a main effect of object type ($F(1, 26) = 12.77, p = .001$), indicating that while toddlers were successful at identifying familiar objects than novel ones, they failed to identify novel objects in both conditions. To verify these results, we made various changes to the lab space to reduce the possible side bias and conducted Study 2, a preregistered conceptual replication of Study 1 with a larger sample (planned $N=64$) and a slightly older age group (19 months). So far, toddlers significantly prefer the accurate labeler (21 out of 29, one-tailed $p=.013$). Collapsed across all data collected to date, toddlers' preference for the accurate labeler appears robust ($p=.005$). Overall, results from these two studies suggest that 18- and 19-month-olds may prefer those who demonstrate linguistic competence. The poster will present findings from the complete sample and results from the looking time measure.

P4-H-145: Sleeping arrangements and mother-infant sleep quality in solo-mother families and in two-parent families

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Co-sleeping (which generally refers to bed-sharing or room-sharing) has been associated with poorer infant and maternal reported sleep problems (e.g., night-wakings) (Volkovich et al., 2015). Yet, most studies have been conducted on two-parent families, with very little attention to non-traditional family structures. In the last decade there is a sharp rise in the number of women who decided to become mothers without the involvement of a partner. These women, often referred to as 'single mothers by choice' (SMC), may have unique characteristics that may affect their parenting (Golombok, 2017) and specifically their nighttime parenting because of the lack of a partner to share nighttime caregiving. Thus, this study examined: (a) the differences in sleeping arrangements (i.e., room sharing versus solitary sleep) between SMC families and two-parent families, and (b) the links between infant-mother sleep quality and sleeping arrangements in both family structures. The present study is part of a larger longitudinal study that started during pregnancy. Data analyzed for this study was collected at 8 months postpartum and included 164 families (86 SMC families and 78 two-parent families). Sleep was assessed with daily sleep logs for 7 nights. Maternal sleep was also assessed with the Insomnia Severity Index (ISI) (Bastien, Vallières & Morin, 2001). Infant sleep and sleeping arrangements (i.e., room sharing versus solitary sleep) were assessed with the Brief Infant Sleep Questionnaire (BISQ) (Sadeh, 2004). Maternal and infant sleep measures were: sleep duration, number of night-wakings, minutes awake at night, and subjective sleep quality. Significant differences were found between the groups in maternal age, sleeping arrangements and in infant and maternal sleep (see Table 1). SMC were significantly older than married mothers ($t(162)=24.15, p<.001$). Room sharing was more prevalent in SMC families (64%) than in two-parent families (42%) ($\chi^2(160)=5.55, p<.05$). Infants in SMC families woke up more ($M=2.95, SD=1.85$) than infants in two-parent families ($M=2.44, SD=1.40$) ($t(162)=1.86, p<.05$). Mothers in SMC families woke up more ($M=3.25, SD=1.22$) than mothers in two-parent families ($M=2.61, SD=1.12$) ($t(162)=2.63, p<.01$). Moreover, mothers in two-parent families reported longer sleep duration ($M=6.34h, SD=.88$) than mothers in SMC families ($M=5.98h, SD=1.07$) ($t(162)=-2.18, p<.05$). Because SMC were significantly older than married mothers, we repeated these analyses while controlling for maternal age. Interestingly, after controlling for mothers' age, no significant differences were found in maternal or infant

sleep quality. When examining the correlations between infant-mother sleep and sleeping arrangements separately for two-parent families and for SMC families, significant correlations were found for SMC families but not for two-parent families. For instance, in SMC families room sharing was associated with more reported infants' number of night-wakings ($\rho = -.22$, $p < .05$) and with lower subjective sleep quality ($\rho = -.35$, $p < .05$). Our findings demonstrate that room-sharing is more common in SMC families, and that sleeping arrangements seem to be differently related to reported infant sleep quality in these families, compared to two-parent families. These findings highlight the importance of studying sleep patterns in SMC families during the postpartum period, as these families may have distinct characteristics and needs.

P4-H-146: Parenting styles, co-parenting and child adjustment in separated families with full vs shared child custody agreements in court

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Co-parenting after divorce has an impact on child adjustment, namely, when parenting gate-keeping and conflict occur. After separation/divorce parents coercive parenting and styles, conflict and triangulation co-parenting types can enhance child's vulnerability. Particularly if the child is under than 3 years of age. With an increase of divorce ratings, child custody arrangements and its impact on young children needs to addressed. We intend to explore the effects of these variables on children of separated parents with current child custody process in family court (litigious and non-litigious). The Portuguese version of Parenting Styles Questionnaire - parent's version; Co-parenting Questionnaire and Strengths & Difficulties Questionnaire where applied to 93 Portuguese parents (49 mothers; 44 fathers) of an infant aged under 3 years of old, separated from 12 to 69 months with custody process in family court to regulate child custody from 12 to 40 months. This purpose sample included 42 parents with shared custody and 51 with full custody agreements. Parents participated willingly and all ethical standards were assured. Findings enhance the predictive power of the model including authority styles (authoritative, authoritarian and permissive) and co-parenting strategies (cooperation, triangulation and conflict) on child adjustment internalized and externalized problems (emotional, behavioral and social dimensions') for both custody agreements. Overall, authoritarian parenting styles and parenting conflict exert major impact on child adjustment. Parents with full custody agreements see their children as presenting more emotional and social problems ($F(3,35) = 22.27$, $p < .001$; $d = 1.11$ and $F(3,44) = 15.21$, $p < .001$; $d = 2.18$). Findings suggest authoritarian parenting styles and parenting conflict as major contributors for poor early child adjustment and well-being, particularly in children living with one parent household in full custody agreement. We emphasize that families had an ongoing custody process in family court, which could contribute to parenting conflict. These findings suggest the need to further study the impact of full and shared child custody agreements on child adjustment and development, in early childhood. Also, we stress the importance of post-divorce parenting educational programs for helping parent's on parenting educational patterns and behaviors, communication skills, emotional regulation, and awareness of what's in the best interest of child well-being and healthy development.



P4-H-147: Effectiveness of a parenting program at early childhood to improve mother-child interaction assessed by observational measure

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Previous studies showed the effectiveness of parenting programs to improve mother-child interactions. However, few studies of parenting programs have been conducted and evaluated in low-and-middle-income countries, especially using observational measures for assessing the outcomes. The "Caring & Growing Together Program" was developed by researchers from the Federal University of Minas Gerais (UFMG - Brazil), in the context of the Grand Challenges Canada - Saving Brains. The longitudinal psychosocial intervention consisted of two individual sessions (0 and 2 months old) of the Newborn Behavioral Observation (Nugent et al., 2007) plus six group sessions (0, 2, 4, 6, 9, and 12 months old, guided by the "Baby's Book", focused in strengthen mother-child interactions and developmental parenting. The quasi-experimental study aims to verify the effect of the intervention on mothers' positive behavior, examining the direct and indirect effects on child behaviors. The sample comprised 67 mothers and their 12 months-old children (60% boys; 75% born preterm), recruited in a public hospital, reference for high-risk deliveries, in a city of Southeast Brazil. Participants were allocated to intervention (IG) or control (CG) groups based on the date of the childbirth (two consecutive blocs of five months), starting with the CG (n=34) and followed by the IG (n=33). The dyads were videotaped at 12 months of child age (post-intervention). A blinded researcher analyzed the videos using the Interactive behavior scale (mothers' intrusiveness and enthusiasm; child enthusiasm, opposition and anger/frustration; Adam et al., 2004) and the Parenting Interactions with Children - Checklist of Observations Linked to Outcomes (PICCOLO; mothers' encouragement scale; Roggman et al., 2013). The scores of each scale were grouped to generate mothers' positive behavior and the child's positive behavior scores. A structural equation model (SEM) was used to test direct and indirect model pathways. We included the group as a predictor, mothers' positive behavior as mediators, and child behavior as outcome. Child behavior was controlled by child sex and prematurity. The pathways were considered statistically significant at $p < 0.10$, due to the sample size, and interpreted according to Kline (2011). Results of the SEM model revealed adequate overall model fit, RMSEA < 0.01 , SRMR= 0.035, CFI = 1.00; $\chi^2/df = 0.61$. Within this model, significant direct pathways were found (Figure 1 and Table 1). The path from the group to mothers' positive behavior was statistically significant, suggesting better behaviors for the IG. The paths from the mothers' positive behavior to children's positive behavior were also significant, showing that children of mothers with more positive behaviors also presented more positive behavior. There was no direct or indirect effect of the intervention on child positive behavior. These findings suggest that the intervention was effective for improving mothers' behavior, such as less intrusiveness, more enthusiasm, and more encouragement skills during dyad interaction. Additionally, the child whose mothers showed more positive behavior presented less opposition and anger/frustration and more enthusiasm. The present study has relevant implications for researchers and practitioners, suggestion that the "Caring & Growing Together Program" is a promising intervention to be implemented in primary health care.



P4-H-148: Changes in co-regulation: Asymmetry in full-term, very low birthweight/preterm, and psycho-socially at-risk infant-mother dyads

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During the first years of life, co-regulated interactions evolve as both mother and infant build new skills and experiences with each other. It is important to investigate the nature of these interactions and how they may differ across families and circumstances to better understand the role of risk in co-regulated interactions. While most research has focused on interactions characterized by mutual responsiveness, or disruptive interactions, less research has focused on asymmetrical interactions, during which both members are engaged, but only one partner contributes to the interactions while the other remains a passive observer. Though limited, previous research has negatively linked asymmetrical co-regulation with cognitive development in infants (Evans & Porter, 2009). However, we have little understanding of how this type of co-regulation develops over the infancy period and how that development may differ across different levels of risk. Mothers and their infants who were born full-term (FT; n = 48), very low birthweight/preterm (VLBW/preterm; n = 62), and into psycho-socially at-risk contexts (PSR; n = 54) participated. Parents in the PSR group came from disadvantaged backgrounds in low socioeconomic neighbourhoods. The objectives were to examine: 1) changes in asymmetrical co-regulation over time, and 2) differences in those changes across groups. Mothers and their infants were visited in their homes when children were 6-, 12-, 18-, and 48-months old. During each visit dyads engaged in a 15-minute free play task. Their co-regulated interactions were then coded using the Revised Relational Coding System (Fogel et al., 2003), which assesses the level of engagement and activity of the dyad. The asymmetrical pattern, which is the focus of this study, entails both members being engaged, but only one member (mostly the infant) contributing to the interaction through actions, vocalizations, movements, and expressions. Multilevel modelling was used to analyze changes in proportions of time spent in asymmetrical co-regulation over time and differences in those changes between groups. Results indicated that the FT and VLBW/PT infant-mother dyads followed similar quadratic trends for time spent in asymmetrical co-regulation over the first years of life, similar to Evans and Porter's (2009) findings, but at a later time (Figure 1). The steep decline in FT and VLBW/PT groups' asymmetrical interactions may be indicative of infants' rapidly developing social and regulatory skills, as they become more adept at contributing to the interaction and/or exploring their environment independently. In contrast, the PSR group followed a significantly cubic trend for time spent in asymmetrical co-regulation and differed from the FT and VLBW/PT groups. Interestingly, at 18-months, an ANOVA showed that the PSR groups spent almost twice the time in asymmetrical co-regulation as the FT and VLBW/PT groups. This difference points to the importance of considering risk status when examining the development of co-regulation. Our results add to the limited body of research on the developmental patterns of co-regulation during infancy (specifically, those patterns involving passive observers, who are usually infants) and how risk is an important consideration when understanding such developmental trends. Importantly, 18-months may be a key developmental point where groups differ, warranting further investigation.

I-Emotional Development

P4-I-149: Does interpersonal behavioral synchrony facilitate toddler's word learning?

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The effect of interpersonal synchrony on children's behavior is an emerging field rich with research potential. The present study aims to investigate the effect of synchrony on learning in early childhood and uncover its underlying behavioral and physiological mechanisms. Recent studies have shown that experiencing interpersonal synchrony encourages affiliative and prosocial behavior in children (Cirelli, Einarson, & Trainor, 2014; Fawcett, & Tunçgenç, 2017) and enhances imitation (O'Sullivan, Bijvoet-van den Berg, & Caldwell, 2018). However, the role of interpersonal behavioral synchrony on children's learning has not yet been investigated experimentally. One possibility is that synchrony, as a coordinated social activity, encourages perceived social bonds between the child and the adult, which leads to their heightened attention and better information retention. Equally likely is that physiological, rather than social learning, mechanisms mediate the effect, given the role of autonomic arousal in attentional fluctuations, information seeking, cognitive engagement, problem solving, exploration and curiosity (Berlyne, Craw, Salapatek, & Lewis, 1963; de Barbaro, Clackson, & Wass, 2017; Ishikawa & Itakura 2019; Hughes & Hutt, 1979). We experimentally induced the experience of synchrony or asynchrony between 2.5-year-old children (N = 40) and the experimenter in the laboratory. While the child was listening to an upbeat song, we trained the caregiver to rock them side to side to the song's beat, either synchronously or asynchronously with the experimenter who was equally engaging in both conditions. Following such prime, children engaged in a novel word learning task facilitated by the same experimenter, followed by a caregiver-child free play break and a retention test phase (Horst & Samuelson, 2008). While children fast mapped novel labels equally well during the learning phase in both conditions, we found above chance retention of novel labels only following the synchronous, but not asynchronous episode, however the independent samples t-test did not reach significance. During the synchrony and learning episodes, we also measured children's physiological arousal (heart rate and skin conductance response signals acquired by a wearable wristband device, Empatica E4) as an index of attention and interest. While data analyses are currently in progress, we expect that children's heightened physiological arousal level following the synchrony episode will accompany higher rates of successful word learning. This study contributes to our understanding of the underlying cognitive and neural mechanisms of interpersonal behavioral synchrony and its role in children's learning. Here we provide some preliminary evidence of greater label retention following a synchronous interpersonal movement episode as compared to an asynchronous episode, extending its role from social cognition to the knowledge acquisition domain.

P4-I-150: Predicting parenting efficacy: Examining effects of infant temperament, marital satisfactions, and parent psychopathology over time

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The multiple determinants of parenting model (Belsky & Jaffee, 2006) suggests that parenting is influenced by child (i.e., temperament), contextual (i.e., marital satisfaction), and intrinsic factors (i.e., psychopathology). Further, the spillover effect between marital satisfaction and parenting is well documented but varies by parent gender. Mothers compartmentalize their roles better than fathers, who are more likely to let marital conflict affect parenting (Cummings et al., 2010). Research has typically conceptualized parenting from a quality (i.e., sensitivity) perspective, but perceptions about ones' parenting (e.g., efficacy) have received less attention in spillover effect research. Efficacy is an important component of parenting to consider, given that it has been associated with positive developmental outcomes over time (Jones & Prinz, 2004). Individual differences factors may also play a role in predicting parenting efficacy. For example, infant temperament might influence parent perceptions (Porter & Hsu, 2003). Parent psychopathology might also play a role in predicting parenting efficacy; depression symptoms are associated with increased parental stress in both mothers and fathers (Sevigny & Loutzenhiser, 2010). The current study examined how marital satisfaction, infant temperament, and parent depression influence parenting efficacy over time in both mothers and fathers. Participants included families (mother, father, and infant) at 4 (n=84), 6 (n=77), and 8 (n=70) months of age. Parents separately completed questionnaires assessing marital satisfaction (Short Marital-Adjustment Test; Lock & Wallace, 1959), infant temperament (Infant Behavior Questionnaire - Revised; Gartstein & Rothbart, 2003), depression symptoms (Inventory of Depression and Anxiety Symptoms; Watson et al., 2007), and parenting efficacy (Parenting Sense of Competence Scale; Johnston & Mash, 1989). Negative reactivity and surgency superfactors scores from the IBQ-R were averaged across mother and father report and used to represent infant temperament. Preliminary multi-level models using SAS PROC MIXED were conducted to test the extent to which the effects of infant temperament, marital satisfaction, and depression influenced parenting efficacy over time. Models were run separately for mothers and fathers. First, an unconditional model revealed that efficacy did not change over time for either parent. For mothers, the fixed effects model revealed that mother report of infant temperament impacted efficacy, such that higher infant surgency was associated with higher efficacy ($B=.14$, $SE=.07$, $p<.05$). For fathers, the fixed effects model revealed a significant effect of paternal depression ($B=-.01$, $SE=.004$, $p<.01$) and infant negative reactivity ($B=-.10$, $SE=.06$, $p<.05$), such that as these factors increased, efficacy decreased. Overall, results suggest that there are different predictors of parent efficacy for mothers and fathers. Specifically, these results support the variability in spillover effects that have been documented in previous work (Cummings et al., 2010). Mothers were better at compartmentalizing their roles as efficacy was only predicted by infant characteristics (surgency). Conversely, fathers' efficacy was predicted by both infant (negative reactivity) and intrinsic factors (depression). Subsequent analyses will examine other predictors of parenting efficacy to determine if the spillover results hold across factors.

P4-I-151: Associations between play-based responding to joint attention and performance on a tablet-based assessment

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Responding to joint attention (RJA)- an infant's ability to respond to cues from another person to attend to an object (Scaife & Bruner, 1975)- is a key milestone in infancy predicting future language and social cognitive development (e.g., Mundy et al., 2007). To more efficiently measure RJA in diverse settings, a tablet task configured with a Tobii EyeX eye tracker was developed to assess infant RJA. We attempted to use it in the context of a pediatric primary care visit. This tablet-based assessment approximates the Dimensional Joint Attention Assessment (DJAA), a behavioral task that assess variability in the sophistication of infants' abilities to respond to 4 trials of bids for joint attention in a naturalistic play setting (Elison et al., 2013). In the tablet version, two animated characters take turns across 16 trials either looking or pointing to another location on the screen, at which a stimulus then appears. The goal of this study is to investigate whether infants' abilities to respond to more sophisticated RJA cues in a play setting is associated with their looking patterns during the tablet RJA task. 173 infants ages 8 to 18 months ($M=11.91$, $SD=2.40$) participated in both the tablet task and an experimenter administered RJA task (DJAA) during a pediatric clinic well-child visit. For the DJAA, individual mean scores reflect the ability to respond to more sophisticated cues and coefficients of variation (or CoV; $M =0.18$, $SD=0.20$) reflect response consistency. For the tablet assessment, infants' ability to predict the location of the stimulus was measured by infant gaze to that location just before the stimulus onset. We also measured whether infants looked at the character while they gave the social cue (i.e., look or point) and infants' ability to react to the social cue and look at the stimulus. We fit a series of logistic random growth models including task covariates and DJAA outcomes to predict infants' probability of successfully looking at the social cue, predicting, and reacting onscreen regions across the 16 trials (Table 1). For the tablet task, infants looked at the social cue 63% of the time, successfully predicted the stimuli 18% of the time, and successfully reacted 69% of the time. DJAA mean scores were not associated with any tablet-based RJA responses. DJAA CoV was positively associated with the probability of attending to the social cue and responding to the target on the tablet task (Table 1). Infants with more consistent DJAA performance (i.e., lower coefficient of variation scores) demonstrated a higher probability of appropriately looking to the social and react regions of the screen (Figure 1). These findings suggest that infants who are more consistent in their abilities to respond to RJA cues from others in a play setting are able to attend and respond to onscreen RJA bids. Further, the tablet-based task can be successfully administered within the context of a well-child pediatric clinic visit.

P4-I-152: The development of infant visual attention from birth to 6 months of age

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Background: Before the onset of crawling or walking, infants discover the world via visual exploration. From birth, neonates give preferential attention to social stimuli such as the faces and eyes of others, a capacity that shapes typical infant development by ensuring that infants engage with the social signals of their caregivers. Interestingly, this preferential orientation is thought to wane by approximately 4-6 weeks before re-emerging. The re-emergence of



preferential orientation around month 2 is accompanied by other major behavioral changes: infants become increasingly alert and gain more control over their own movements (Bronson 1974). These findings suggest that month 2 may mark a critical transition from more reflexive to volitional orientation in typical infancy. The present study prospectively maps longitudinal trajectories of developmental change in orientation to animate and inanimate stimuli during this critical window of development. Objective: (1) To map trajectories of change and rate of change in visual orientation towards animate and inanimate stimuli; and (2) To identify inflections in rate of developmental change (i.e., time points marked by change in the developmental course of visual orientation). Methods: Infant visual orientation was assessed using the 6 orientation items of the NICU Network Neurobehavioral Scale (NNNS). The 6 items assess orientation towards: (1) an experimenter's face, (2) an experimenter's voice (auditory only), (3) an experimenter's face and voice; (4) a ball; (5) the sound of a rattle (auditory only); and (6) a rattle (visual and auditory). Data were collected at up to 17 time points between birth and 6 months in N=95 healthy full-term infants with no family history of developmental disability. Stimuli were presented in infants' midline and moved to the right or left in a 90 degree arc. Auditory only stimuli were presented to the right or left of the infant (rather than beginning at midline). Infant orientation was scored (on a scale of 1-7 and 1-9 for visual and auditory stimuli, respectively) based on the degree of orientation towards the stimulus. Trajectories were fit using functional principle component analysis (Yao et al, 2005). Results: Animate stimuli elicited greater tracking than inanimate stimuli during the first 20 days of life (Figure 1). Inflections in rate of developmental change were observed between 30 - 50 days for all orientation items, suggesting a plateauing in rate of change beginning around 40 days, followed by a developmental spurt. Orientation continued to increase thereafter, followed by a plateau in rate of change beginning around 130-160 days. The precise timing of the initial inflection point and final plateauing for each item is provided in Table 1. Conclusion: This study provides densely-sampled prospective longitudinal measures of visual orienting during infants' first 6 postnatal months. Our findings suggest that infants may orient more readily towards animate compared with inanimate stimuli in the first days of life. The inflections observed in rate of developmental change around day 40 are consistent with the notion that the period before and after month 2 marks a significant change in the developmental course of visual orientation. Next steps include examination of the neural mechanisms associated with this change, and examination of visual orienting trajectories in infants who are later diagnosed with autism spectrum disorder.

P4-I-153: Mothers' warm parenting attitudes on their and children's smart devices consumption

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We as human beings cannot live without digital media in these days. Digital media is even commonly used by very young children, and they are more frequently exposed to smart devices, such as smartphones and tablets. Those who are 'digital natives' are recently becoming an interest research topic in order to deeply understand children's physical, socioemotional, and cognitive development under the effect of digital media (Shin & Li, 2017). Mothers are noted as one of the most influential factors with respect to the young media consumers. Several studies explored the effects of mothers' own media practices and mothers'



attitudes towards media on their young children's media use (Lauricella et al., 2015). Specifically, mothers' avid media use was associated with their greater use of media as a parenting tool, and it finally affected to children's high levels of media indulgence. As a result, this study aimed to examine how mothers' parenting attitudes moderate the association between mothers' dependency on smart devices and young children's overindulgence in smart devices. The sample consisted of 278 Korean young children aged below 36 months, their mothers completed questionnaires. Measures were included mothers' dependency on smart devices (Lee, 2016), mothers' parenting attitudes (Kim & Rohner, 2002), and young children's overindulgence in smart devices (Lee, Jung, & Kim, 2015). Hierarchical regression analyses were conducted to examine the relations among variables. Mothers' age, educational attainment, and monthly household income were considered as covariates. Mothers' dependency on smart devices were significantly related to infants and toddlers' overindulgence in smart devices, and the associations were moderated both by mothers' parenting attitudes. Interaction effects were detected as illustrated in Figure 1. Findings from this study suggest that mothers' smart devices use plays an important role in developing young children's media use, and that mothers' positive parenting attitudes can be worked as a protective factor for children's overindulgence in smart devices use. Based on results, the significant role of mothers' positive parenting attitudes, which is essential to preparing for infants and toddlers' future success in current digital world, will be discussed more in depth.

P4-I-154: Analysis of the mental state language that Chilean toddlers are receiving, considering different adults and contexts

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Introduction: Mental state language (MSL) has several benefits for toddlers, facilitating the development of the theory of mind (Ruffman et al., 2002), attachment security (Ensink et al., 2016), and socioemotional development (Dunn et al., 1991; Farkas et al., 2018). However, the frequency and quality of MSL vary considering the age of the child, the type of interaction, and the adult who interacts with the child. For example, mothers increase their references to cognitions (Doan & Wang, 2010) and emotions (Farkas et al., 2018) in a storytelling versus free-play contexts. During booksharing, adults' language is more complex and rich (Stich et al., 2015), and shows higher lexical diversity and syntactic complexity in comparison with play (Salo et al., 2016), being then a rich context for exposing toddlers' to mental state language. Teachers show a higher frequency of total MSL and specific references to desires, emotions, and causal talk than mothers, interacting with 12-months children (Farkas et al., 2017). Aims: To analyze similarities and differences on MSL that 30-months Chilean children are exposed to, comparing two different adults (mothers, teachers) and three contexts/materials (storytelling, free-play, children's books). Method: 73 Mothers and 75 teachers were asked to tell two stories to children aged 28-33 months, and interact with them during 5 minutes of free-play. Adults' speech and 40 children's books were transcribed and coded with the Evaluation of the Mentalization of Significant Caregivers (Farkas et al., 2017). Data were collected when children were 28-33 months. Results: Considering first the contexts, the results show a higher frequency of MSL in book sharing contexts, against free-play ($t=9.95$, $p=.000$), and children's books have a higher rate of MSL compared with storytelling ($t=6.86$, $p=.000$) and free-play contexts ($t=10.15$, $p=.000$) (see Figure 1). Concerning the type of adults, teachers show a



higher frequency of MSL against mothers, but only in the storytelling context ($t=2.47$, $p=.015$) (see Figure 1). About the specific references, the most mentioned in the literature are references to desires, cognitions, and emotions, and from a developmental perspective, when children are 12 months old more references to desires are expected, but when they are 24-30 months old, higher frequencies to cognitions and emotions are expected, and a decrease in desires references. This pattern is observed in storytelling contexts and children's books, but not for free-play, where desires are much frequent compared with cognitions and emotions, which corresponds to a pattern expected for younger children (see Figure 2). More references to desires are observed during free-play ($t=4.64$, $p=.000$ for mothers, $t=3.87$, $p=.000$ for teachers), while during storytelling are found more references to cognitions ($t=-2.32$, $p=.023$ for teachers) and emotions ($t=-4.82$, $p=.000$ for mothers, $t=-6.85$, $p=.000$ for teachers). Teachers also use more references to desires ($t=2.96$, $p=.004$) and emotions ($t=2.23$, $p=.027$) versus mothers, but only during storytelling context. Conclusions: MSL varies considering different contexts and adults. In this scenario, children's books are relevant artifacts to contribute with MSL to toddlers. Storytelling contexts show a more appropriate developmental pattern compared with free-play, and then have to be promoted.

P4-I-155: Improved child adjustment following brief relationship enhancement and co-parenting interventions during the transition to parenthood

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Background: The transition to parenthood is a significant relationship stressor for many couples. Many couples report declines in relationship satisfaction and difficulty managing individual stress and co-parenting. These parental difficulties are associated with both child temperament as well as emotional and behavioral problems (Harold & Sellers, 2018). Several parenting and couple interventions have been developed to buffer stress associated with transition to parenthood. Objective: In the current study we report secondary analyses of a three-arm randomized controlled trial of brief (6-hr) interventions that focused on improving either relationship satisfaction or co-parenting, delivered during pregnancy and the early postpartum period. The primary aims were to determine the direct and indirect effects of intervention on (1) infant negative emotionality, and (2) internalizing or externalizing problems. Method: 90 heterosexual couples (180 participants), who were pregnant with their first child, were randomized to receive either (1) a relationship intervention, (2) a co-parenting intervention or (3) an information only control. Results: At 12-months postpartum, couples who received either the relationship or co-parenting intervention rated their infants lower in negative emotionality ($B = -.315$, $p = .038$ and $B = -.445$, $p = .003$, respectively) and lower in externalizing symptoms ($B = -.091$, $p = .024$ and $B = -.091$, $p = .020$, respectively), compared to the information only control. Interventions were not directly associated with infant outcomes at 24-months of age; however, there were indirect effects. The indirect effect of intervention through negative emotionality on 24-month internalizing was significant for both the couple and co-parenting interventions ($B = -.025$, 95% CI: -0.070, -0.001, and $B = -.035$, 95% CI: -0.085, -0.008, respectively; see Figure 1). In addition, the indirect effects of intervention through 12-month externalizing on 24-month externalizing was significant for both couple and co-parenting interventions ($B = -.045$, 95% CI: -0.095, -0.008, and $B = -.045$, 95% CI: -0.089, -



0.011, respectively (see Figure 2). For both models, parents in the intervention groups reported reduced behavioral and emotional problems at 12-months, which were then associated with reduced externalizing and internalizing symptoms at 24-months, compared to the control group. Conclusion: The findings indicate that brief couples or co-parenting interventions delivered during the transition to parenthood have secondary benefits for infant behavioral and emotional adjustment. Intervention appears to have short-term effects on infants (i.e., at 12-months of age) but does not directly affect more long-term outcomes (i.e., at 24-months). However, intervention appears to have 'spill-over' effects on longer-term outcomes through improvements in infant outcomes at 12-months.

P4-I-156: Associations between maternal mentalization and infant temperament in the UK

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Background: Infant temperament is thought to influence the caregiver-infant relationship regarding the bidirectional nature of the development of early relationships. However, with the complexity and broadness of infant temperament, previous research about infant temperament and maternal mentalization depends on how and when temperament was assessed, and what aspect of parental mentalization was studied. The present study aimed to explore the association of infant temperament on maternal mentalization including different aspects of maternal mentalizing abilities and different measurements of infant temperament at a certain age, and thus the patterns of infant temperament's associations on parental mentalization can be compared and clarified. Method: 63 British mothers with their infants aged 4 to 8 months participated in the study as part of a larger cross-cultural study. For maternal mentalization, mind-mindedness was measured by a 10-minute free-play observation, and parental reflective functioning was assessed by the Parenting Reflective Functioning Questionnaire (PRFQ; Luyten, Mayes, Nijssens, Fonagy, 2017). Infant temperament was measured by a mothers' self-report questionnaire (Parenting Stress Index-Short Form; Abidin, 1995) as well as the infant version of the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith & Rothbart, 1999). In the current study, infant temperament measured by the mothers' self-report questionnaire was called 'perceived infant temperament' as the results of the questionnaire were based on mothers' evaluation about their infants, while infant temperament measured by the Lab-TAB was called 'observed infant temperament' as the results of the Lab-TAB were produced by a researcher's observation. Results: Mothers' perception of infant temperament was related to subscales of the parental reflective functioning questionnaire. For instance, mothers who perceived their infants had a difficult temperament were likely to report high levels of struggling to understand the infants' mental states (i.e., pre-mentalizing modes, $r=.28$, $p<.05$), and low levels of certainty about the infants' mental states (i.e., certainty about mental states, $r=-.28$, $p<.05$). However, interest and curiosity in mental states, which is the key subscale of the parental reflective functioning questionnaire, was not related to perceived as well as observed infant difficult temperament. Mind-mindedness was also not related to infant temperament by any measurement. Conclusion: The results suggested that infants' difficult temperament was not related to mothers' interest in their infants' mental states, and mothers' mind-related comments to their infants during mid-infancy (6 months). It indicates parental mentalization, such as mothers'



perception of their interest and curiosity about the infants' internal states and the actual maternal behaviour related to mentioning mind-related comments, may be independent from infant temperament during mid-infancy. However, mothers' perception of their difficulty of mentalization to their infants seemed to be related to their perception of infant difficult temperament. These findings imply diverse dynamics underlying between different aspects of parental mentalization and infant temperament.

P4-I-157: Does it matter how parents reflect? Associations between parental reflective functioning and infant temperament

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Introduction: Individual differences in infant temperament traits are crucial for the experience and expression of infants' internal states. Determined and influenced by both biological and environmental factors, infant temperament (e.g. reactivity and self-regulation) can be modulated through experiences with infants' caregivers. Parental Reflective Functioning (PRF) is the parent's capacity to reflect on their own mental states and those of their children and to link them accurately to behaviour. PRF has been associated with parenting behaviour and with offspring's social-emotional development. A reflective parent could be more sensitive to the infant's cues, support its self-regulation, and modulate the infant's internal experiences through the affective relationship. On the other hand, PRF could also be influenced by infant temperament. A more reflective parent could pick up more on the infant's signals, recognise its distress and might, therefore, perceive it as having more difficulties. However, there is still little known about the possible associations between PRF and infant temperament as well as the direction of the associations. Existing studies have shown contradictory findings using various study designs. In this study, we aim to investigate a) whether there is an association between postnatal PRF and infant temperament assessed concurrently and b) whether postnatal PRF predicts infant temperament later in infancy. Methods: As part of a longitudinal cohort study, a subsample of n = 63 mothers provided data for the present analysis. PRF was assessed using the Parent Development Interview-Revised (PDI-R) at 7 months postpartum. Infant temperament (negative emotionality, fear and soothability) was measured using the German version of the Infant Behaviour Questionnaire (IBQ) at both 7 and 12 months postpartum. Results: The PDI-R data are currently being coded using the standard RF-coding procedure adapted for PDI-R. Preliminary analyses gave some indication that there is no significant correlation between PRF and infant temperament at 7 months. However, higher PRF score at 7 months correlated significantly with lower infant distress to novelty at 12 months. Furthermore, a simple linear regression showed a significant predictive effect of PRF at 7 months on infant distress to novelty at 12 months in the same direction. This effect was not found in the other IBQ subscales used in our study. Further maternal variables that potentially influence this association will be taken into account in the final analyses. Conclusion: Our analysis aims to highlight the potential relevance of PRF as a parental regulatory capacity for the development of early infant temperament. The final results will give an insight into possible distinctive patterns of this association depending on infant temperament traits. Furthermore, potential clinical implications to promote parental co-regulation in infancy will be discussed.



P4-I-158: Mother-infant sleep and perceived bonding in solo mother families compared to two-parent families

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The regulation and consolidation of sleep-wake patterns is one of the most prominent developmental processes of early childhood. It has been demonstrated that parents have a critical role in these processes (Sadeh, Tikotzky, & Scher, 2010), however, so far, most of the research in the area of parenting and child sleep focused on traditional two-parent families. Solo mother (i.e., mothers who decided to parent alone) families are a relatively new, but rapidly growing type of single parent family (Office for National Statistics, 2015), yet the research regarding this family structure is limited. In the current study, we were interested in examining sleep patterns of mothers and infants, in solo mother families compared to two-parent families. We also examined mothers' perceived relationship with their infant (i.e., bonding) in both family structures. Finally, we also explored whether family structure moderates the links between perceived bonding and both maternal and infant sleep. The study included 98 solo mother families and 121 two-parent families, that were recruited through announcements on social media and childbirth preparation courses. Participants were visited at home by a research assistant during the third trimester of pregnancy and at four months post-partum. Maternal and infant sleep were assessed for seven nights with actigraphy. Actigraphy is a reliable objective measure that provides continuous assessment of activity-based sleep-wake patterns. Actigraphic sleep measures were: sleep duration, number of night wakings and percent of true sleep minutes from sleep duration (i.e., sleep percent). During the sleep assessment week, mothers completed two sleep questionnaires (Insomnia Severity Index [ISI]; Brief Infant Sleep Questionnaire [BISQ]) and a mother-infant bonding questionnaire (Postpartum Bonding Questionnaire [PBQ]). Solo mothers were significantly older than married mothers ($t(217)=26.95, p<.001$) and therefore, maternal age was controlled for in subsequent analyses. During the pregnancy assessment, there were no significant differences between the groups in mothers' sleep, and at the 4 month postpartum assessment, no significant differences in mother-infant sleep and perceived bonding were found between the groups (see table for descriptive statistics and independent ANCOVA tests). Family structure had a moderating effect on the associations between perceived bonding and infant sleep (infant actigraphic sleep percent, $t=2.82, p<.01$; infant actigraphic night wakings, $t=-2.93, p<.01$). For solo mother families, but not for two-parent families, more negative mother-infant bonding was associated with lower infant actigraphic sleep percent and with more infant actigraphic night-wakings (see Figure). These findings suggest that although there are no significant differences in maternal-infant sleep and perceived bonding between solo mother families and two-parent families, maternal bonding is more strongly associated with infant objective sleep quality, in solo mother families compared to two-parent families. Hopefully, a better understanding of the contribution of mother-infant relationship to sleep development in solo mother families, will facilitate the development of sleep intervention programs especially adjusted to solo mother families.



P4-I-159: Prenatal and postnatal stress as predictors of maternal self-efficacy beliefs

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Background. Maternal self-efficacy has been identified as a critical component of child and family functioning (Chau & Giallo, 2015; Jones & Prinz, 2005; Mouton & Roskam, 2015; Sanders & Woolley, 2005). Maternal self-efficacy is defined as a mother's perceived competence and ability to positively influence the behavior and development of her child (Coleman & Karraker, 2003). These maternal cognitions and beliefs are important for understanding parenting practices. Although progress has been made in understanding the importance of maternal self-efficacy, important gaps remain in our understanding of what child and family variables may contribute to the development of maternal self-efficacy, especially in the first 6 months of life. The transition to parenthood can be a time of great change and stress for mothers. These stressful experiences may contribute to the beliefs mothers have about their parenting abilities. To begin to address gaps in our understanding of how parenting beliefs develop, we used variables known to be markers of stress to investigate whether prenatal and postnatal stress may be associated with poorer maternal self-efficacy during early infancy. Prenatal and postnatal stress were hypothesized to be associated with poorer maternal self-efficacy beliefs due to the connection between stress and self-efficacy later in life. Procedures. Data from Phase I of The National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD), a comprehensive, longitudinal study on various aspects of children's development, was used for this study. The dataset includes a sample of 1,364 children and their families from 10 locations across the United States. Mothers' reports of their prenatal and postnatal stress variables were collected when the study child was first born at the hospital recruitment visit and at a 1-month home visit. When children were 6-months old, maternal reports of self-efficacy were gathered. Separate prenatal and postnatal risk indexes were created first by dichotomizing each stress variable and then summing the dichotomies; as such, the higher the risk index, the more stress a mother experienced both prenatally and postnatally. A multiple regression model was used to examine the relative contribution of the prenatal and postnatal stress indexes in explaining maternal self-efficacy beliefs, controlling for child sex, race/ethnicity, and socioeconomic status. Results and Discussion. Overall, results supported our hypotheses. Both prenatal and postnatal stress indexes were positively associated with more self-reported concerns of self-efficacy by mothers. Women who experienced more stress prenatally and postnatally exhibited poorer self-efficacy beliefs at 6 months. These findings begin to provide evidence for important predictors of later self-efficacy in mothers. Notably, these results are some of the first to examine maternal factors that may influence maternal self-efficacy and advances our knowledge about the importance of the prenatal and post-delivery period in the development of maternal beliefs about their ability to parent. These results have many implications for practice and can be used to support early identification methods of prenatal and postnatal stress to intervene in the development of maternal self-efficacy beliefs.

P4-I-160: Listening to emotions: Exploring the associations between mothers' self-reported and observed emotional expressiveness



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The development of emotion processing in infancy is heavily influenced by the emotional climate of the family environment. One element of infants' early family environment is caregiver expressiveness. Greater overall family expressiveness has been linked to earlier development of emotion processing abilities, such as intermodal emotion-matching in 9-month-old infants (Ogren, Burling, & Johnson, 2018). In addition, greater family positive affect, in particular, has been found to predict greater expression of positive affect in 12-month-old infants (Planalp et al., 2017). Furthermore, 12- to 16-month-old infants whose mothers report greater expression of negative emotions have been found to exhibit less arousal when presented with emotional faces (Aktar, 2018), suggesting that parental emotional expressiveness impacts infants' attention towards emotional information. Long term, parental expression of positive emotion has also been linked to higher levels of prosocial behavior in 2-year-olds (Lindsey, 2013). Researchers interested in measuring caregiver expressiveness often rely on self-report questionnaires, which ask parents to report on their frequency of expressing a range of emotions (e.g., Positive and Negative Affect Schedule, PANAS; Watson, Clark, & Tellegen, 1988; Family Expressiveness Questionnaire; FEQ, Halberstadt, 1986). Given the importance of family expressiveness for the development of emotion processing in infancy, it is necessary to examine whether self-reported levels of expressiveness correlate with direct observational measures of emotion expressiveness. One way that emotional expressiveness may be transmitted is through the voice. In particular, previous researchers have suggested that infant-directed speech (IDS) is a rich source of emotion - specifically, higher and more varied pitch are thought to be indicators of emotion expression (Trainor et al., 2000; Biersack et al., 2005). In the current study, we measured the vocal properties of mothers' speech during a free-play interaction with their 7-month-old infants, including mean pitch (Hz), pitch range (Hz), and intensity (i.e., volume; dB). Mothers also completed the PANAS scale to measure general positive and negative emotion expressiveness. We hypothesized that positive emotion expressiveness as measured by the PANAS would be positively correlated with pitch range and mean pitch, and we did not have a directional hypothesis regarding negative emotion or intensity. Seventy-one dyads have been tested to date with ongoing data coding; a sample of twelve infants have been included in the current analysis. Pearson correlation analyses revealed a significant positive correlation between general negative emotion and vocal intensity $r(10) = .784, p = .003$ (Figure 1). None of the correlations between general positive or negative affect and mean pitch or pitch range were significant in the current analysis ($ps > .13$). These results are preliminary and require further examination with our larger sample. However, the current findings suggest that the overall volume of mothers' speech correlates with their self-reported negative affect, while pitch range and mean pitch do not correlate with self-reported positive or negative emotion. Given that the PANAS scale is a highly relied upon measure of emotion expressiveness, it is important for us to continue to explore the relationship between this scale and other observable measures of emotion expressiveness.

P4-I-161: Wait and see: Observational learning of the emotion regulation strategy distraction in toddlers

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Some emotion regulation strategies are related to the development and maintenance of mental disorders in childhood, adolescence, and adulthood (e.g., Aldao and Nolen-Hoeksema, 2012; Feng et al., 2009; Hannesdottir & Ollendick, 2007; Suveg & Zeman, 2004). Teaching infants and toddlers age-appropriate adaptive emotion regulation strategies might be one fundamental step in preventing or reducing the risk of mental disorders. To explore whether the use of the emotion regulation strategy distraction can be shaped through observational learning, we randomly assigned $N = 66$ twenty-two-month-old toddlers to three conditions - experimenter model condition, parent model condition, or no model control condition. All toddlers first participated in a waiting situation designed to elicit frustration and anger. Afterwards, toddlers either experienced a situation where a model demonstrated how she coped with a wait by distracting herself (experimenter and parent condition), or they played for an equivalent period of time (control condition). Lastly, all toddlers participated in a second waiting situation. Specifically, waiting situations consisted of a two-minute period in which the toddlers either waited for a gift or a snack, respectively, while the parent filled out questionnaires. We found a numeric increase in distraction in both experimental conditions and a decrease in distraction in the no model control condition (see table 1). There were no significant differences in length of distraction between the parent model and the experimenter model condition. A 2 (Waiting situation: 1, 2) x 2 (Condition: model conditions combined; control condition) mixed model ANOVA showed a significant waiting situation by condition interaction effect, with $F(1,64) = 4.88$, $p = 0.032$, $\eta^2 = 0.07$. This suggests that the use of distraction as an emotion regulation strategy in 22-month-olds can be shaped by observational learning from both strangers and parents. In an ongoing follow-up study using a similar approach, we study the role of temperament in the use of distraction as an emotion regulation strategy in 24-month-olds (planned final $N = 96$). Again, toddlers participate in two waiting situations and a modelling situation in between. In one experimental group, the model distracts herself with a calm toy (e.g., building blocks, baby stacking blocks) and in the second experimental group, the model distracts herself with an active toy (e.g., lawn mower, wheelbarrow). We assess toddlers' temperament using parent report (Early Childhood Behavior Questionnaire (Putnam, Gartstein & Rothbart, 2006); Inventar zur integrativen Erfassung des Kind-Temperaments (Zentner, 2010)) and give toddlers the choice between a toy for active use and a toy used for calm activities in each waiting situation. We hypothesize that high-surgency toddlers imitate more distraction from an active model and profit more from active distraction strategies whereas low-surgency toddlers imitate more distraction when being placed in a calming environment with regard to both toys and model behavior. We are currently at the end of data collection and will present results at ICIS. In sum, we explore a new way of teaching an emotion regulation strategy to toddlers with regard to individual differences, which might prove helpful in raising and teaching them both at home and in nurseries or kindergarten.

P4-I-162: The relation between maternal internalizing symptoms and infant processing of emotional faces

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Children of depressed or anxious mothers are at heightened risk for developing similar internalizing symptoms. Researchers have hypothesized that one of the ways in which risk is transmitted is via the emotional environment provided by the parent (Aktar & Bögels, 2017). Depressed mothers provide an emotional environment for their offspring characterized by fewer expressions of positive emotions and disproportionately greater instances of negative emotions (Dawson et al., 2003). Maternal anxiety has been shown to predict attention to threatening emotional faces in their infant offspring (Morales et al., 2017), suggesting that there may be an anxiolytic effect on infants' emotional processing. However, research examining patterns of emotion processing in young infants of depressed mothers is mixed, and often focuses on a single timepoint (e.g., de Haan et al., 2004). Even less is known about how parental anxiety impacts emotional processing in young infants over time. The current research examines the impact of maternal depression and anxiety symptoms on infant processing of emotional faces over time. As part of an ongoing longitudinal examination of attention in a diverse sample of infants, latency to fixate emotional faces was examined in infants at 8 and again at 12 months using an eye tracking task. Infants viewed an attention grabbing stimulus in the center of the screen, followed by an emotional face (happy, angry, or neutral) in one of the four corners of the screen. We measured latency to fixate the emotional face on each trial. During the infants' 8-month visit, maternal depression symptoms were measured using the Beck Depression Inventory (Beck et al., 1961), and maternal anxiety symptoms were measured using the Beck Anxiety Inventory (Beck et al., 1988). We found that both maternal depression symptoms ($N = 46$, $b = .10$, 95% CI [.03, .17], $t = 2.83$, $p = .007$) and maternal anxiety symptoms ($N = 45$, $b = .10$, 95% CI [.07, .12], $t = 6.83$, $p < .001$) moderated attention to angry faces over time. Specifically, when maternal anxiety symptoms were low, there was a significant negative relation between infants' latency to fixate to the angry face between their 8 month and 12 month visit ($b = -.413$, 95% CI [-.6969, -.1292], $t = -2.939$, $p = .005$). When maternal anxiety and depression symptoms were high, there was a significant positive relation between infants' latency to fixate to the angry face between their 8 month and 12 month visits (anxiety: $b = .511$, 95% CI [.2879, .7348], $t = 4.622$, $p < .001$; depression: $b = .697$, 95% CI [.2754, 1.1191], $t = 3.336$, $p = .002$). In other words, when maternal symptomatology was low, infants who were slow to fixate faces at 8 months got faster by 12 months, whereas infants of mothers with higher symptomatology remained slow over time. These findings highlight the ways in which maternal internalizing symptomatology may relate to infants' patterns of attention, particularly for negative emotions.

P4-I-163: The role of infant temperament on four-month mother-infant face-to-face interactions

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Objective: Past research showed that infant temperament has an impact in early interactions (Calkins, Hungerford, & Dedmon, 2004; Puura et al., 2013); however, assessing infant temperament with regard to dynamic systems view of interaction that take into account both infant and mother self- and interactive contingency in face-to-face interaction (Beebe et al., 2016) is not common. The purpose of this research was to examine whether infant temperament would predict mother-infant self- and interaction contingency during face-to-



face interaction at 4 months in a Turkish middle-class sample of 56 dyads. The modality pairings assessed in relation to infant temperament dimensions were infant gaze-mother gaze, infant vocal affect-mother touch, infant gaze-mother touch, and infant facial affect-mother facial affect self- and interactive contingency. Infant temperament dimensions were positive emotionality, negative emotionality, and orienting/regulatory capacity (Putnam, Helbig, Gartstein, Rothbart, & Leerkes, 2013). Method: Interactions at 4 months were filmed split-screen, and the first uninterrupted 2.5 mins were coded on a 1s time-base for infant gaze, mother gaze, infant vocal affect, mother touch, infant facial affect, and mother facial affect with video microanalysis. Very Short Form of Infant Behavior Questionnaire-Revised was filled out by mothers at 4 months. Communication modalities such as gaze, and touch were micro-analyzed by the first author with Behavioral Coding of Mother-Infant Interaction at 4 months after inter-rater reliability training (Beebe et al., 2010). Multilevel time-series analyses evaluated self- and interactive contingency with Dynamic Structural Equation Modeling via Mplus 8.1 (Muthén & Muthén, 1998-2017). Four different multilevel time series models were run. Infant temperament dimensions were predictors of infant gaze-mother gaze self- and interactive contingency; infant vocal affect-mother touch self- and interactive contingency; infant gaze-mother touch self- and interactive contingency; and infant facial affect-mother facial affect self- and interactive contingency. Results: Results indicated that infant negative emotionality significantly predicted mother touch interactive contingency coordinating with infant gaze. The increase in infant negative emotionality at 4 months predicted decrease in mother touch interactive contingency to prior infant gaze behavior at 4 months. Infant positive emotionality, and orienting/regulatory capacity were not significant predictors of infant gaze-mother gaze, infant vocal affect-mother touch, and infant facial affect-mother facial affect self- and interactive contingency in this research (see Figure 1). Conclusions: Social synchrony is matched states of infant gaze with maternal affectionate touch (Feldman, 2015). This research implies that infant negative emotionality may have an inverse impact on social synchrony, an important factor for mother-infant bonding and infant development. Findings also suggested that infant self-contingency may not only be what the infant brings interaction such as temperament, but may be co-constructed within dyadic relationship.

P4-I-164: Neonatal pain/ stress exposure, temperament at 3 months and parental perception of preterm infants' behaviour at 12 months

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Background: A problem of the long term neurobehavioural consequences of the early exposure of prematurely born neonates to procedural pain/ stress in neonatal intensive care units becomes an urgent issue nowadays (Monte Cassiano et al., 2016, 2017). According to Montiroso et al. (2016), prematurity and excessive neonatal pain may lead to altered temperamental profiles at the age of three months. In line with the developmental model elaborated by Rothbart and colleagues (e.g. Derryberry & Rothbart, 2001; Rothbart, 2007), such temperamental difficulties may contribute to compromised functioning in later life. The aim of this study was to analyse the relationship between neonatal, procedural pain exposure (PE), temperament at the age of three months and behavioural problems in 12 month old infants as perceived by their parents. Method: The study was conducted as a part of a longitudinal project on the relational and biological predictors of self-regulation in preterm



children. Out of 95 families initially enrolled in the project, 78 provided data for the current analyses. 27 extremely preterm (p1), 28 very & moderately preterm (p2), and 23 full term infants (c) participated. Neonatal, procedural pain exposure was assessed on the basis of each child's medical records. Infant Behaviour Questionnaire Revised (IBQ-R) was completed by mothers and fathers to assess infants' temperament at the corrected age of three months. In-depth, semi-structured interviews with both parents were conducted at the infants' corrected age of 12 months and analysed with Atlas.ti to discern parental representations of babies' behaviour. Child's developmental status, medical risk factors, socio-economic status, and maternal/paternal depression were controlled for. Group comparisons were performed with reference to 1) birth status (initial groups), 2) the level of pain exposure (high, moderate, low). Results: Although no statistically significant differences were found among the p1, p2 and c groups across the 14 temperamental dimensions and the three factors of IBQ-R, Cuddliness differentiated the groups with varying degree of neonatal pain exposure ($p < .05$). Exploratory analysis was run to discern distinct temperamental and behavioural profiles in infants with varying degree of neonatal pain exposure. Two clusters were identified with generalized EM algorithm in Statistica 13: 1) infants with lower level of parent reported behavioural difficulties, higher developmental scores and higher scores in Orientation/ Regulation, 2) infants with higher level of parent reported behavioural difficulties, lower developmental scores and lower scores in Orientation/Regulation. Significantly more infants with high neonatal pain exposure belonged to Cluster 2, as opposed to infants with low or moderate PE, who represented cluster 1 more frequently. Qualitative analysis of parental perceptions of infants behaviour was conducted Conclusions: Studying early pain/ stress exposure and temperament may contribute to better understanding of potential risk and protective mechanisms contributing to behavioural and developmental outcomes of prematurity. At the same time, no developmental process can be considered outside of the realm of parent- infant relationship. Parental representations of infant's behaviour may reflect the history of traumatic experiences in the neonatal period as well as the everyday experience of interactions with the baby with potentially altered temperament profile.

P4-I-165: Matching emotional expressions in music and faces in 7-month-old infants

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In the first year of life, infants become sensitive emotional expressions and they can gather this information from a variety of sources such as the face, the voice and music. Numerous studies have suggested that infants' ability to distinguish facial expressions of emotion and emotional tones of voice is well-established (Vaillant-Molina, Bahrck, & Flom, 2013; Grossman, 2012). Meanwhile, Flom, Gentile and Pick (2008) showed that infants discriminate between happy and sad music, dishabituating from one to the other. However, research on the intermodal matching of emotion in music and in expression is unclear. Several studies have claimed that infants under one year can discriminate sad music and sad faces after being familiarised with happy music and faces (Sullivan, Gentile, and Pick, 1998) or looked longer at congruent expressions when hearing happy music but incongruent expressions when hearing sad music (Nawrot, 2003). However, in both cases the pattern of the results could be due simply to an infant preference for happy facial expressions. In none of these studies were



infants' baseline preferences for happy or sad faces established. Additionally, no studies have been conducted with fearful music, which is also thought to be a cultural universal (Fritz et al., 2009). In the current study, we use a looking preference method to explore these issues. Twenty-seven infants (M age = 216.3 days, SD = 9.45, 15 females) saw pairs of faces in two conditions: baseline silence and accompanied by music. In the silence condition, the infants were shown two static female faces showing two different emotional expressions (happy vs sad, happy vs fearful, fearful vs sad) with each pair presented for ten seconds. Next, the infants were presented with twelve trials; each lasting twenty seconds, consisting of a single musical excerpt and a pair of emotional faces, one of which was congruent and one contrasting. For example, in one trial, the infants would hear fearful music and see a fearful expression on the left and a happy expression on the right. All displays and musical excerpts were counterbalanced across the twelve trials for each infant. The dependent measure was the looking time to each face. Analysis of baseline silence showed no significant preference for any emotional faces $F(2, 42.21) = .54, p = .55$ (see Figure 1). In the music condition, there was a main effect of Music type $F(2, 52) = 4.89, p = .01$. Infants looked longer at the screen when happy music was playing. There was also an interaction of Music type and Emotional pairing $F(1, 26) = 9.72, p = .004$. In no condition was a consistent preference found for either congruent or incongruent facial expressions (see Figure 2). No other effects or interactions were significant. Inconsistent with the findings of previous research (Nawrot, 2003), the findings of this study suggest that infants of this age are unable to match the emotional tone of music with related facial expressions.

P4-I-166: Regaining maternal attention: Jealousy responses across the first year of life

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Infants have an innate desire to form social bonds and jealousy protests are typically observed when an infant is trying to regain attention lost by a caregiver to a social rival who threatens that bond (Hart & Legerstee, 2011). Jealousy protests are characterized as gaze, negative affect, approach, and withdrawal type behaviors. Studies have demonstrated that infants as early as six months of age are capable of displaying stereotypical jealous behavior in cases when the infant's mother directed her attention to a social rival (Hart & Carrington, 2002). Research shows that negative affect and approach behaviors in response to a jealousy inducing paradigm (Hart et al., 1998) are associated with left frontal EEG asymmetry in the first year of life (Platt & Jones, 2018). The aim of this study is to examine jealousy type behaviors during the first year of life. Consistent with past research (i.e., Hart et al., 1998), behavioral and physiological data were collected cross-sectionally from 44 mother-infants at 9-months (M= 8.95; SD= 0.95) and 50 dyads at 12-months (M=13.06, SD=1.03) during two conditions (counterbalanced). Mothers ignored their infant and attended to a social object (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), $(\ln(\text{right}) - \ln(\text{left}))$). At 9-months paired samples t test demonstrated that proportions of approach style behaviors such as mother directed gaze and overall approach (ts ranged from 3.67 to 3.89; $p_s < 0.001$) were higher in the social object condition. At 12-months paired sample t tests revealed that the proportions of approach style behaviors such as mother-directed gaze, proximity, approach touch, total approach, and negative affect were significantly higher during the social object compared to the non-social object, (ts ranged from -2.46 to -6.08; $p_s < .01$) and correlations demonstrated positive associations between frontal EEG asymmetry and mother-directed gaze, touch, and negative affect (rs ranged from .35 to .67, $p_s < .05$). Ultimately, infants demonstrated approach-type behaviors during the social object and later in first year of life left frontal asymmetry was associated with mother-directed behaviors. Infants appear to have the capability to express complex emotions, primarily if motivated by the desire to regain the loss of an attachment figure's preferential attention to a social competitor. EEG markers linked to approach behaviors offered insight about underlying physiological patterns that occur during social situations (Platt & Jones, 2018) in infancy. This may indicate that during the first year of life the jealousy system is developing, at the end of the first year of life these responses may be stronger and linked to brain organization in infancy.

P4-I-167: Validation of a laboratory measure of infant emotional reactivity at the neural level

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The Late Positive Potential (LPP) is visible in the EEG waveform a positive deflection that overlaps with a period of facilitated attention to emotional stimuli roughly 300-2000 ms following stimulus presentation (Cuthbert et al., 2000). The LPP and can be modulated by volitional cognitive processes of regulation (Zang et al., 2017), but in absence of these regulatory efforts is generally regarded as a neural measure of emotional reactivity and motivational salience. In adults, greater LPP amplitudes are linked to greater emotional reactivity and the processing of more self-relevant (vs. less self-relevant) information (Cuthbert et al., 2000). Adult LPP amplitudes are positively associated with anxiety symptoms and negatively associated with depressive symptoms (MacNamara et al., 2016). Although LPPs have recently been extended to childhood and adolescent populations (Dennis & Hajcak, 2009; Kujawa et al., 2012), their use in infancy remains rare and, to our knowledge, there have been no effort to empirically validate infant LPPs against infant behaviors. Such an effort is important because evidence for adult-like LPP in older children is mixed (Dennis & Hajcak, 2009; Hajcak & Dennis, 2009) and developmental science is likely to continue its efforts to extend LPP assessment into the infant period. In the current work, we present preliminary evidence for a validated paradigm for LPP elicitation during infancy. Twenty-three infants between 6 and 12 months ($M = 8.74$ months; $SD = 2.19$) of age visited the laboratory with their mothers. Before the visit, mothers reported on infant temperament, reflecting trait-level individual differences in propensities for positive and negative emotion in infants, using the Infant Behavior Questionnaire. Infants viewed two images (mother or confederate [unfamiliar mother]) repeated across 24 trials (12 trials for each photo). An electrode position by face type interaction ($F(2, 30) = 3.18, p = 0.06$) suggested the presence of a traditional (i.e., adult-like)



LPP effect that differed across electrode sites. Specifically, infants showed more positive amplitudes to pictures of mothers ($M = 4.689$, $SD = 6.858$) than to pictures of confederates ($M = 1.526$, $SD = 6.646$), but only at parietal (Pz) electrodes. Notably, the Pz electrode is the location typically associated with the LPP in adults, reflecting a surprising lack of regional change in LPP between infancy and adulthood. Most importantly for our study aim, greater infant LPP to pictures of the infant's own mother (vs. confederate mother) was associated with less temperamental negative emotion ($r = -0.528$, $p = 0.04$) and greater temperamental positive emotion ($r = 0.657$, $p = 0.03$). These results demonstrate a link between LPP and trait-level individual differences in infant emotion in the first year of life. Data collection for this project remains ongoing.

P4-I-168: A person-centered approach to understanding mothers' subjective experience of children's temperament

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It is not temperament alone that determines the developmental course, but the interaction of the child's temperament with the adequacy of environmental responses to it (Thomas & Chess, 1968). For very young children, much of their environment consists of their relationships with caregivers, and, for many, the mother-child relationship is of primary importance. These relationships are co-constructed, influenced not just by children's reactive tendencies, but also by mothers' subjective experience, how they receive, accept, and respond to their child's reactivity. Proceeding from a person x environment fit perspective, this study employs a person-centered approach using repeated measures latent profile analysis (RMLPA) to examine patterns of child temperamental reactivity (Negative Emotionality scale of the EASI: Buss & Plomin, 1984) and stability and change in mothers' subjective experience of relational stress (Dyadic Interaction subscale of Parenting Stress Index SF: Abidin, 1995) from 14 to 36 months. Next, a series of multinomial logistic regressions were performed to assess whether differences in children's skill development and behavior or mothers' own characteristics might distinguish among the patterns profiled. The sample included 3,001 children (1,510 males) and their mothers from a nationally representative sample taken from a larger longitudinal study conducted in the U.S. Following RMLPA, mother-child dyads were assigned to five profiles consisting of one expected large group of children with an easy temperament and mothers with consistently low levels of relational stress from 14 to 36 months, encompassing 78% of dyads, and four groups characterized by heightened temperamental reactivity and various patterns of mothers' subjective experience of the emerging parent-child relationship over time, representing the remaining 22% of dyads. These patterns include highly reactive temperament paired with consistently mild relational stress (Mild Stable), highly reactive temperament with early (at the 14 month timepoint only) but not persistent relational stress (Early only), highly reactive temperament with late onset (at the 36 month timepoint only) relational stress (Late onset), and highly reactive temperament with chronic relational stress (Chronic) (Figure 1). Membership in each profile was differentially related to mothers' knowledge of child development and the degree to which they believed their life circumstances to be under their own control. In addition, children's vocabulary at 14 months and their observed behavior toward their mothers at 36 months varied between certain profiles



(Table 1). These findings confirm there is heterogeneity in maternal response to children's heightened reactivity, which suggests that there is wide variation in the relational environments experienced by highly reactive children. Not only did some mothers experience pronounced relational stress while others did not in response to similar levels of child reactivity at various points throughout early childhood, but these patterns of stability and change in relational stress over time were primarily influenced by maternal knowledge and dispositions rather than variation in children's behavior or skills. Results highlight the important role maternal perceptions and beliefs have in influencing both their own experience of and satisfaction in the parenting role as well as shaping the relational environments in which highly reactive children develop.

P4-I-169: Disengaging from distress in adult and infant strangers: Rethinking the role of personal distress in young children

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From late toddlerhood on, prosocial behavior becomes progressively discriminative, nuanced, and differentiated (Hay & Cook, 2007; Malti & Dys, 2018). Compared to young children's other-oriented responding, disengaging behavior in an empathy-arousing context has not received much attention. Moreover, how egoistic distress relates to prosocial and disengaging responding remains unclear. This study aimed at describing children's disengaging behavior and how it related to distress arousal evoked by distress in adult and infant strangers. Examining these processes may prove helpful in reducing insensitive responding and nurturing individual prosocial competence (Hepach & Warneken, 2018). 61 preschoolers (23 females, Mage = 44 months, SD age = .94) encountered a female adult stranger feigning stomach ache followed by an infant manikin emitting increasingly intense cry sound in a bassinet (each lasting approximately 4 min). Behaviors were coded for: 1) other-oriented behaviors (empathic concern, cognitive inquiry, and helping actions), 2) self-oriented personal distress (e.g., frowning, fussing, crying), and 3) disengagement (e.g., turning inward, shutting down, looking away, leaving). Duration of a behavior was tallied by the proportion of time spent in the entire simulation. The mean inter-observer reliability kappa values was .95. Across the conditions, preschoolers spent significantly greater amount of time in disengagement (M = 41.13%, SD = 22.51%) than in other-oriented behavior (M = 33.21%, SD = 16.86%) and personal distress (M = 11.45%, SD = 13.52%) (all significantly different at $p = .05$ level). Based on a difference score between the times spent in other-oriented behavior and disengagement, preschoolers with positive difference scores were categorized as "prosocial responders" while those with negative scores "disengagers." Approximately 2/3 of the sample ($n = 39$) were disengagers. The results of Wilcoxon Rank Sums tests indicated that the median of personal distress for prosocial responders was higher (20.32%) than that for disengagers (4.28%), $\chi^2 = 10.63$, $df = 1$, $p < .0001$. Across adult and infant conditions, empathic concern was positively correlated with personal distress, $r = .30$, $p = .02$, and $r = .60$, $p < .001$, respectively. Furthermore, personal distress was negatively correlated with disengagement, $r = -.46$, $p < 0.0005$, and $r = -.36$, $p < 0.01$, respectively. Unique to the infant condition, the relation between personal distress and disengagement became non-significant, $b = -.14$, $SE = .15$, $t = -.97$, $p = .34$, when empathic concern was controlled, suggesting a mediating role of empathic concern, $F(2, 58) = 7.38$, $p = .001$. $R^2(\text{adj}) = 0.2$ (indirect effect = $-.19$, $SE = .09$, $CI: [-0.39, -0.03]$), yielded



by a bootstrapping procedure with 5000 resamples). The findings indicated that preschoolers were not always helpful in a context where the strangers' predicament was plain to see. This study provided a unique perspective to examine disengaging behavior via the lens of personal distress and its relation to prosocial behavior. When responding to strangers in distress, self-oriented distress may not necessarily implicate in disengaging action. Disengagement merits rightful attention for its nature and function and its relations to other elements of empathy-related responding.

P4-I-170: Infant attachment and cortisol reactivity to the strange situation among children adopted internationally

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Experiencing adversity during the first couple years of life can impair the responsiveness of the hypothalamic-pituitary-adrenocortical (HPA) axis to later psychosocial stressors. For example, children who have experienced early deprivation in the form of institutional care show blunted HPA axis responsivity, even after they have been adopted internationally into stable and enriched family environments (Koss et al., 2016; McLaughlin et al., 2015). A question that is important both theoretically and practically is whether internationally adopted children's relationships with their adoptive parents can promote recovery in children's HPA axis functioning. Specifically, the security of the infant-parent attachment relationship is expected to help regulate HPA axis reactivity to stress during early development (Groh & Narayan, 2019; Gunnar, 2017). The objective of the current study was to test the hypothesis that infants and young children who have been adopted internationally will exhibit blunted HPA responses to a psychosocial stressor if they have formed insecure attachments to their adoptive parents, but internationally adopted children who form secure attachments will exhibit a moderate HPA response to stress. The current study included 59 infants and young children who had been adopted internationally from institutional or foster care. Approximately one year after adoption when children were between the ages of 11 and 33 months ($M = 24.73$), children and their adoptive parents completed the Strange Situation Procedure, a widely used interpersonal stressor (Ainsworth et al., 1978). Children's HPA axis activity was assessed by collecting salivary cortisol samples at three time-points: upon arrival at the lab as well as 15 minutes and 30 minutes after the completion of the Strange Situation. Because there is a 20-minute lag between the onset of a stressor and increases in salivary cortisol levels (Gunnar et al., 2009), the last two cortisol samples reflected HPA activity 5 minutes before and 10 minutes after the end of the Strange Situation. Children's overall cortisol responses to the Strange Situation were estimated by calculating the area under the curve with respect to increase (Pruessner et al., 2003). Fraley and Spieker (2003) proposed that infant attachment quality can be represented using two dimensions. We conducted an exploratory factor analysis of the nine attachment ratings to evaluate the validity of this dimensional approach among children adopted internationally. The results indicated that a two-factor solution best accounted for the data (see Table 1). Consistent with Fraley and Spieker (2003), one factor reflected children's avoidance versus proximity seeking and contact with their adoptive parents, and the other factor represented children's resistant and disorganized attachment behaviors. The two attachment dimensions were used in the linear regression analyses predicting children's cortisol responses. As hypothesized, internationally adopted children who exhibited



attachment avoidance exhibited more blunted cortisol responses during the Strange Situation than children who sought proximity and contact with their parents ($\beta = -.31$, $p = .02$; see Figure 1). Attachment resistance, on the other hand, was not significantly associated with cortisol responses. In conclusion, forming secure attachments after adoption appears to promote recovery in internationally adopted children's HPA axis responses to stress.

J-Translational Science and Policy

P4-J-171: Strengths & gaps in existing infant toddler curricula: A review and analysis

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With an increase in expectations for empirically-based infant toddler curricula (Chazan-Cohen et al., 2017), a Curriculum Consumer Report was published by the National Center on Early Childhood Development, Teaching, and Learning (n.d.) to review the most widely used curricula available for infants and toddlers. The current study expands on this review to include one additional curriculum, and four additional criteria for effective curricula. The criteria for effective curricula in the Consumer Report are: 1) Evidence Base for Child Outcomes, 2) Research-Based Curriculum, 3) Scope and Sequence, 4) Alignment with the Head Start ELOF, 5) Learning Goals for Children, 6) Ongoing Child Assessment, 7) Parent and Family Engagement, 8) Professional Development and Materials to Support Implementation, 9) Learning Experiences and Interactions, 10) Learning Environments and Routines, 11) Cultural Responsiveness, 12) Linguistic Responsiveness, 13) Individualization for Children with Disabilities, Suspected Delays, or Other Special Needs, and 14) Individualization Based on Interests, Strengths, and Needs. Each criterion has a set of sub-criteria based on early childhood research, Head Start Performance Standards, and other standards from the National Association for the Education of Young Children, and Division for Early Childhood. The current study visually summarizes the ratings for the original 14 main criteria and 34 sub-criteria, providing a detailed review-at-a-glance. Additional criteria not included in the original Curriculum Consumer Report were used to evaluate the original six and one new curriculum, Early Learning Matters (2019). New criteria include: 15) Developmental Coverage, coverage of learning domains including mathematics, science, social studies, and arts, in addition to developmental domains including approaches to learning, social-emotional, communication, cognition, and physical; 16) Format of the Curriculum includes strengths and challenges in how teachers navigate through the curriculum; 17) Instructions for Teachers describes the degree to which curricula communicate what to do, how to do it, and why, such as providing knowledge of child development; and 18) Teacher Usability examines whether the curriculum is routines-based, integrates across domains, provides practical suggestions or tips for what to say (scriptedness), and is linked to an assessment system. Strengths across curricula are that they are mostly research-based, most provide professional development materials to support implementation, and Parent and Family Engagement is addressed by most existing curricula. Three of the seven curricula provide a background knowledge of development as integrated into lessons/units or as separate background materials. Substantial gaps exist in the criteria for Evidence Base for Child Outcomes as none of the curricula met this standard.



Only two out of seven curricula are aligned with the Head Start ELOF. And there is generally minimal evidence of cultural and linguistic responsiveness across curricula. Additionally, most curricula provided minimal guidance for teachers on using routines and transitions as the basis for creating opportunities to support development. This review indicates a need for further research to establish the Evidence Base for Child Outcomes and calls on the field to develop curriculum materials that are more usable for teachers, and more culturally and linguistically responsive to our youngest learners.

P4-J-172: iParenting: Parenting infants in a digital age

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From headlines touting "explosive growth in screen use by toddlers" (CNN, 2019) and "Smallest Tots Spring Too Much Time on Screens" (WebMD, 2019) to "Two studies lay the blame for childhood screen time at moms' feet" (MIT Technology Review, 2019), it is clear that we are at a critical time, not only for research on the impact of screen time on infant development but also on the responsibility and ability of researchers and pediatric organizations to communicating guidelines and evidence-based information so that caregivers are not blamed, but rather empowered to make educated choices in supporting their infant's development. How are parents navigating this new digital world? What are their struggles and how can we reach them? This study seeks to be a first step in bridging the gap between researchers and caregivers by asking caregivers themselves about their perceptions of, habits around, and behaviors relating to screen time for their children and themselves. This is part of a larger study asking about the perceptions, behaviors, and opinions across development of caregivers of children ages birth to 18, but findings around caregivers of infants will be the focus of this presentation. This online survey asks caregivers about their behaviors and actions (e.g., do they set limits for their own use of screen media; do they set limits for their children), their habits in terms of finding out information to guide their use of screen time for their infant (e.g, where do they look?; how much do they trust the information they find?); and their patterns in terms of curating and guiding the types of screen time their infant experiences (e.g., do they allow their infant to use educational media and/or entertainment media - and if so, what factors guide their selections?). Data collection is ongoing, but as of November 2019, 24 caregivers of infants ages birth to three years have completed the survey. Efforts are ongoing to collect a large, economically diverse sample. This poster investigate the caregiver characteristics (e.g., education level, socioeconomic status, age of parent, etc.) and their impact on caregivers' thoughts, behaviors, and actions (see Figures 1 and 2 for a preview of pilot data). Thus far, the data suggest that while the majority of infant caregivers set limits, how and why they set limits, the factors that stand in the way of setting limits, and where they get information varies greatly among families, despite the best efforts of major organizations, such as the American Academy of Pediatrics and Common Sense Media, to share high quality information. This project seeks to move beyond the headlines to investigate where caregivers are getting their information, what they struggle with in terms of setting limits, and will serve as the basis by which researchers and pediatricians can begin to have meaningful conversations with families to empower rather than generate fear for caregivers.



P4-J-173: Keeping up: Patterns of infant development and parent involvement for low-income families enrolled in Early Head Start

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Without intervention, low-income children are likely to fall behind age expectations in multiple domains (health, social, cognitive, language) by the time they reach kindergarten (Wertheimer et al., 2003). Low-income (compared to higher-income) children are at a disadvantage due to the likelihood of experiencing more early stressors and fewer enriching opportunities (Amso & Lynn, 2017). High-quality, enriching parent-infant interactions predict infants' early social, language, and cognitive outcomes, and are often the focus of early intervention programs such as Early Head Start (EHS) (Spiker et al., 1993; Poehlmann & Fiese, 2001; Tamis-Lemonda et al., 2004). We studied parent-infant interactions of 43 families (infants ages 0-3) who were enrolled in a rural EHS program in the U.S for one year. Parents and EHS home visitors developed a School Readiness Plan including goals for each child in several developmental domains. Every two weeks, parents documented via an in-kind report the total minutes that they spent working with their child in each domain. Children were assessed several times each year on developmental milestones using the Hawaii Early Learning Profile (HELP). The purpose of this study was to identify predictors of the amount of time parents spent working with their infants on developmental goals, and to understand children's trajectories on the developmental assessments. First, we ran a series of regressions predicting the number of minutes that parents reported working with their children across 6 categories: cognitive, receptive language, expressive language, social-emotional, fine motor, and gross motor. For all categories except receptive language, initial HELP scores negatively predicted the amount of parent-child interaction over the next 9 months in that category ($ps < .05$). That is, parents spent more time working with children whose scores were initially low (Table 1). Next, we ran repeated-measures ANCOVAs with infants' HELP scores (initial and 1-year later) as the dependent variables. Across categories, we found that children who were not eligible for special education services (not on an IFSP) progressed as expected, maintaining age-level scores. However, children on an IFSP scored lower than those not on an IFSP in all categories, and fell further behind age level on cognitive, expressive language, and gross motor assessments (Figure 1). There were no other significant predictors, besides an age interaction in the social emotional domain. Our results indicate that EHS children tended to remain at age-level, and their parents were responsive to children's developmental needs (spending more time interacting with low-scoring children). Unfortunately, parent-reported time did not predict developmental progress. This is consistent with studies in which simple quantity of time mothers spent with infants did not predict social, language, or cognitive outcomes (Booth et al., 2002; Huston & Aronson, 2005). However, parents in this study were specifically reporting time spent on identified developmental goals. One possible interpretation is that encouraging interaction toward particular goals is not enough; parents need more guidance regarding how to support infants through interaction. Future researchers may wish to assess the quality and effectiveness of different parent-child activities within these domains, and additional ways of documenting parent-infant activities.