devmocon

POSTER ABSTRACTS

Development in MOTION online conference

22nd-24th June 2021

Marie Skłodowska-Curie Actions Innovative Training Network (MOTION)

Poster Session:
24th June, 15.15-16.30 CEST

motion

Contents

devmocon

A1. Differences between human- and robot- directed speech and communication? Evidence from 5-year-olds

Anja Gampe (University of Duisburg-Essen) & Katharina Zahner-Ritter (University of Trier)

While research on human-robot-interaction is growing, we know little about how children's trust towards artificial intelligence. Here, we investigate the characteristics of remote communication with Voice Assistants by directly comparing the interactions in children who believe to interact with a robot Voice Assistant or a human in a complex problem-solving scenario.

Fifty 5-year-old children completed a treasure hunt, with the help of an interaction partner named "Sila" who was introduced as a human vs. a robot (between-subjects design): Provided with hints on keys, children had to ask Sila which box they were supposed to open next. In the first three interaction-trials, Sila understood the child's uttered object label (pre-misunderstanding), followed by two trials in which Sila misunderstood the label (misunderstanding, e.g., child says *elephant*, Sila understands *diamond*) and three trials without misunderstanding (post-misunderstanding).

We measure children's communicative behavior with Sila on three different levels: 1) willingness to communicate by number and length of utterances directed to Sila during the treasure hunt; 2) expectations towards the interaction partner by speaking rate, pitch-related cues, and grounding (positive grounding was coded by acknowledgement of the partner's utterance (uh huh, yeah) and a relevant next turn of the child; negative grounding if the child initiated repair activity); and 3) emotional arousal in misunderstanding-trials by pitch and intensity. In the talk, we will present first findings on how communication in terms of speaker-specific variation evolve and differ during the three experimental phases across the two conditions (human vs. robot Voice Assistant). Investigating communication on these three levels in the three phases allows us to gain a holistic picture on child-voice-assistant interaction, and to study potential interplays across different communicative levels. We will discuss the results in light of social trust for artificial intelligence.

A2. The interplay between static/dynamic balance and lexical comprehension/production: a normative study with preschoolers

Giorgia Lettere (University of Padova), Giulia Calignano (University of Padova), Irene Leo (University of Padova), Francesca Maritan ("Giovanni XXIII" Kindergarten and Nursery school), Laura Mattera ("Giovanni XXIII" Kindergarten and Nursery school), Patrizia Granata ("Giovanni XXIII" Kindergarten and Nursery school), Daniela Lucangeli (University of Padova), & Eloisa Valenza (University of Padova)

Investigations on motion and language association in childhood has been mainly dominated by studies on developmental disorders in which the presence/absence of motor skills were only detected with rare assessment of the qualitative aspects of postural and motor skills. But which are the typical trajectories of postural and language interplay in the preschool age? To get a better model of typical development, we need normative studies. The present study offers a wide view of postural and language abilities in a representative cohort of typically developing children from 3 to 5 years old (N = 222). Specifically, we measured (i) postural abilities by taking advantage of quantitative and qualitative indexes of dynamic and static balance recorded via Nintendo Wii balance board: with progressives' degrees of difficulty assessing the impact of visual information processing. We also measured (ii) lexical comprehension and production abilities through the Phono Lexical test (Vicari et al., 2007). We analyze the effect of interest while dealing with individual variability and, notably, by treating age as a continuous factor, thanks to Generalized Additive Mixed-effects modeling. Results indicate a main effect of age predicting an increase in balance and linguistic abilities. In particular, we found a pivotal role of visual information in boosting postural performance and a reduced number of semantic and phonological errors and helps as predicted by age. Furthermore, by taking advantage of a Network-analysis we weighted the associations between postural and linguistic indexes finding that static balance is a good candidate predictor of lexical production. Finally, we stress the relevance of reporting and discussing missing data as an informative qualitative index within a postural and linguistic assessment in the preschool age. Overall, the current study provides new knowledge and methodological suggestions regarding the co-occurrence of the motor and linguistic domains from which to start to collect data using cutting-edge technology.

A3. Identifying common phrase-level pitch contours in natural infant-directed speech

Manash K. Sahoo (Indiana University-Bloomington), Jeremy I. Borjon (Indiana University-Bloomington), Chen Yu (University of Texas Austin), & Linda B. Smith (Indiana University-Bloomington, University of East Anglia)

Compared to adult-directed speech, infant-directed speech (IDS) is characterized by a higher fundamental frequency, increased pitch variability, exaggerated and repetitive intonation contours, a slower rate of speech, and a distinct spectral timbre[1]. Such exaggerated acoustic features may modulate the infant's attentional state[2,3] and highlight information at the level of words[4] and sentences[5]. Previous research[6] used longitudinal data collected from three mothers to reveal four common categories of pitch contours at the word-level: rise (a constant rise in pitch), fall (a constant fall in pitch), hill (an initial rise followed by a fall in pitch), and valley (an initial fall followed by a rise in pitch). The present study aimed to expand this finding by leveraging a large, longitudinal corpus of data collected from 42 unique caregivers interacting with infants 9-24 months of age across 164 experimental sessions. Utterances were defined by pauses in speech greater than 400ms and were manually coded resulting in a dataset 23,548 minutes in total duration. Agglomerative hierarchical clustering across the 17,670 utterances revealed 6 optimal utterance clusters. Pitch contour utterance clusters included complex contours such as hill and valley, however simple rise and fall contours were not found. Instead, the prosodic contours of caregiver speech would begin flat and gradually rise or fall, or they would begin with a fall or rise and end with a flat contour. To validate these clusters, we trained a k-nearest neighbors classifier on randomly partitioned data (80/20 split), to which we achieved 97.548% accuracy. Analyses revealed no developmental change in the proportion of prosodic clusters emitted by caregivers to infants 9-24 months of age. Future research will examine this on the word level, as well as how these different phrase-level clusters of pitch contours influence infant behavior such as visual attention and object exploration during naturalistic play.

A4. Moving language: Mothers' verbs correspond to infants' realtime locomotion

Ramya Manikkan, Anabelle Rampersaud, Kelsey L. West, Karen E.Adolph , & Catherine S. Tamis-LeMonda (New York University)

How do infants learn language? Infants can only learn the words that they hear. We tested whether infants' actions affect the words that their caregivers say—specifically whether infant locomotion influences caregivers' language about locomotion. Compared to crawling infants, walking infants travel greater distances at faster speeds (Adolph, et al, 2012). Does enhanced locomotion in walkers influence the verbs that caregivers say? We hypothesized that walking creates new opportunities for infant verb learning.

To disentangle locomotor ability from age, we observed same-aged crawlers and walkers (16 13-month-old crawlers and 16 13-month-old walkers) and an older group of walkers (16 18-month-olds) during two hours of activity at home. Mothers' language was transcribed verbatim. We then identified each "locomotor verb" that mothers said—that is, verbs pertaining to locomotion such as "come," and "bring". Finally, we identified each bout of infant crawling and walking.
Enhanced locomotor ability in walkers indeed opened up new opportunities for verb learning. Although mothers' overall language input was more frequent to older compared to younger infants, their locomotor verbs were more frequent to walkers than to crawlers. Preliminary findings show that caregivers directed more utterances to 18-month-olds (M = 2,006.00, SD = 579.02) compared to 13-month-old crawlers (M = 1,553.75, SD = 728.42) and walkers (M = 1,363.50, SD = 619.29), F (2, 31) = 3.23, p = .052. Notably, caregivers directed twice as many locomotor verbs to 13- and 18-month-old walkers (M = 53.13, SD = 15.40; M = 53.00, SD = 25.14, respectively) compared with 13-month-old crawlers (M = 25.25, SD = 12.87), $F(2, 31) = 5.46$, p = .01. Moreover, mothers' locomotor verbs were related to infants' moment-to-moment locomotion: Infants who moved more frequently received more locomotor verbs, and infants who moved less frequently received fewer locomotor verbs, $r(26) = .42$, p = .035. Our findings indicate that locomotor development leads to more advanced forms of activity, which in turn prompts caregivers to use more advanced forms of language.

A5. Markerless Motion Capture Advancements Offer a New Look Into Infant Persistence

Hannah Solby, Mia Radovanovic & Jessica Sommerville (University of Toronto)

Motion capture technology has long been used to gain insights into motor processes, however research investigating more complex cognitive psychological processes has not fully utilized this method. Largely, this is due to the inherent challenges of motion capture systems: they are financial straining and tedious to implement. Advancements in artificial technology are removing these barriers. DeepLabCut (DLC) is an open-source software that allows users to track body parts through space without the use of markers or specialized equipment. DLC expands the range of questions we can ask, and answer, by providing an informative, objective, precise measure.

To demonstrate the feasibility of implementing DLC, we provide a case study investigating infant persistence. Persistence in the face of difficulty is certainly necessary but sometimes, it is rational to give up trying on a task and strategize another approach. While persistence research has previously focused on time spent trying as an operationalization of persistence, we investigated if important differences emerged if we not only asked 'how long do infants try?' but also 'how do infants try?' We proposed that as infants explored new ways of solving a problem, there would be more spatial variability in rope movement. As such, we used DLC to measure spatial variability as proxy for exploration in an archival dataset collected by Lucca et al. (2020). The application of DLC revealed two novel facets of persistence (overall spatial variability and deviation from demonstration) that did not follow the patterns observed by Lucca et al. (2020) when measuring trying time. Simultaneously, spatial variability was highly predictive of other facets of persistence, such as frustration and optimism. These results highlight the multifaceted nature of persistence and the importance for research to measure persistence with multiple approaches in order to understand its nuances.

A6. The efficiency of trees: a topological study on face perception in infants

Silvia Polver (University of Milano-Bicocca), Ermanno Quadrelli (University of Milano-Bicocca), Chiara Turati (University of Milano-Bicocca), Hermann Bulf (University of Milano-Bicocca)

Introduction The aim of this study was to characterize the efficiency of processing and the topological functional configurations of 7-months-old infants' brain networks during emotional face perception, and to assess the role of face dynamics in shaping such organizations.

Methods Seven-month-old infants were randomly assigned to static (N = 22) or dynamic (N = 22) emotional stimuli presentations, comprising angry, happy, and neutral facial expressions[1].

We constructed the MSTs ("minimum spanning trees") on connectivity matrices for the alpha (6-9 Hz) and theta (3-5 Hz) bands on the 128-channel EEG signal. We then applied a stepwise linear regression with backward selection using the Akaike Information Criterion. All contrasts were corrected using the False Discovery Rate.

To characterize the efficiency of trees we used the Diameter: the smaller the Diameter the more efficient the communication between vertices[2].

To investigate the overall centrality of trees, we used the maximum eigenvector centrality (Emax)[3].

Results For the alpha band, results showed a decreased Diameter, $F_{(1,130)} = 5.18$, $p < 0.05$, in response to dynamic stimuli compared to static stimuli, $t_{(130)} = -2.27$, $p < 0.05$ (Figure 1).

For the theta band, results showed a decreased Emax, $F_{(2,129)} = 3.68$, $p < 0.05$, in response to angry faces compared to happy faces, $t_{(126)} = -2.68$, $p < 0.05$, with no effects for neutral faces (Figure 1).

Conclusions Results for the Diameter in the alpha band index a more efficient processing of dynamic stimuli, possibly guided by dynamic stimuli being more ecological, given that the alpha band is involved in the integration of complex information[4].

Regarding the theta band, the processing of happy faces might be more immediate compared to negative emotional expressions in infancy, due to greater experience with happy expression[5]. This hypothesis is supported by the role of the theta band in the elaboration of emotional information[6].

A7. iTapp: Interactive Toddler App

Eleanor. K. Braithwaite (Centre for Brain and Cognitive Development, Birkbeck, University of London), Emily. J. H. Jones (Centre for Brain and Cognitive Development, Birkbeck, University of London), & Robert. Leech (Kings College London)

Since smartphone use is now relatively ubiquitous, it is timely to explore how we can use these technologies in the field, particularly to increase the participation of families who are typically missed from developmental research.

Increasing diversity is critical to increasing generalizability of findings and creating effective support for the populations who may benefit the most from early intervention. Simultaneous overrepresentation of one demographic and underrepresentation of others may lead to a skewed interpretation of what constitutes 'typical' development and consequently of what is 'atypical'.

In addition, toddlerhood is a critical period during which children undergo considerable development, yet there remains a deficit of research into this age range. During toddlerhood, rapid social, emotional and motor development occurs, meaning collecting data in a timely and effective way is critical.

We are leveraging technological developments to gather data from typically hard-to-reach populations with reduced demands for participants and their families. We are developing an app for collecting information about child behaviour in low resource (i.e. non-laboratory, 'real life') settings. The app will consist of activities that the parent tries with their child; the parent then reports on their child's behaviour. It may also consist of touchscreen 'games' which the toddlers complete themselves.

In order to improve the reach of this research, the app will be developed in conjunction with parents, in a form of participatory-guided research. Recruitment of parents will focus on early education and care settings in areas of higher deprivation in an attempt to engage with parents of wider socioeconomic background than is typically included in research.

The aim is to develop an app which is well-suited for the needs and wants of families from a range of backgrounds, such that it can be used as a tool for remote data collection a more diverse sample of toddlers.

A8. Parent-child synchrony from birth to adulthood mediates neural representation of empathy

Adi Ulmer Yaniv (Interdisciplinary center Herzliya & Bar Ilan University), Roy Salomon (Bar Ilan University), Shani Waidrgoren (Interdisciplinary center Herzliya), Ortal Shimon-Raz (Interdisciplinary center Herzliya & Bar Ilan University), Amir Djalovski (Interdisciplinary center Herzliya & Bar Ilan University), & Ruth Feldman (Interdisciplinary center Herzliya)

Mammalian young are born with immature brain and rely on the mother's body and caregiving behavior for maturation of neurobiological systems that sustain adult sociality. While research in animal models indicated the long-term effects of maternal contact and caregiving on the adult brain, little is known about the effects of maternal–newborn contact and parenting behavior on social brain functioning in human adults. We followed human neonates, including premature infants who initially lacked or received maternal–newborn skin-to-skin contact and full-term controls, from birth to adulthood, repeatedly observing mother–child social synchrony at key developmental nodes. We tested the brain basis of affect-specific empathy in young adulthood and utilized multivariate techniques to distinguish brain regions sensitive to others' distinct emotions from those globally activated by the empathy task. The amygdala, insula, temporal pole (TP), and ventromedial prefrontal cortex (VMPFC) showed high sensitivity to others' distinct emotions. Provision of maternal–newborn contact enhanced social synchrony across development from infancy and up until adulthood. The experience of synchrony, in turn, predicted the brain's sensitivity to emotion-specific empathy in the amygdala and insula, core structures of the social brain. Social synchrony linked with greater empathic understanding in adolescence, which was longitudinally associated with higher neural sensitivity to emotion-specific empathy in TP and VMPFC. Findings demonstrate the centrality of synchronous caregiving, by which infants practice the detection and sharing of others' affective states, for tuning the human social brain, particularly in regions implicated in salience detection, interoception, and mentalization that underpin affect sharing and human attachment.

A9. Early Walking Leads to Changes in Parents' Spatial Input

Mert Kobaş & Tilbe Göksun (Koç University)

Walking onset can provide a cascading effect, leading changes in infants' social and physical interactions. Walkers comprehend and produce more words than crawlers (Oudgenoeg-Paz et al., 2012; Walle & Campos, 2014). Walking brings an advantage to interact with objects at distant places and share them with caregivers, which increase parent-child interactions (Clearfield, 2011; Karasik et al., 2014). Following these, walking experience may also increase parents' spatial verbal input related to location, deictics, and amount. We investigated whether (1) parents' spatial input changes by time between 14- to 26 months of infants' age, (2) spatial input is related to locomotion status at 14 months.

We tested 20 full-term infants at three timepoints (10 girls, Time-1: Mage=14.3; Time-2: Mage=20; Time-3: Mage=26.3). At every time point, we recorded parent-child free play sessions. Locomotion status was coded from Time-1 videos. Infants who walk more than 20 seconds independently were coded as walkers. Parents' spatial input related to location, deictics were coded from every time points (for a detailed coding schema, see Kısa et al, 2019). A mixed ANOVA results showed that parents' spatial input did not change across time, $p>.05$. The interaction between locomotion status and spatial input was significant, $F(2, 34)=4.05$, $p=.026$. Post-hoc tests revealed that caregivers of walkers produced more spatial input than caregivers of crawlers only at Time-3, $p=.016$. No other significant differences between walker groups were found at Time-1 and Time-2.

Our results suggest that walkers and crawlers do not receive different amounts of spatial words from their parents at 14 and 20 months. Parents of early walkers talked more spatially to their children at 26 months. The experience in walking enables different individual trajectories for development of cognitive skills such as communication through cascades. Therefore, the advantages of early walking on parents' spatial input may become prominent at 26 months.

A10. Real-time parent-infant negotiation during infants' acquisition of stair descent

Aaron DeMasi (The Graduate Center, the City University of New York), Michele Goncalves Maia (The Graduate Center, the City University of New York), Taylor N. Evans (University of Washington), Jalyssa Matos (Drew University), Lana B. Karasik (The College of Staten Island, the City University of New York & The Graduate Center, the City University of New York), & Sarah E. Berger (The College of Staten Island, the City University of New York & The Graduate Center, the City University of New York)

Parents report explicitly teaching infants to back down stairs because it is the safest descent strategy, despite the challenge associated with facing away from the goal1,2. In experimental settings, infants use parents' social information to make decisions in risky locomotor situations3. But how do parents spontaneously teach their infants a challenging, novel locomotor skill in real time, while keeping them safe?

To answer this question, we observed parents teaching their infants to descend stairs and documented the relation between parents' teaching behavior and infants' descent behavior. We recorded 22 infant-parent dyads (mean age= 13.91, *SD*=2.73; mean walk experience=79.73 days, *SD*=55.81) for 10 minutes in their homes using video-conferencing technology. From video we coded infant locomotor behaviors (e.g., backing down the stairs) and parent physical (hands-on and hands-off) and verbal behaviors.

The most common teaching strategies were hands-on spotting, verbal instruction, and moving infants' limbs (29% of trial duration). However, sequential analysis revealed that hands-on and verbal strategies alone were among the least likely to elicit subsequent infant behaviors. The only parent-led strategies that prompted infant behavior were the simultaneous combinations of hands-on and hands-off (e.g., touching baby while pointing), hands-off and verbal, or all three strategies. In contrast, almost any infant behavior, alone or in combination with parent strategy, significantly elicited additional infant behavior. Verbal strategies were intermittent, possibly to emphasize physical teaching strategies. The most common infant behavior was backing down which accounted for only 9% of trial duration.

Thus, learning to descend stairs was by-and-large infant-led and parents, while prioritizing keeping their babies safe, did not effectively teach stair descent. Parental control of infants' bodies may have reduced opportunities for practice. Ongoing analyses will consider how parents modify teaching techniques in response to infants' behaviors and the contexts in which infants are unlikely to respond to teaching attempts.

A11. Temporal dynamics of parent-toddler movement during shared attention

Sara E Schroer (University of Texas at Austin) & Chen Yu (University of Texas at Austin)

Social interactions are like a dance, with partners coordinating multimodal behaviors, making predictions about each other's actions, and sharing attention. By the second year of life, toddlers readily engage in shared attention (SA) (Yu & Smith, 2013), can predict their parents' actions (Monroy et al., 2020), and parent-toddler dyads move synchronously during an interaction (Hoch, Ossmy, et al., 2020). Although children will still their body while attending to and manipulating objects during solo play, little is known about how parent-toddler dyads coordinate their movement while sharing attention to an object.

We examined how 31 parent-toddler dyads (12-24mo) moved their heads and hands during instances of SA. While playing in a home-like lab, dyads wore 3 sensors to record movement, as well as wireless eye trackers to capture visual attention. Using the gaze data, we defined moments of SA at the frame-level (Yu & Smith, 2016) and calculated speed of each sensor in 3-dimensions (x,y,z) at each frame.

We plotted the temporal profiles of dyadic speed before and during SA and compared movement during SA to baseline speeds outside of SA. We found that dyads slowed their movement while in SA (*ps* < 0.01, using one-sample t-tests). We then analyzed mean speeds within SA using linear mixed effects regressions. Although toddlers' heads moved faster than parents' ($p < 0.001$), dyadic head speed negatively predicted the duration of SA (*ps* < 0.001). Lastly, we observed that hands moved more within SA if the attended object was being held (*ps* < 0.03, but toddler right hand $p = 0.052$). Our results suggest that dyads coordinate their movement during SA, with the attended object actively manipulated even as their bodies still. Our findings provide the foundation for studying the role of sensorimotor processes in coordinating social behavior and how these abilities develop in infancy.

A12. How Mothers Teach their Children to Use Everyday Objects

Brianna E. Kaplan (New York University), Jaya Rachwani (Hunter College, City University of New York), Isabella Kasaba (New York University), Catherine S. Tamis-LeMonda (New York University), and Karen E. Adolph (New York University)

The activities of daily living—eating, dressing, and grooming—involve objects that require specific designed actions for use (e.g., buttoning a shirt or unscrewing the lid of a jar). Children struggle to discover and implement designed actions because they often entail non-obvious object properties and require complex and specific motor actions (Rachwani, et al., 2020, J Exp Psych: Gen). Success also depends on the relations between children's bodies and motor skills, and the biomechanical requirements of the object, (i.e., the "child-environment fit"). Caregivers are cultural experts that likely provide social information to help children overcome the difficulties of discovering and implementing designed actions. However, researchers know little about if or how caregivers scaffold these actions. Mothers of 12- to 36-month-olds were asked to teach their children to open containers. The type (twist-off or pull-off lids) and the size (smaller than children's palms to bigger than children's hands) of the containers were varied to examine if mothers vary their teaching in accordance with the designed action and the child-environment fit.

We detailed the specific manual and verbal behaviors mothers used to teach their children, and preliminary results show that developmental change differed by mothers' behavior type. Mothers' overall manual input decreased across age ($p<.001$) and mothers' overall verbal input remained constant ($p=.16$). Mothers tailored their manual input to the type of designed action (twist or pull) and their verbal input to the child-object fit (container size). However, children were most successful when their mothers provided the least amount of manual input ($p=.02$), and children's success was not related to mothers' verbal input ($p=.31$). We are currently investigating the real-time correspondence between mothers' and children's behaviors.

A13. Investigating the links between brain function and parent-infant interaction in infants at elevated likelihood for Autism

Eirini Papageorgopoulou (Centre for Brain and Cognitive Development, Birkbeck, University of London)

Background: Some of the core signs of Autism Spectrum Disorder (ASD) include reduced eye contact and delays in social communication and interaction. Such precursors of ASD begin at around 12 months of age on the basis of behavioural characteristics, but brain function measures have been able to identify subtle differences in gaze and face processing and attention in these infants before that time. 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. However, research linking brain function and parent-child interaction (PCI) in the context of ASD has been limited. Methods: Using a Structural Equation Modelling approach, this study will explore associations between brain function and quality of PCI in a group of 247 8-month-old infants with (at elevated likelihood) and without (typical likelihood) a family history for ASD by correlating Event-Related Potential responses (ERPs) to faces with aspects of unstructured PCI and examining these based on 36-month ASD outcome. Results: We expect to find that PCI (particularly infant attentiveness and parent non-directiveness) will be linked to ERP responses implicated in response to faces differentially for EL-ASD infants from TL controls. Conclusion: this project will offer significant insights into the possible risk factors leading to ASD outcome and the role that PCI could play in children's developmental trajectories, which could form the basis for setting appropriate parent-targeted interventions and identifying early pre-emptive strategies for vulnerable infants.

A14. Mother Brain is Wired for Social Moments with the Baby

Ortal Shimon-Raz* (1), Roy Salomon* (2), Miki Bloch (3,4), Gabi Aisenberg Romano (3,4), Yaara Yeshurun (5), Adi Ulmer-Yaniv (1,2), Orna Zagoory-Sharon (1), Ruth Feldman (1)

1. IDC Herzliya, Israel
2. Gonda Brain Research Center, Bar Ilan University, Israel
3. Department of Psychiatry, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel
4. Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel
5. School of Psychological Sciences, Tel Aviv University, Tel Aviv, Israel.

Reorganization of the maternal brain upon childbirth, primed by oxytocin surge, triggers the expression of the species-typical maternal social behavior which usher young to social living (Feldman, 2015a; Numan and Young, 2016). These brief social moments of mother-infant social contact carry profound effects on the infant sociality, reorganize the infant's lifetime oxytocin system (Champagne et al., 2001; Feldman, 2016; Francis et al., 1999; Krol et al., 2019), augment the salience of social cues (Marlin et al., 2015), and sculpt the infant's brain and behavior to life within the social ecology (Hammock, 2015) and likely have a distinct signature in the maternal brain. Utilizing a double-blind, within-subject oxytocin/placebo administration crossover design, mothers' brain was imaged twice using fMRI while observing three naturalistic maternal-infant contexts in the home ecology; "unavailable", "unresponsive", and "social", when mothers engaged in synchronous pick-a-boo play. We found four processes by which the maternal brain registers social moments with the baby. Salience - social moments with the baby increased activations throughout the maternal brain network; Brain-behavior coupling - caregiving behavior linked with socially-driven neural response; Oxytocin sensitivity – the maternal network's responsivity primarily in the social context; and Temporal engrams– consistent temporal patterns across the maternal network characterized response to social play. Findings describe how the mother's brain compiles and amplifies these precious social moments to generate dyad-specific brain-behavior patterns that initiate the cross-generational transmission of human sociality.

A15. Using customized NIRS-EEG to study infant functional connectivity during sleep

Louisa K. Gossé (Birkbeck College, University of London), Frank Wiesemann (Research & Development, Procter & Gamble, Schwalbach am Taunus), Clare Elwell (Department of Medical Physics and Biomedical Engineering, Biomedical Optics Research Laboratory, University College London), & Emily J.H. Jones (Birkbeck College, University of London)

Introduction. Recent research has shown that sleep quality matters more for infant development than sleep duration. It is still unclear what happens in the infant brain during sleep that can impact development. Simultaneously, there is large individual variability in functional connectivity patterns in infancy and these individual differences have been shown to predict later cognitive development[1]. Studying individual differences in functional connectivity patterns during sleep could provide information about underlying mechanisms connecting sleep and development. To study this we developed the first bespoke neuroimaging headgear that combines both wireless EEG for sleep stage assessment and fNIRS to assess connectivity patterns during infant sleep. We present results of a proof-of-concept sleep study to investigate the feasibility of using combined NIRS-EEG during a nap to provide a novel way to understand the ways in which sleep and development are related.

Method. N = 26 infants (age 5-8 months) took part in the nap study at Birkbeck Babylab, London, UK. 11 (7 girls) infants slept using a customized NIRS-EEG headgear that combined a 20-channel EEG system (ENOBIO) with a 44-channel NTS Gowerlabs NIRS system. Parent-report questionnaires recorded infant developmental status and habitual sleep patterns. fNIRS data was epoched into 120s epochs and channel-by-channel correlational analyses were performed to obtain connectivity matrices for every epoch. Thereafter, k-means cluster analysis was used on all concatenated sleep epochs of all participants to identify recurring connectivity patterns in the NIRS data.

Results. Infants nap duration varied from 23-63 minutes (*M*: 39.64, *SD*: 13.96). Connectivity matrices of every epoch/ subject showed differences in connectivity across the sleep period in every infant. Overall occurrence of connectivity clusters differs across individual naps. Insights from the sleep study were used to design a new version of the headgear that was wireless.

Discussion. The results suggest individual differences in connectivity pattern occurrence during a nap in infants, that we interpret as individual differences in sleep quality. This first proof-of concept study showed the feasibility of using NIRS-EEG to study the relationship between sleep and development. The newly designed wireless NIRS-EEG headgear enables future infant sleep studies outside of the lab.

B1. Individual differences in cognitive and psycho-emotional functioning and the impact of acute physical activity in children with ADHD

Madeline Crichton (University of Western Ontario), Hannah Bigelow (University of Western Ontario), Marcus Gottleib (University of Western Ontario), Barbara Fenesi (University of Western Ontario).

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common neurodevelopmental disorders in childhood. ADHD is characterized by deficits in executive functioning (EF), which includes cognitive skills such as inhibition, working memory, and cognitive flexibility. Even single, short bouts of physical activity have been shown to lead to immediate improvements in EF, and therefore physical activity has been proposed as an intervention for children with ADHD. However, children with ADHD are not a homogeneous group and individual differences may impact the effectiveness of physical activity interventions for this population. This study investigated the impact of individual differences in cognitive and psycho-emotional functioning on the effect of an acute bout of physical activity in children with ADHD. In a within-subjects design, 16 children with ADHD (age 10-14) completed a 10-minute moderate intensity physical activity session and a control session (silent reading) one week apart. Measures of mood and self-efficacy were collected at the beginning of each session. Participants completed a measure of inhibitory control pre-intervention, post-intervention, and after a 10- minute delay. Participants with lower inhibitory control at pre-intervention benefited more from physical activity than participants with higher inhibitory control. Participants' mood state impacted the effect of physical activity on inhibitory control, whereas participants' self-efficacy did not. This study demonstrates that individual differences in cognitive and psycho-emotional functioning can alter the impact of physical activity on children with ADHD.

B2. Human infants can learn and generalize number-action mappings

Ludovica Veggiotti & Maria Dolores de Hevia (BabyLab INCC Paris, CNRS [Integrative Neuroscience and Cognition Center, UMR 8002], Université Paris Descartes, Sorbonne Paris Cité)

Humans' inborn ability to discriminate, represent, and manipulate numerical quantities' is supported by the parietal cortex, which is also involved in a variety of spatial and motor abilities (Eger, 2016). While the behavioral links between numerical and spatial information have been extensively studied, little is known about the behavioral connection between number and action. Some studies in adults have shown a series of interference effects when simultaneously processing numerical and action information (e.g. adults are quicker in opening (closing) their hand in response to large (small) numbers; Andres et al., 2004). We investigated the origins of this link in human infants (7- to 9-month-old) using a habituation paradigm. Forty infants were tested in one of two experimental conditions: one group was habituated to congruent number-hand pairings, where the larger the number, the more open the hand-shape associated; the second group was habituated to incongruent number-hand pairings, where the larger the number, the more close the hand-shape associated. In test trials, both groups of infants were presented with one instance of a congruent and one instance of an incongruent pairing (using new combinations of numbers and hand-shapes). We found a significant Habituation condition x Test trial interaction (p=.01), as only infants habituated to a congruent number-hand pairing showed a significantly higher looking time to the test trial depicting an incongruent pairing (cong: M=6.1s vs. incong: M=12s; p_{bonf}=.02); in contrast, infants habituated to an incongruent pairing did not show any looking time difference between test trials (cong: M=10.4s vs. incong: M=9.2s; p_{bonf}=1). These findings show that infants spontaneously associate magnitude-related changes across the dimensions of number and action-related information, offering thus support to the existence of an early, preverbal number-action link in the human mind.

B3. Move together, bond together: Visuomotor synchrony and social bonding in children and adults

Ellen M. Howard (The University of Nottingham), Danielle Ropar (The University of Nottingham), Roger Newport (Loughborough University), & Bahar Tunçgenç (The University of Nottingham & University of Oxford)

Interpersonal synchrony is a fundamental part of human social interaction, with known effects on facilitating social bonding. Moving in time with another person facilitates prosocial behaviour, however, it is unknown if the precise degree of synchronisation predicts the degree of social bonding. Moreover, while people readily fall in synchrony even without being instructed to do so, we do not know whether such spontaneous synchronisation elicits similar prosocial effects as instructed synchronisation.

We investigated how context (social vs non-social stimulus) and instruction (instructed vs uninstructed) influenced synchronisation accuracy during a finger-tapping task and social bonding with the interaction partner. We tested 53 children from a wide age range (27 girls, *M*age = 8.80, age range: 4.53 – 14.32 years). As dependent variables, we assessed (i) how physically close the children preferred to be to their interaction partner in hypothetical scenarios, and (ii) how much they spontaneously mimicked the mannerisms of their interaction partner during a conversation. The results revealed a facilitatory effect of the social (compared to non-social) context on visuomotor synchronisation accuracy, social closeness and spontaneous mimicry. We found a significant negative relationship between synchrony errors and social closeness (r =-.34, p = .01), therefore the greater the synchronisation the greater the feelings of closeness. Children also synchronised better when explicitly instructed to try their best to match the stimulus compared to when they were left free to tap as they wished. Instruction did not have an impact on feelings of social closeness or mimicry frequency. These findings suggest that whilst a broad joint action context facilitates visuomotor synchronisation and bonding, the precise degree of sensorimotor coupling can further facilitate social bonding in children. Future research can use larger sample sizes to examine how these patterns change over the course of development.

B4. Does the emotional information conveyed in adults' action kinematics inform infants' object exploration?

Joanna Rutkowska (Donders Institute, Radboud University), Julia Mermier (Department of Psychology, University of Milan-Bicocca), Marlene Meyer (Donders Institute, Radboud University), Chiara Turati (Department of Psychology, University of Milan-Bicocca), Hermann Bulf (Department of Psychology, University of Milan-Bicocca), & Sabine Hunnius (Donders Institute, Radboud University)

Infants use others' behaviour to guide their own actions and object exploration (Brosseau-Liard &Poulin-Dubois,2014; Carpenter et al.,1998) and take advantage of emotional information embedded in others' facial expressions and vocalisations to modulate their own behaviour toward objects (Mumme & Fernald, 2003). Recently, it has also been shown that infants are sensitive to the emotional information conveyed by others' action kinematics (Addabbo et al., 2019). The current study investigates whether 12-month-old infants are capable to use the happy and disgust information embedded in adults' object transportation movements (kinematics) to modulate their behaviour towards the same objects. After watching the videos of an adult transporting two objects, one with happy kinematics and one with disgusted kinematics, infants will be presented with the two previously shown objects and allowed to play with them. We expect that infants will choose to first interact with the object transported with happy kinematics and that they will look at it and play with it more than with the object transported with disgusted kinematics. The data collection is currently in progress. To date, this is the first study examining infants' sensitivity to happy and disgust kinematics, and whether kinematic cues are sufficient to influence infants' object exploration behaviour.

B5. How do children learn to associate specific characteristics to social category members?

Magali Mari (Ludwig-Maximilians-Universität München & Université de Neuchâtel)

Young children like adults can predict the characteristics of others, based on their social category membership (e.g., “if the social category A play the piano, then X, as a member of category A, will also play the piano). Whereas previous research showed evidence that children of 3 years old can predict characteristics based on social category membership (Kinzler, Shutts, & Correll, 2010; Over & McCall, 2018), less is known about the mechanisms involved when children learn to associate characteristics to social category members.

The present study investigated whether children (4-9 years old) learn to associate characteristics to social category members based on labels, repetitive pairings, or both. Previous works showed that using a label upon the presentation of a category member’s characteristic suffices to prompt children to generalize the characteristic to all category members wearing this label (Gelman & Heyman, 1999; Kinzler et al., 2010; Moty & Rhodes, 2021). Other works revealed that children need to be exposed repetitively to social category members and their characteristics to be able to generalize the characteristics to other members (Bigler & Liben, 2006; Riggs & Long, 2020). This study aimed to investigate these mechanisms simultaneously and in interaction.

In a pilot study, 19 children were randomly assigned to one of three conditions that manipulated how characteristics were presented: with a label (“This Kroller makes baskets”), with repetitive pairings (presenting six individuals out of eight who make baskets), or both in interaction (six “Krollers” out of eight make baskets). All children were also assigned to a control condition (“This person makes baskets”). Then children were introduced to a new individual from the same social category and asked to predict its characteristic. The pilot study revealed that 7–9-year-olds relied more on labels than repetitive pairings to make their predictions, whereas 4–6-year-olds relied more on repetitive pairings. A full study is planned to further attest those results and to provide new insights on the mechanisms involved in children’s learning of social category characteristics.

B6. The development of being moved by sad music

Mareike Kaemmerer (UCLouvain), Naomi Marchant (University of Brussels), & David Grüning (Heidelberg University)

Listening to sad music can well be a positively moving experience (Eerola et al., 2016).
The aim of the present study is to draw a temporal trend of childrens' experience to be moved by sad music. That is, we attempt to show how children's age affects their emotional response to sad music. To enlighten the underlying processes of this trend we will, across the age span of 3 to 12 years, assess (1) children's ability to use the theory of mind (ToM), (2) their ability for empathy, and (3) their attachment with central figures in their life.

We plan to recruit pupils of different ages from Belgian schools. In the first part of the study, we will assess childrens' ability of ToM (Peterson et al., 2012), empathy, and their attachment (Stern & Cassidy, 2017). In the second part of the study, the children will individually listen to a piece of sad music. Afterwards, their emotional responses to the music will be assessed with age appropriate questionnaires.

The measurement design is at the center of our presentation. Measurements must meet two criteria to ensure that the results are comparable across all ages. First, they need to adequately measure the same construct across childhood. Second, the measures should be comprehensible for our youngest participants. Appropriate scales remain to be selected for the measurement of the three underlying variables. We suggest to evaluate children's emotional responses to a sad music piece (i.e., scared, happy, angry, calm, sad) with a graphically supported 4-point Likert-scale (Nook et al., 2020). Advantages and limitations of scales under consideration will be discussed.
With the planned study we hope to enlighten the developmental stages of being moved by music and identify mechanisms associated with this process.

B7. Until it bores me': Learning Progress Maximisation as the Reward Mechanism to solve the Exploration-Exploitation Dilemma in Infants

Elena Altmann, Marina Bazhydai, & Gert Westermann (Lancaster University)

Infants explore the world to learn about it based on their intrinsically motivated curiosity. However, the mechanisms underlying such exploratory behaviour are largely unknown. We propose a new theory in which active learners explore randomly until encountering a familiar entity (e.g., a second stimulus from a previously encountered category) because here, learning is suddenly maximised. Such a category will then be exploited as long as the learning progress is above an individually varying 'boredom threshold'; Above this threshold, learning is rewarding–positively reinforcing exploitation. Below this threshold, the learning progress is too small to be rewarding, and they will return to random exploration. The threshold itself can be lowered through inhibition, allowing sustained attention despite smaller learning progress. Here, we will first test this theory in a gaze-contingent eye-tracking task: 10-month-old infants will be introduced to two novel stimulus categories with 30 exemplars each (Fribbles, TarrLab). Two identical "houses" will be presented on a computer screen, and a new exemplar from either category will be revealed when the infant fixates on the corresponding house. This design will enable us to distinguish between exploration–switching from one category to the other–and exploitation–consecutively triggering exemplars from the same category. In follow-on studies we will test older children as well as adults, who will be able to trigger exemplar presentations via key presses. Across age groups, we will measure the number, speed, and sequence of trigger-events, as well as the switches between categories. We hypothesise that if a category was triggered twice it is more likely to be triggered again; the first two triggers establish familiarity and allow for learning which will be rewarding, reinforcing further exploitation. While the length of 'exploitation-runs' may differ between participants (representing varying boredom thresholds), constant switching between categories is unlikely as it inhibits maximised learning.

B8. Spatial biases in infants' learning of serial order: evidence for the role of cultural experience

Martina Arioli (University of Milano-Bicocca), Viola Macchi Cassia (University of Milano-Bicocca), Nobu Shirai (Niigata University), Megumi Kobayashi (Institute for Developmental Research, Aichi Human Service Center) Martina Arioli (University of Milano-Bicocca), Hermann Bulf (University of Milano-Bicocca), Masami K. Yamaguchi (Chuo University)

Recent evidence shows that directional spatial information modulates serial order processing in preverbal infants raised in Western cultures, who are better at learning increasing numerical order and rule-like structures from left-to-right oriented sequences than from right-to-left sequences (de Hevia et al., 2014; Bulf et al., 2017).These findings resonate with those showing that the spatial attributes of short-term memory for serial order vary cross-culturally in adults 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 representation of order by testing implicit learning of spatio-temporal visual sequences in Japanese and European 7-month-old infants. 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 organized in ABB and ABA rule-like patterns presented in left-to-right or right-to-left orientation. Test trials consisted of triplets of novel shapes depicting the familiar or a novel rule with the same spatial orientation as the familiarization trials. Japanese infants successfully transferred the familiarization rule to the familiar test sequences irrespective of spatial orientation, while European infants failed when sequences were presented from right to left.

We interpreted European infants' failure under right-to-left presentation condition as the developmental outcome of implicit experience with a 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 we recorded 1-min sessions of joint book reading and toy construction; the scoring of the directional behaviors produced by the caregiver will help us to clarify the role of cultural experience in driving infants' spatial biases.

B9 The temporal architecture of neonatal imitation: a report of work in progress.

Timothy McGowan (Laboratory for Innovation in Autism, University of Strathclyde), Christos Tachtatzis (Electronic & Electrical Engineering, University of Strathclyde, UK), Jonathan Delafield-Butt (Laboratory for Innovation in Autism, University of Strathclyde)

Neonatal imitation is of fundamental concern for understanding the nature of human communication, its evolution and development. Since the publication of Meltzoff and Moore's (1977) seminal paper, it has been discussed and debated at considerable length but the temporal structure within which imitation is claimed to occur has received limited attention. We propose that underlying successful examples of neonatal imitation exists a narrative temporal structure, consisting of phases of arousal and intensity that can be split into four distinct states: introduction, development, climax and resolution (Delafield- Butt & Trevarthen, 2015). This is common to human pre-verbal and verbal meaning-making, and is expressed and perceived not only through vocalisations but also through movement (Delafield-Butt & Trevarthen, 2015; Malloch, 1999; Malloch & Trevarthen, 2009).

To test this, we will apply a computational analysis to the vocalisations and movements of both participants and experimenters in recordings taken from past studies of neonatal imitation. We will use audio analysis to consider the pitch, timbre, volume and general intensity of acoustic expression, and video-based tracking software using a form of deep learning (specifically convolutional neural networks) in order to predict and track the location of body parts. Another machine learning approach (for example a similarity learning based Siamese network architecture) will then be used to cluster data according to features corresponding to levels of intensity in the interaction. This clustering according to similarity will better enable us to understand if there is a common temporal structure underlying neonatal imitation, and if this common structure follows a narrative framework. The presence of a narrative structure will support the view that neonatal imitation is a dialogical phenomenon (Nagy, 2006) that forms one of the first examples of primary intersubjectivity (Kugiumutzakis & Trevarthen, 2015), exemplifying the importance of the neonatal period in human psychological and social development.

B10. Measuring Theory-of-Mind in Children with Multiple, Severe Disabilities: Preliminary Cases from a Pilot Investigation

Naomi Aldrich, Mallory Haynie, Lisa K. Kenyon, & Naomi J. Aldrich (Grand Valley State University)

The pilot investigation addresses limitations concerning the assessment of the sociocognitive capacities of children living with multiple, severe disabilities. The inherent difficulty in assessing the abilities of these children lies in how to do so without relying on tasks/response actions that prevent assessment for those with lower skill levels for whom diminished mental functioning is often assumed (Hutton & Pharoah, 2002; Kurmanaviciute & Stadskleiv, 2017).

Given the increased health risks associated with the COVID-19 virus for this population, we developed a fully-online protocol to measure parental perceptions of children's social cognition while accounting for children's executive functioning and daily living skills (e.g., communicative abilities) and parental mind-mindedness (e.g., inclination to treat child as an independent thinker with own behavioral motivations), parenting stress, and socio-economic status (SES).

As part of our ongoing pilot, the mothers of three boys with cerebral palsy, varying in impairment (Gross Motor Function Classification System III, IV, and V; 11y; 7m – 13;5), participated in two sessions across a 3-week period. During the first session, the mother completed assessments of her child's theory-of-mind abilities (CSUS), daily functioning (ABAS), and SES (HOI). In the second session, the mother completed measures of her child's executive functioning (BRIEF), parenting stress (PSI), and a mind-mindedness interview (i.e., i.e., Can you describe [child] for me?). The interview was scored for mind-mindedness (Meins & Fernyhough, 2015), and was coded using an automated text-analysis program (LIWC). Overall, differences were found between the three boys' theory-of-mind abilities that may relate to differences in impairment, executive functioning, and daily life skills. Similarities and differences were observed between mothers' levels of analytical thought, clout, authenticity, and emotional tone when describing their son. While additional data is needed, this initial evaluation supports the current protocol's use for assessing theory-of-mind skills in children living with multiple, severe disabilities.

C1. The functioning of visual attention in infants at risk for Autism Spectrum Disorder

Giada Basset & Bulf Hermann Sergio (University of Milano-Bicocca)

Autism is a neurodevelopmental disorder which underlying causes constitute a large field that is still being explored. The aim of this work was to outline the main research advances in the study of the relation between autism spectrum disorder (ASD) and visuospatial attention as its early marker, focusing on the theoretical framework, the main results achieved and the possibilities of early interventions. More specifically, the present work summarizes those studies that used an infant sibling approach to investigate attention disengagement and shifting in preverbal infants at risk for ASD, and the relation between these early attentional processes and the first signs of ASD assessed through follow-up measures like the Autism Observational Scale for Infants (AOSI). Results revealed that atypicalities in attention disengagement and shifting in the first months of life are linked to ASD diagnosis. For example, it has been shown that long latencies in visual disengagement of attention and reduced facilitation effects are predictive of ASD: an increment in the latency of visual disengagement between 7 and 14 months predicts ASD diagnosis, along with atypicalities in the neural response to gaze shifts at 7 months and in visual disengagement at 14 months. Overall, these findings indicate that visuo-spatial attention may be an early marker of ASD, allowing to identify infant at risk before a diagnosis of ASD and offering the possibility to implement early interventions that take advantage of the neuronal plasticity of toddlers.

C2. Children´s multi-step action planning in home environments

Maria Paz Cebrecos, Lisanne Schröer, & Denis Mareschal (Centre for Brain and Cognitive Development, Department of Psychological Science, Birkbeck, University of London, United Kingdom)

Action planning is an important skill that develops through infancy and childhood. In everyday life, adults execute a large number of action sequences with multiple action steps. Humans structure action sequences into sub-goals to attain a desired goal (Hayesroth & Hayesroth, 1979). Under laboratory conditions, pre-school children can hierarchically organise goal representations when executing action sequences to achieve a hierarchy of goals (Freier et al., 2015; Schröer et al., 2021). In daily life, children are exposed to multiple goals simultaneously rather than one isolated goal at a time. The aim of this study is to look at children´s multi-step action planning in home environments. More specifically, we want to identify what strategies children employ when planning action sequences to simultaneously achieve several goals.

We designed an experiment in which 4-, 5-, and 6 years-old children will draw and colour a model house while simultaneously performing a secondary task. Additionally, because working memory (WM) plays an important role in planning (Radüntz, 2020) and is essential for maintaining and coordinating sub-goal sequences, we will assess WM using a backward digit span task.

We hypothesize that both planning and working memory abilities will improve with age. Moreover, we expect older children to employ more efficient planning strategies, such as interleaving the action sequences of different main goals to achieve them simultaneously. Finally, we think that the secondary task will affect children´s performance over the main goal, especially at branch points between sub-goals. This deterioration effect of the secondary task will be larger in younger children.

C3. Deciding upon the motor goal: The physical expression of selective motor planning in preschoolers

Johanna K. Maninger (Centre for Brain and Cognitive Development, Birkbeck University of London), Lisanne Schröer (Centre for Brain and Cognitive Development, Birkbeck University of London), Richard P. Cooper (Centre for Cognition, Computation and Modelling, Birkbeck University of London), & Denis Mareschal (Centre for Brain and Cognitive Development; Centre for Cognition, Computation and Modelling, Birkbeck University of London).

It has been demonstrated that the ability to plan and organize hierarchical action sequences improves in preschoolers with increasing age. This improvement can be investigated through embodied markers of planning (Schröer et al., 2021). Children who were able to accurately follow a pre-set subgoal order on a construction task displayed relative stillness of their non-constructing hand while executing a subgoal.

The present study is trying to identify such embodied markers of sequential action planning by looking at existing video recordings of 40 three- to five-year-old children performing the Duplo construction task. The study looked at markers such as hesitation, unimanual construction behaviour, looking at experimenter, and mouth movement.

Results indicated that children who were able to follow the action sequence in line with a main goal (good planners) were less likely to look at the experimenter and hesitated less than children who were unable to follow the main goal and confounded the subgoal order. Additionally, younger children, compared to older children, hesitated more, tended to construct unimanually even when struggling, and were more likely to look at the experimenter.

Furthermore, older children, as well as children who successfully followed the subgoal steps and overall goal, were more likely to show hesitant behaviour at branch points (subgoal switch), than younger children and children who mixed up the action steps and were unable to follow the main goal. These results demonstrate that hierarchical sequential action planning matures over the preschool years and that embodied markers could be beneficial in the investigation of this development.

C4. Measuring and understanding the interplay between in-home noise and the development of infant sleep and sensory processing

Brittney Chere, Giulia Serino, Natasha Kirkham (Birkbeck, University of London)

While it is known that environmental noise negatively affects many aspects of development during school-aged years (Shield & Dockrell, 2003), it is still unclear how and what aspects of noise may be affecting early infant development, particularly sleep and sensory processing. Furthermore, the difficulty with measuring the ever-changing infant sleep pattern has led to mixed findings on how sleep affects infant development (e.g. Tikotzky & Volkovich, 2019). Sixty-nine 10-to-12-month-old infants were included in the current study. The novel facet of this study was the direct measure of in-home noise using an SLM, both from the room the baby sleeps in and another room the baby spends many hours in, giving a clear indicator of the infant's experience with environmental noise. Furthermore, sleep was measured using both the BISQ and a Sleep Diary, and the Toddler Sensory Profile 2 Questionnaire was used to measure auditory and general sensory processing. Principal component analyses were used to reduce the dimensionality of the sleep and noise measures. The BISQ had two components, night sleep disturbance and day sleep, and the Sleep Diary had a night sleep disturbance component and a sleep duration component. Interestingly, the two noise measure components were noise from the baby's room and noise from the other room, rather than being grouped based on specific aspects of the noise (e.g. noise fluctuation). These were then used as predictor variables in further regressions, which revealed that while noise did not influence sleep, noise from the other room significantly predicted better auditory processing ability (r^2 = .096, p = .023). Furthermore, higher night sleep disturbance (BISQ only) predicted significantly worse general sensory processing ability (r^2 = .109, p = .012). These results make evident the importance of directly measuring in-home noise and using various sleep measures to better understand infant development.

C5. The role of spatial frequencies in newborns' preference for dynamic emotional expressions

Valentina Silvestri, Martina Arioli & Viola Macchi Cassia (University of Milan-Bicocca)

The processing of human faces relies both on featural/local and configural/global information, mediated, respectively, by low and high spatial frequencies (Goffaux et al., 2005). Several studies show that adults' expertise in emotion discrimination relies on the encoding of the low spatial frequencies content of the stimuli (Vuilleumier et al., 2003), which has also been linked to the involvement of the fast-responding magnocellular visual pathway. Recent evidence suggests that, unlike adults, infants' (7 months) discrimination of facial emotional expressions is mediated by high spatial frequencies (Jessen & Grossmann, 2017).

The few existing studies investigating newborns' ability to discriminate facial emotional expressions suggest that happy faces are preferred over fearful faces under static presentation condition (Farroni et al., 2007), while they are not preferred over disgusted faces when stimuli are dynamic (Addabbo et al., 2018). In light of earlier demonstration that newborns rely on low-spatial frequencies when discriminating among neutral facial identities (de Heering et al, xx), we aimed (1) to replicate earlier demonstration of newborns' preference for happy over fearful faces using dynamic stimuli, and (2) to investigate which spatial frequencies (SF), high or low, are necessary and sufficient to evoke this preferential response.

Three groups of 2-day-old newborns (N = 63) were tested in a preferential looking task in which dynamic displays of happy and fearful expressions were simultaneously presented under three spatial filtering conditions: Full-Spectrum, Low-Pass (< 0.5 c/g), High-Pass (> 0.6 c/g). A preference for the happy face was found in both the Full-Spectrum and the High-Pass conditions, but not in the Low-Pass condition, suggesting that, like older infants, newborn rely on the high-SF content of the stimuli when encoding and discriminating facial emotional expressions. Results are discussed in light of their implications for the understanding of the perceptual and neural mechanisms involved in emotion processing at birth.

C6. Young children show a lower body posture after failing to help others: Insights from motion depth sensor imaging

Stella C. Gerdemann [1,2], Bianca Dietrich [3], Jenny Tippmann [4,5], Jan M. Engelmann [6], Robert Hepach [7]

(1) Department of Early Child Development and Culture, Leipzig University, Germany
(2) Leipzig Research Center for Early Child Development, Leipzig University, Germany
(3) Department of Psychology, Bremen University, Germany
(4) Center for Evidence-based Healthcare, Technical University of Dresden, Germany
(5) Institute for Medical Informatics and Biometry, Technical University of Dresden, Germany (6) Department of Psychology, University of California, Berkeley, USA
(7) Department of Experimental Psychology, University of Oxford, United Kingdom

The self-conscious emotions, guilt, and shame, motivate the adherence to social norms, including to norms for prosociality (Kagan 1981; Kochanska et al., 2002; Vaish et al., 2016). Despite the relevance of self-conscious emotions to behaviors such as helping and sharing, key aspects of their early development remain poorly understood. Here we measured children's emotional expression via changes in their upper body posture recorded using a motion depth sensor imaging camera (Hepach et al., 2015; 2017). In Study 1, 5-year-old children (N = 68) displayed a lowered upper body posture in response to being unable to help someone in need compared to the resolution of the situation, $\chi 2(1) = 10.45$, $p = .001$. Failing to help lowered children's upper body posture regardless of whether children were observed by an audience or not. To investigate the development of this emotional response and to replicate the findings of Study 1, we conducted Study 2 with 4- to 5- year-old children (N = 93). Five-year-olds showed a greater decrease in upper body posture than 4-year-olds, $\chi 2(1) = 5.61$, $p = .02$, and children showed lowered upper body posture after failing to help compared to the resolution of the situation, $\chi 2(1) = 4.23$, $p = .04$. Our findings suggest that being observed is not a necessary condition for young children to express a negative emotional response after failing to help. We conclude that 5-year-olds, more so that 4-year-olds, show negative emotions when they fail to adhere to social norms for prosociality.

C7. Is there convergence between toddler attention during naturalistic exploration and toddlers observing the exploration?

Annie Schwartzstein (Princeton University), Sammy Floyd (Princeton University), Lillian Mannion (Princeton University), Chen Yu (University of Texas at Austin), & Lauren Emberson (Princeton University)

Research has begun using head-mounted camera recordings to investigate how children process input from their natural environment and understand attention and object exploration in these settings (Smith et al., 2011; Bambach et al., 2017; Yu & Zhang, 2016). One approach to understanding this is by recording visual input received by one child as they explored and presenting it to another child in a laboratory setting. There are myriad benefits to this approach (e.g., experimental control, recording behavioral/neural responses), commonly known as a playback approach (Aslin, 2009). Addressing a key assumption of this approach, the present work explores whether there is convergence between the attention of naturalistically-situated participants and in-lab participants viewing the input. Twenty-five 18- to 24- month-old toddlers viewed egocentrically recorded 10-second clips of object exploration of 11 different toys from the perspective of other toddlers of the same age. To investigate how context may affect attention, each toy was shown in two conditions: the No Context condition showed the 10-second object exploration clips, while the Context condition showed the same 10-second clips with 10 seconds of additional footage preceding and following object exploration. We hypothesized that toddlers watching the videos would, like the headcam-recorded toddlers, look at the main toy being explored and be synchronized with other laboratory-based toddlers, and that additional footage would increase the synchrony of toddlers, as this allowed more opportunity to align with the headcam-recorded toddler. Our results revealed that toddlers synchronize their attention with other participants and with the toddler who generated the video, and toddlers focus on the primary toy being explored. Contrary to our hypothesis, we found that additional footage decreased synchrony within our participants and decreased how often toddlers looked at the main toy. We consider these findings in relation to bottom-up vs. top-down sources of information from object exploration.

C8. Do children like angles? Sensitivity to low-level visual features on emotional judgment in children

Yaelan Jung (Princeton University, Department of Psychology), Annie Schwartzstein (Princeton University, Department of Psychology) , Claudia Damiano (KU Leuven, Department of Psychology and Educational Science) , Wil Cunningham (University of Toronto, Department of Psychology), Dirk Bernhardt-Walther (University of Toronto, Department of Psychology) , Lauren Emberson (Princeton University, Department of Psychology)

Simple visual features, such as angles or the length of a line, impact emotional and aesthetic judgment on objects (Bar & Neta, 2006; Larson, Aronoff, & Stearns, 2007). For example, research has shown that people prefer objects with smooth curves to those with sharp angles. Is such preference to smooth lines an innate property of the human visual system? Non- smooth curves are highly correlated with negative stimuli (i.e., sharp teeth, knives) and this, among other factors, may have supported evolutionary adaptation. If this is true, young children with limited experience in the real-world should show the same preference for smooth curves as adults. On the other hand, preference to smooth lines may be a trait that is learned throughout experience, which children acquire as they age. In the current study, we aim to explore how low-level visual features impact emotional judgments in children, and how this sensitivity might change with age. We predict that preference to smooth lines is a property that children learn through experience. If this is the case, then we should expect greater impact from low-level visual features on emotional judgment as children age. Otherwise, there will be no age differences on the sensitivity from low-level visual features. To study how preference for smooth curves change over the course of development, we are currently collecting data from four different age groups: younger children (3-5), middle children (6-8), older children (9-11), and adults. In a pre-registered study, we will systematically explore how different low-level features (Orientation, Curvature, and Length) in abstract pictures impact emotional judgments (happy vs. upsetting) using the paradigm designed by Damiano, Walther, & Cunningham (in revision). While online data collection is concluding, pilot data suggests that children's sensitivity to these features is different to adult's sensitivity. Our pre-registered analyses will be presented in our poster.

C9. Visual rule learning in 3-month-old infants: the role of working memory

Giorgia Gintili, Martina Arioli, Roberta Bettoni, Viola Macchi Cassia, Hermann Bulf (University of Milano Bicocca)

Rule learning (RL) is defined as the ability to detect repetition-based, high-order rules from triplets of elements and to generalize them to new items. Many studies have demonstrated that RL is a domain-general mechanism that emerges early in infancy and operates in different domains and modalities. RL abilities have been widely explored in infants older than 5 months of age. At younger ages, only a study by Ferguson et al. (2018) indicated the presence of RL abilities in 3-month-old infants when the triplets of visual items were presented simultaneously on the screen and irrespectively from the saliency of to-be-learned stimuli (geometrical shapes vs. images of animals). The aim of the present study was to extend Ferguson et al.'s findings in a condition in which the load of infants' working memory was increased. Using a visual habituation task, 3-month-old infants (N= 35) were exposed to ABB and ABA visual sequences of low-salient (geometrical shapes) or high-salient stimuli (images of looney tunes). Differently by Ferguson et al. (2018), visual stimuli were not presented simultaneously, but were displayed sequentially from left to right. Results showed that infants were not able to learn and generalize the ABB/ABA repetition-based visual rules, neither in the low-salient stimulus condition, nor in the high-salient one.
When compared to Ferguson et al.'s findings, our data indicate that a sequential presentation of the visual items disrupted 3-month-olds' RL abilities, because it requires to maintain in memory the visual features of earlier figures in order to create a high-order relationship with the later elements of the triplets, thus challenging infants' working memory abilities.

C10. Effects of increasing the cost of movement on infants' locomotor exploration

Justine Hoch, Christina Hospodar, & Karen Adolph (New York University)

Independent locomotion is one of the most significant achievements of infancy. Through spontaneous locomotor exploration, infants accumulate vast amounts of locomotor experience and encounter numerous opportunities for learning. But why does stationary infant who can locomote to get up and go? A growing body of research suggests that, for typically developing infants, locomotion appears to be largely self-motivating. Most of infants' locomotor bouts aren't directed toward reaching new destinations, and infants move just as much in an empty room as in a room filled with toys (Cole et al., 2016; Hoch et al., 2018; Hoch et al., 2019).

Here, we asked whether locomotor exploration changes if movement is made more costly. To answer this question, we experimentally increased the cost of walking by dressing 14-month-old toddlers (N=25) in a weighted snowsuit loaded with 15% of their body weight and an unweighted fabric snowsuit with the padding removed. Using a counterbalanced, within-subjects design, we observed infants as they played independently in a room filled with toys in each condition for 10 minutes. We also collected standard measures of walking proficiency in each condition using a pressure sensitive carpet.

The weighted snowsuit decreased walking proficiency, thereby increasing the cost of walking. In the weighted condition, infants were slower, and took shorter, wider steps—all markers of less mature walking, $ts \geq 2.93$, $ps \leq .008$. Moreover, during free play, infants in the weighted condition spent less time in motion, took fewer steps per hour, and fell more frequently, $ts \geq 2.69$, $ps \leq .01$. But critically, making movement costly changed the way that infants explored. In the weighted condition, infants went to objects less frequently, their caregivers more frequently, and visited destinations that were shorter distances and fewer steps away, $ts \geq 2.35$, $ps \leq .02$. These findings have implications for understanding how effortful activity can change the way infants explore.

C11. A top-down modulation of bottom-up properties to select and sustain attention in one-year old infants

Andrés Méndez (Universidad de la República), Chen Yu (University of Texas), & Linda Smith (University of Indiana)

Object saliency (bottom-up) and internal control (top-down) are often considered competing factors for attention. Infants' abilities to purposefully sustain gaze on an object, often measured in the context of toy play, is assumed to require the internal suppression of distractors and is considered an early marker and risk point in the development of the internal regulatory processes mediated by the pre-frontal cortex. An objecť s ability to attract attention, however, does not solely depend on the internal suppression or enhancement of its sensory representation. Visual input depends on the position and movement of the eye and head in space; that is, it is closely related to behavior. Here we show that sustained attention by one-year-old infants includes an increase in the external salience of the target that is created by the infants' own behavior. Using head-mounted eye trackers, we measured infants' gaze during object play and the momentary visual size of objects in the infant's field of view. Visual size is well-known to robustly attract gaze. We found that when infants directed gaze to an object, they simultaneously changed the spatial relation of their body to the attended object increasing the target's visual size relative to distractors. The onset, duration, and offset of the increased salience was time-locked with the onset, duration and offset of infant gaze to the object. The findings challenge characterizations of attention as a competition between bottom-up and top-down control and implicate instead a collaboration in which top-down goals drive behaviors that externally suppress distractors.

C12. Compensatory motor behavior in children with limb differences

Laura-Ashleigh Bird 1,2 , Prof Tamar Makin 2 & Dr Dorothy Cowie 1
1. Durham University
2. University College London

Objectives: How flexible are body representations and motor skills during development? To answer this question, we study compensatory motor strategies in children with congenital upper limb differences.

Methods: Participants were 17 children (2 years 11 months – 10 years) with one functional hand, whereby 'function' is defined as the ability to perform a pincer grip. Children were filmed completing a series of 14 semi-ecological tasks including undoing buttons, opening a Velcro bookbag, and pulling apart Lego bricks. Compensatory motor strategies were coded offline.

Results: We observed children use a variety of effectors including the mouth, legs, and torso, to substitute for their missing hand. Use of the residual limb was consistently higher than use of other effectors (78% of task time compared to 18%, 2%, 37%, and 8%, p<.001 for each comparison). Whilst the balance of effectors used was highly variable between participants, from around 5-6 years we observed a marginally significant reduction in foot use as a proportion of task time (13% compared to 1.3%, p =.054).

Discussion: Children with limb differences not only rely on their residual limb, but flexibly adapt their behaviour using alternative effectors. Our data suggest that social factors may play a role in developmental changes in effector use: at 5-6 years when foot use declines, children's seated school environment may physically inhibit foot use and raise awareness that foot use is not common among peers. More work is needed on how effector use changes with age, and how it may be supported by the developing brain.

C13. What's behind a look? The cognitive factors underlying infant habituation and dishabituation

Francesco Poli (Donders Institute), Rogier Mars (Donders Institute, University of Oxford), & Sabine Hunnius (Donders Institute)

Habituation is one of the most used and studied effects in infancy research and yet, its cognitive underpinnings are still a matter of debate. Here, we make use of computational modeling to investigate the cognitive factors realted to habituation in a novel way. Specifically, we tested infants (N=60, mean age=8 months) on a visual learning task and made use of computational modeling to extract parameters indexing their attention, learning and memory performance. Infants were also tested on a habituation task, so as to relate individual differences in the parameter estimates of the visual learning task to their habituation and dishabituation. The data analysis is currently in progress, and the results will give us insights into what cognitive factors are related to habituation and dishabituation.

C14. Fetal motor activity of teratogenic-exposed babies and neonatal abstinence syndrome likelihood during the onset of COVID-19

Staci Weiss (University of Cambridge), Heidi Taylor (Temple University), & Michelle Long

Though the incidence of opioid-exposure in infants born in the US has seen a modest rise in the last decade (.004% of livebirth in 2019), the probability of detecting and measuring severity of impact on children remains an open question. Only 46.1 & 71.9% of infants exposed prenatally to opioids (including methadone) exhibit symptoms of NAS by 6 weeks, which is primarily diagnosed by the jerkiness of infant movements in NICU. We analyzed the kinematic trajectories of eye and mouth-directed movements evidence in the 4-D ultrasounds of 60 mothers referred from three groups with unique treatment and exposure paths: 1. those who went into withdrawal during their first trimester and abstained from using opioids subsequently, 2. those who continued using and tested positive on at least one of the two biosamples, and 3. those treated with methadone. The amplitude peak of movement, indicating a more rapid approach, was higher for opioid exposed infants (M=4.21) than with methadone compliant (M=3.94) and abstinent mothers (M=3.81). The significant interaction between velocity, group and type of movement, was driven by methadone-compliant mothers T (3) =3.91, p=0,1: slopes were significantly different in amplitude for NAS and no NAS for all comparisons except eye-directed movements of methadone-exposed infants, which did not differ. However, mouth directed movements distinguished NAS in this sub-sample (p =.01), so basically, the laborious process of manually tracking and identifying the type of movement is worthwhile to distinguish differences in this subsample. The odds ratio of the logistic regression indicated that 91% of the binary diagnostic of NAS or No NAS was predicted by prenatal movement trajectories, differentiated by group.

devmocon

Development in MOTION online conference

22nd-24th June 2021

Marie Skłodowska-Curie Actions Innovative Training Network (MOTION)