

## **P-1 The depth of conflict: ERP amplitude at N2 is associated with variation in reaction time in a perceptual interference task**

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Background: Children with prenatal exposure to selective serotonin reuptake inhibitor's (SSRI's) or medically untreated depression (DEP) show increased behavioral problems. We suggest that these problems may stem from intrinsic deficits in inhibitory control and interference suppression. Also, we investigate whether individual variation in reaction times on the Attention Network Task (ANT) reflect slowed cognitive processing, a common assumption, or rather a less optimal neural activation. Methods: Children with prenatal exposure to SSRI's (N=28, M=69.02 months, SD=4.76) or DEP (N=42, M=68.41 months, SD=5.16), and a comparison group with no exposure ((N=33, M=67.73 months, SD=5.16) were tested on a modified version of the ANT while recording EEG and behavioral data. To explore the neural correlates of interference suppression, event-related potentials were coded as either fast or slow by using the median-split of behavioral reaction time for each child. Findings: Our findings revealed no effect of prenatal exposure upon interference suppression. However, we found a significant difference in the mean amplitude of the N2 component at frontal electrodes between fast and slow trials, with fast trials being associated with increased amplitudes. There was no effect on peak latency ERP, suggesting that the same cognitive process supports both fast and slow responses, but for slower trials these processes are not fully engaged. Conclusion: These results suggest a link between the amplitude of the frontal N2 component and perceptual conflict resolution in children.

## **P-2 The role of inhibitory control in adolescent scientific and mathematical reasoning**

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Science and maths reasoning requires the integration of new evidence about the world into one's existing theories. This necessitates revising previously held theories or developing new theories through a process called conceptual change. While the traditional view holds that naïve theories are revised in the face of new evidence, neuroimaging research with adults suggests that old theories are still present even when new ones are learnt. Inhibitory control plays an important role, as the processing of counterintuitive material requires the inhibition of underlying beliefs and perceptual biases. When solving counterintuitive scientific problems, experts recruit areas of the brain associated with conflict monitoring, error detection and inhibitory control: lateral prefrontal cortex, and anterior cingulate cortex. The current project investigates the relationship between reasoning and inhibitory control, and how this changes through adolescence. The task battery includes measures of semantic inhibition, response inhibition, and a novel test of science and maths reasoning. Eleven- to 15-year-olds observe pictures, sentences or equations representing intuitive or counterintuitive science or maths statements, and judge whether they are correct. Analyses will focus on the relationships between these measures, and the results will inform future neuroimaging work to investigate the neural bases of these mechanisms in adolescence. This work has important implications for education, as it may suggest that inhibitory control training should be a focus in maths and science curricula.

### **P-3 Is adolescence a sensitive period for relational reasoning?**

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Relational reasoning is the ability to identify relationships across multiple mental dimensions. It is linked to logical thinking and problem solving and is known to undergo protracted development during childhood and adolescence. In this study, we investigated the impact of relational reasoning training during adolescence, and specifically whether adolescents benefit more from relational reasoning training than other age groups. Participants (n=448, age 11-33 years) were divided into three training groups, who underwent between 10 and 20 days of online training in relational reasoning, numerosity discrimination or face processing; the latter two served as active control groups. Participants were tested before training, after completing training and again six months after that. Effects of the three training programmes on relational reasoning performance were measured and compared between age groups (children, young adolescents, mid-adolescents, adults). All age groups improved their relational reasoning performance after training in relational reasoning. However, mid-adolescents and adults benefited more from training compared with young adolescents and children. The study provides a better understanding of the effectiveness of online training on relational reasoning in adolescence and may have implications for education.

### **P-4 Dorsal Stream hierarchical organization and the development of visual attention**

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Rationale: Visual pathways are hierarchically organized along a caudal-to-rostral gradient. Information is processed locally in primary visual cortex (V1) and then fed rostrally to higher-order regions. Feedback connections then resolve competition between visual inputs. We tested whether development of connectivity within and between caudal visual regions explains the integrity of local within- and between-region functional connectivity in subsequent hierarchical steps. Methods: Resting-state fMRI scans from the PING Study were analyzed (N=83, Age=3-20). We assessed connectivity within and between structurally connected regions, specifically V1--MT--inferior parietal (IP)--frontal eye fields (FEF) --prefrontal cortex (PFC). Results: In children only, greater local V1 connectivity predicts greater local IP connectivity, and greater connectivity between V1 and MT predicts greater local PFC connectivity. Critically, greater V1--MT connectivity also predicts better attentional control in children. By adolescence, increases in connectivity between dorsal stream regions are associated with weaker local connectivity within upstream hierarchical regions. Greater V1--MT connectivity in adolescents and adults predicts weaker local MT and FEF connectivity, and greater MT--IP connectivity also predicts weaker local FEF connectivity. These data indicate a shift from local to between-region connections, and potentially from feedforward- to feedback-weighted processes. Future work will explore the directionality of between-region connections using effective connectivity analyses.

### **P-5 Differential effects of socioeconomic status on declarative and procedural memory systems**

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While prior research has shown a strong relationship between socioeconomic status (SES) and declarative (explicit) memory, the relation between SES and procedural (implicit) memory remains unknown. Convergent research in both animals and humans has revealed a fundamental dissociation, both behaviorally and neurally, between a declarative memory system that depends on medial temporal-lobe structures and the dorsal-lateral prefrontal cortex (DLPFC) and a procedural memory system that depends on the basal ganglia. Due to the dissociation of declarative memory and procedural memory in the brain, there is reason to believe that SES may not affect these two systems equally. Here, we measured performance in 58 adolescents (mean age 14.4) from higher (n = 35) and lower (n = 23) SES backgrounds on tests of declarative memory (complex working memory span) and procedural memory (probabilistic classification) and their hippocampal, DLPFC, and caudate volumes. Lower-SES adolescents had worse declarative memory performance ( $W = 571$ ,  $p < 0.01$ ,  $r = 0.39$ ) and reduced hippocampal (Right:  $t(55) = 2.57$ ,  $p = 0.01$ ,  $r^2 = .19$ ; Left:  $t(55) = 2.64$ ,  $p = 0.01$ ,  $r^2 = .22$ ) and DLPFC volumes (Right:  $t(55) = 3.80$ ,  $p < 0.001$ ,  $r^2 = .48$ ; Left:  $t(55) = 2.15$ ,  $p = 0.04$ ,  $r^2 = .33$ ), but there were no significant differences between the low-SES and high-SES groups on learning on the procedural memory task or caudate volumes (all  $p > .6$ ). These findings suggest that SES may have a selective influence on hippocampal-prefrontal dependent declarative memory and little influence on striatal-dependent procedural memory.

## **P-6 The development of observational learning: An ERP approach**

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Observational learning is an important mechanism for cognitive and social development. The underlying neurophysiological mechanisms are, however, still not well understood. In two developmental EEG studies we adapted a probabilistic reward-based observational learning paradigm to compare ERPs of observational and individual reinforcement learning. We investigated how (study 1) children's similarity in age to the observed person (peer vs. adult) and (study 2) the age of the observer (children vs. adults) affects the integration of observed information. In study 1 (Rodriguez+Buritica et al., in press) children's feedback-related negativity to observed outcomes (oFRN) showed a similar distinction between outcome valences, as did the FRN for own outcomes. Moreover, children imitated the choices of similar others (peers) more than those of dissimilar others (adults) and the oFRN showed a trend of being larger observing similar compared to dissimilar others. Preliminary results of study 2 showed that both age groups benefit from social information during learning. Children's oFRN and adult's P3 response to observed outcomes (oP3) reflected the learning rate from social information. Thus, children seem to be more sensitive to outcome information, whereas adults seem to rely more on context updating mechanisms. Our results suggest that the oFRN serves as a measure of observational learning in children and varies with the model-observer similarity. Children and adults benefit from social information during learning. However, ERP results point to age-specific learning mechanisms.

## **P-7 Developmental changes in the influence of COMT genotype on the processing of self-generated thought**

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The Val158Met polymorphism of the COMT gene is a major determinant of prefrontal dopamine levels. The Met allele, which results in lower enzymatic activity and higher dopamine availability, has been associated with better executive function and working memory in adults, whereas the Val allele has been associated with advantages in affective processing. A recent study has demonstrated that the effect of COMT genotype on working memory emerges during adolescence, consistent with developmental changes in the dopaminergic system. We investigated the association between COMT genotype and the flexible modulation of the balance between the processing of self-generated, stimulus-independent information as opposed to perceptually based, stimulus-oriented, information in a cross-sectional sample of healthy adults and adolescents (N=300, aged 9- to 37-years). Participants processed self-generated or stimulus-orientated information in alternating blocks, in the presence or absence of affective distractors. We predicted genetic associations would interact with age. Task accuracy exhibited an age-group x genotype x condition interaction. In adults, individuals homozygous for the Met allele made fewer errors when selecting and manipulating self-generated thoughts, while in the developmental group there was no Met allele benefit on performance. These results extend previous findings of developmental variation in the association between COMT genotype and prefrontal cognition to a novel aspect of executive function: the ability to select and manipulate self-generated information.

## **P-8 Predictors of individual growth rates in mathematics achievement**

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Research in understanding children's individual differences in math achievement has been flourishing. Various abilities have been identified as being important for math achievement: children's IQ, Working Memory (WM) and counting abilities, and their ability to compare and/or conduct simple arithmetic with nonsymbolic (i.e., abstract quantities) or symbolic (i.e. in their Arabic form) numerosities. Notably, so far only children's average general math achievement in cross-sectional, correlational or longitudinal designs is being addressed. In reality, though, no one is average and all individuals develop at their own rate. We addressed the question: Which cognitive predictors uniquely predict children's individual growth rates? We conducted a large-scale longitudinal study assessing children's general math achievement in the beginning and end of grades 1 and 2. Latent growth modeling revealed that children's performance on all components of WM, their IQ, counting skills, nonsymbolic approximate comparison, symbolic approximate comparison and addition explained individual differences in children's initial status in math achievement. Children's performance in the symbolic approximate addition task (i.e., in the form of: "a+b" vs. "c"; "Which was larger?") was the only skill, however, which uniquely predicted individual growth rates in math achievement until the end of grade 2. This study highlights the importance of children's approximation skills and brings forth important implications for interventional designs and mathematics education.

## **P-9 Is adolescence a sensitive period for learning numerosity discrimination?**

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Areas of the brain underlying cognitive skills such as the manipulation of working memory, decision making and numerical skills undergo significant development during human adolescence. Due to the protracted development of these brain regions it has been suggested that adolescence is an ideal time to acquire and strengthen skills such as processing numerosity. The current study investigated whether adolescence is a sensitive period for learning. Participants (n=448, age 11-33 years) were divided into three training groups, who underwent between 10 and 20 days of online training in numerosity discrimination, relational reasoning, or face processing; the latter two served as active control group. Participants were tested before training, after completing training and again six months after that. Effects of the three training programmes on numerosity discrimination performance were measured and compared between age groups (children, young adolescents, mid-adolescents, adults). It was hypothesised that during adolescence, training effects on the numerosity discrimination task would be maximal in the numerosity discrimination training group compared with other training groups. This study provides a better insight into sensitive periods in adolescence. Implications for education will be discussed.

## **P-10 Optimising methods for perceptual learning in children**

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Visual information guides the development of social cognition and behavior. However, some children receive atypical visual input early in life, and process visual information abnormally. These children might benefit from perceptual learning, a method that successfully improves vision in adults. However, methods and results of perceptual learning studies cannot be generalized from adults to children, due to their immature perceptual and cognitive skills. The current study aimed to optimize methods for perceptual learning in children, by studying effects of age and reward on improved sensitivity to details (higher spatial frequency; HSF). A total of 118 typical children between 5 and 12 years participated in a perceptual learning task, receiving either positive (winning points) or negative (losing points) reward. In each trial, two HSF gratings were presented, embedded in zebras to represent its stripes. The child indicated which zebra had the most stripes. The spatial frequency (SF) difference between gratings varied across trials according to performance. Results showed that children could discriminate smaller HSF differences over time, which suggests that their sensitivity for details improved. No effects of age or reward condition on learning rates were observed. This study provides a method that is effective, motivating, and applicable for short sessions to train vision in children. This method can now be applied and extended to investigate neural changes due to perceptual learning in typical and atypically developed children.

## **P-11 Early executive functioning in children reared in different social environment**

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The growing body of research evidence emphasizes that early life adversity can negatively impact the development of executive functions (EF). Rearing in institutional care is one of the most dramatic examples of adverse early experience for young children. Issues arising in this context include vulnerability of specific brain-behavioral circuits to severe conditions of institutional environment at early ages. This is especially true for immature brain regions amongst which prefrontal cortex is the most vulnerable one. It could be proposed that specific vulnerability of prefrontal cortex neural circuits to environmental variations may be manifested in early EF deficits. The objective of the study was to evaluate the early stages of EF development in relation to various conditions of social environment. Subjects were 2 groups of children (22 - 57 months old) reared in orphanages and biological families. Multitask EF battery was administered. Results revealed dramatic reductions in EF performance among children reared in institutional care: EF composite scores in group of institutionalized children were significantly low. Research data also showed more specificity in performance of baby home children on 'hot' EF measures. Results obtained in the study allowed proposing diverse trajectories of early EF in young children reared in different conditions of social environment. Considering the prolonged period of EF development and neuroplasticity of prefrontal cortex neural circuits results give rise to concerns about long-term effects of early deprivation.

### **P-12 The contribution of individual differences in self-regulation to children's school functioning: A multidisciplinary perspective**

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Self-regulation is currently receiving much attention from researchers in different disciplines, such as temperamental and neurocognitive approaches. These approaches are integrated in this project, which was designed to study children's self-regulation linked to school functioning. In our study, the contribution of Effortful Control (EC) and Working Memory (WM) to school functioning was analyzed in a group of 142 children aged 6-12 years, who came from families living in disadvantaged neighborhoods. The methods combined experimental procedures, standardized tasks, as well as children's, parents' and educators' reports. A Structural Equation Modeling approach was used to ascertain the extent to which children's academic achievement and social behaviors at school could be explained by individual differences in self-regulation skills (EC and WM), taking also into account other variables such as SES, parental supervision/involvement, IQ and study skills. Direct and mediational paths were explored in the models tested. Results showed a coherent pattern of relations, suggesting that parents' supervision/involvement in children's education fosters children's self-regulation, which in turn positively affects study skills and contribute to a better academic and social functioning at school. Our results highlight the benefits of an integrative approach to the study of self-regulation in childhood and its potential contribution to school adjustment across different social conditions.

### **P-13 Auditory Statistical Learning in Children with ASD Relates to Verbal IQ: An EEG Study**

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30% of children with autism spectrum disorder (ASD) remain minimally verbal (MV). Using electroencephalography to characterize cognitive skills that underlie language learning can reveal pathways to language impairment. A crucial precursor to the development of language is auditory statistical learning (ASL). Typically developing (TD) infants use ASL to determine transitional probabilities (TP) between syllables in the speech stream, allowing them to detect word boundaries (Kuhl, 2004). In this study, 30 children with ASD (19 verbal, 11 MV; age 5-10) participated in an ASL event related potential (ERP) paradigm. Participants heard a 4-minute stream of 4 pseudo-words repeated randomly. This exposure phase was followed by a test phase, with the pseudo-words (high TP between syllables) interspersed with non-words (low TP). Mean amplitude of the ERPs 300-500ms after word offset was calculated for each condition. The MV and verbal groups differed in the magnitude of the amplitude difference between conditions in the left frontal region ( $t=2.43$ ,  $p=.02$ ), with the MV group showing a larger difference. Condition difference was negatively correlated with VIQ ( $r=.46$ ,  $p=.01$ ), but not correlated with NVIQ or age. Verbal children with ASD may use different neural mechanisms that contribute to their language development. MV children show preserved ASL and may be a domain to target in language-based interventions. Further investigations will include age-matched and mental age-matched TD comparison groups to understand developmental trajectory of ASL in children with and without ASD.

## **P-14 Sensorimotor Integration in Typically Developing Children and Those with Autism**

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Research has shown that 80-94% of children with autism (ASD) have some kind of sensory abnormality and/or suffer from motor delays. While most of the research related to sensory and motor delays in children with ASD has been conducted in isolation, little is known about the link between the two, or sensorimotor integration. We define sensorimotor integration as the brain's ability to successfully transform sensory data into a motor response. The current fMRI study examined the neural substrates of sensorimotor integration in typically developing children (TD; N=2) and those with ASD (N=6) between 6-8 years of age. The sensorimotor integration fMRI paradigm consisted of two conditions: children were asked to 1) imitate individual pictures of a left hand performing "meaningless" gestures (imitation condition) or 2) to perform a simple motor movement (thumb or finger response) as the control condition. After correcting for multiple comparisons ( $p's < 0.05$ ), the results showed TD children primarily recruited areas in the motor cortex during the control condition and the visual cortices, cingulate gyrus, pre-motor and pre-frontal areas during the imitation task. In contrast, the children with ASD recruited nearly the same brain regions for both tasks, including the visual cortices, right parietal, bilateral pre-motor areas, and right pre-frontal cortex. These findings suggest that both a simple motor task and an imitation of a hand gesture requires extensive thinking and planning in children with ASD, when the simpler motor task comes more automatically in TD children.

## **P-15 Social attention in high functioning young adults with autism spectrum disorder: Visual gazing during viewing of naturalistic emotional scenes**

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Background: Perceiving the right social cues is very important for understanding and navigating through the social environment. Eye-tracking studies in children with ASD are suggestive of restricted social attention but only few studies have addressed whether this impairment persists into young adulthood, while correct processing of social situations is very important in this phase. We compared spontaneous gaze behavior and processing of own emotions during viewing of dynamic naturalistic emotional scenes between young adults with high functioning ASD (HFASD; N = 53) and their typically developing (TD) peers (N = 31). Method: Stimuli consisted of naturalistic video clips with varying emotional content (sad, happy, cheerful, pain and anger) in social interactions. Social gaze was analyzed with fixation duration (in seconds) for multiple customized areas of interest. Additionally, participants were asked to label their emotions and rate their intensity. Results: Initial analyses suggest that HFASD individuals display a tendency to attend less to social features (eyes, faces and bodies) during social interactions than TD's. Although HFASD individuals experienced the same type of emotions as the TD group, they rated them as less intense. Conclusion: Using naturalistic social-emotional stimuli to investigate social attention in ASD can enhance ecological validity of study results. Our preliminary findings tentatively support the notion that impairments in social attention and deviant emotional processing continue beyond childhood despite a high level of functioning in ASD.

### **P-16 Does experience shape the brain? The effect of cataract on development of visual segmentation**

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Environmental input plays a crucial role in the development of visual perception. The role of visual input can be studied in patients treated for congenital cataract, who received no visual input early in life, but typical visual input after cataract was treated. However, some visual processes remain impaired after treatment. The current study investigated remaining impairments in visual segmentation, a basic visual process that is necessary to process individual objects. Twelve children (average 11 years) that recovered from cataract before the age of 5 years, and 34 control children participated in the study. Each child performed two visual tasks. In a neurocognitive texture segregation task, the difference in Event-Related Potential (ERP) response to homogeneous (no segmentation) and checkered stimuli (segmentation) was investigated. In addition, behavioral performance on contour integration, related to segmentation, was measured. Results showed decreased performance of the cataract group on contour integration, but not on ERP reflections of segmentation. However, ERP reflections of processing of the separate line elements were delayed in the cataract compared to the control group. These findings imply that specific aspects of segmentation are impaired after cataract, and that visual experience is necessary for the typical development of processing of line elements and for behavioral segmentation. These results, as well as the different findings in ERP versus behavioural measurements, are discussed in terms of feedforward and recurrent connectivity in the visual cortex.

### **P-17 White matter plasticity associated with working memory training in 6year old children**

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Working memory is critical for a range of cognitive functions. Working memory capacity can be improved with adaptive cognitive training. Although studies of adolescents and adults report experience-dependent changes in white matter (WM) associated with such training our knowledge of structure-function relationships in young children is limited. Cogmed's computerized adaptive training program has been shown to improve children's working memory. This pilot study examines training-induced WM plasticity in young children after Cogmed training. Healthy 6-year-old children were randomly assigned to 5-weeks of visuospatial working memory training (N=5) or to a waitlist-control group (N=7). Cognitive assessments (AWMA, CANTAB) and structural magnetic resonance imaging (MRI) scans, with DTI, were obtained for all children on three separate visits, each separated by 6-weeks. Measures collected at visit 1(V1) and 2(V2) provide information about developmental changes in WM and cognition, over 6-weeks, while measures collected before (V2) and after training, visit 3(V3), provide information about training-induced changes in WM and cognition. DTI parameters of WM were analyzed for associations with working-memory scores using functional regression models. Verbal and visuospatial working memory scores were significantly improved for training children compared to controls (p-values .03 to .0009). Improved scores from V2-V3 were also associated with changes in the WM tract connecting left fronto-parietal regions (p=.006). Associations were not found in controls or prior to training V1-V2.

### **P-18 Maturational trajectories of subcortical grey matter microstructure: A longitudinal study**

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Cross-sectional diffusion imaging studies have reported age-related increases in fractional anisotropy (FA) and decreases in mean diffusivity (MD) in subcortical grey matter structures during childhood and adolescence. Some white matter tracts appear to develop earlier in girls than boys, and in boys the development may continue into adulthood. It is unknown whether the sexes also differ in their maturational trajectories of subcortical grey matter microstructure. Here we examined the maturational trajectories of FA and MD of subcortical structures using a large longitudinal dataset. Eighty-eight children and adolescents aged 7-19 years underwent MRI 2-11 times (713 scans) on a 3T MR-scanner. Mean amygdala, hippocampus, accumbens, caudate, putamen and thalamus FA and MD values were extracted. Age-related changes over time in ROI MD or FA for boys and girls were estimated using generalized additive mixed models with smoothing splines. FA increased linearly or almost linearly with age in both sexes in all ROIs (ps<.048), except for the putamen in boys (p=.26). MD decreased with age in all ROIs in both sexes (ps<.0001). In girls, the MD trajectories were non-linear and reached a plateau at the age of 12-13 years in all ROIs, except amygdala. Interestingly, this is the average age at which females reach sexual maturity. In boys, MD decreased linearly throughout the studied age range. While unknown, the observed apparent difference between sexes in the maturational trajectories of subcortical MD may be mediated by differences in sex hormones and/or when the sexes enter puberty.

## **P-19 Association between amygdala and hippocampal volumes and condom use for adolescent girls**

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Adolescence marks the initiation of new socio-emotional and physical behaviors, including sexual intercourse. Numerous factors influence how and when youth decide to engage in sex and what protective measures to take in this context. Further, evidence suggests that patterns of brain and socio-emotional development differ by gender in this age group. Thus, we sought to determine how brain volumes correlated with safer sexual behaviors, and how those relationships compared by gender. Specifically, we posited that protected sex (defined as condom use) would correlate with regional brain volumes implicated in social and emotional functioning (e.g., amygdala, hippocampus, ventral striatum), and that these relationships would differ between female and male youth. We used Freesurfer to extract cortical and subcortical volumes among an ethnically-diverse sample of 134 high-risk, sexually-experienced youth (M age 16.03 years (SD 1.18) range = 14-17; 28.8% female). We conducted multiple linear regressions using frequency of condom use as the dependent measure (regional volumes), followed by an examination of interactions with gender. We found significant volumeXgender interactions, with follow up analyses indicating frequent condom use was related to smaller volumes across the bilateral amygdala, left hippocampus, and right globus pallidus in females. No relationship between regional brain volume and protected sex emerged for males. These data highlight the potential relevance of limbic and striatal structures in decisions about safer sex behavior for adolescent females.

## **P-20 Left But not Right Amygdala Volume Associated with Early Attachment Disturbance and Later Limbic Irritability**

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Poor maternal care in rodents has important effects on the amygdala. In humans, the amygdala develops rapidly during the first two years of life, so disturbed care during this period may be particularly important to amygdala development. Studies have shown that orphanage rearing and maternal depressive symptoms are associated with enlarged amygdala in childhood. Other evidence indicates that left amygdala develops more rapidly than right and is more responsive to maternal cues. Thus, we predicted that quality of the early attachment relationship would be related to amygdala volume and that the effect would be greater on left than right amygdala. Predictors of amygdala volume were assessed among 18 low-income young adults (8M/10F, 29.33±0.49 years) recruited in infancy (8.5±5.6 months) and followed longitudinally. Left but not right amygdala volume in adulthood was associated with both maternal and infant components of a disorganized attachment relationship at 18 months of age (overall  $r = .68$ ,  $p < .004$ ). Later stressors, including childhood maltreatment, were not significantly related to left amygdala volume, but were related to right volume. Left amygdala volume was further correlated with dissociation and limbic irritability, and left amygdala volume mediated the prediction from disturbed attachment in infancy to limbic irritability in adulthood. Results are consistent with a model in which left amygdala plays a role in monitoring threats related to maternal availability in early life, while right amygdala plays a greater role in monitoring threats of hostile attack.

## **P-21 An Integrative Pluralistic Approach to Social Developmental Neuroscience: Locating Diverse Epistemologies Along Ecological Continuum**

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The present work adopts Mitchell's (2004) integrative pluralistic approach to developmental social neuroscience which addresses the ecological continuum of epistemologies (Manson, 2008). In situating the plurality of cultural systems and social processes involved in ontogenesis (Nsamenang, 2011), this method serves as a tool toward truly integrative developmental science; it enables consideration of neglected or depreciated cultural perspectives alongside dominant Western perspectives through the application of social neuroscience models (Cappacio & Cappacio, 2013). The increasing appreciation of somatic psychology and extended cognition (e.g., Damasio, 1999; Sutton, 2010), neurophenomenological accounts (e.g., Thompson & Varela, 2002), and the transdisciplinary sciences where the social encounters the biological and physical (e.g., new materialisms; socio-biological and cultural anthropology), complement and inform social neuroscience developmental models (Adolphs, 2015) focusing upon brain mediation and intra-action participation (Barad, 2007). Moreover, rapidly shifting globalization influences and their impact upon the human-environment relationship, signal the need for developmental science to examine ecological multi-leveled influences (Greenfield, 2009) in hopes of offering accurate depictions of socio-cultural development among global populations. An illustrative case of youth's socio-emotional and world development through weaving in the indigenous Haida Gwaii context highlights the proposed approach.

## **P-22 A comparison of default-mode connectivity in children with ADHD, dysthymic disorder and typically developing children**

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Pediatric attention-deficit/hyperactivity disorder (ADHD) and depression have both been associated with a failure to adequately suppress default-mode network (DMN) activity. The present study aimed to determine whether there are differences in DMN connectivity among children with ADHD, dysthymic disorder (DD) and typically developing children (TDC). 20 children with a diagnosis of ADHD, 20 children with a diagnosis of DD and 20 TDC aged 9.7-16.8 years underwent a 6 min resting-state scan. Preprocessing and statistical analyses were performed using CONN a functional connectivity toolbox compatible with SPM12. 6 DMN ROIs (PCC (posterior cingulate cortex), MPFC (medial prefrontal cortex), right and left IPL (inferior parietal lobe), right and left PFC) served as seed regions. Compared to TDC the clinical group (combined ADHD + DD) showed increased functional connectivity of the 6 seed regions and several cortical clusters. Only the right IPL showed heightened connectivity with the right frontal pole in TDC compared to the clinical group. Comparisons of ADHD and DD groups revealed increased connectivity between PCC and right lateral occipital cortex, between left IPL and right fusiform cortex, between left PFC and right postcentral gyrus in children with ADHD. DD children showed increased functional connectivity between MPFC and left frontal pole compared to ADHD children. The results suggest differential functional connectivity of DMN regions in children with ADHD, DD and TDC. This may help delineating the underlying pathophysiology between these two diagnostic disorders.

### **P-23 Early high hormone levels in pubertal girls with MDD associated with depressive traits and resting connectivity**

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Adolescence is a period during which the prevalence rate of major depressive disorder (MDD) increases sharply, particularly for females. One identified risk factor for MDD in females is the early onset of puberty, as pubertal hormones may have an adverse impact on developing neural systems serving emotion reactivity (ER) and cognitive control (CC). However, the influence of early puberty and hormone levels on the functional connectivity (FC) within and between networks underlying ER and CC is unknown. The current preliminary study evaluated the relationship between age-regressed levels of progesterone - a hormone shown to influence amygdala reactivity - with depressive symptoms and mean FC of ER and CC networks in 9-12 year old MDD and healthy girls. Networks examined were the Salience network - an ER network involved in detecting and orienting to salient stimuli, and a Cognitive Emotion Regulation network previously shown to exhibit altered FC in MDD. In MDD girls, higher progesterone levels were significantly related to increased depression severity, and marginally correlated with stronger average FC within the Salience network - relationships not seen in healthy girls. Both groups showed a negative relationship between progesterone levels and later sadness coping. These findings suggest early high hormone levels influence neural and behavioral MDD traits.

### **P-24 Effects of Stress on Bodily Freezing in Adolescents**

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Freezing is a major defensive stress-response, characterized by reduced body-sway and heart rate. Exacerbated freezing in threatening situations has been associated with increased basal and stress-induced glucocorticoid levels and with long-lasting stress-related symptoms in animals. However, the effects of stress-induced changes on human freezing are unknown. A new measure has been developed to quantify freezing-like behavior in humans using a stabilometric force-platform such that shifts in body-sway can be assessed in high temporal and spatial accuracy. Previous research has shown that exposure to angry (vs. neutral) faces can induce reductions in body-sway and heart rate in humans. We used this method to assess the effects of stress and stress-induced cortisol on human freezing responses to angry vs happy and neutral faces. Participants were 90 adolescents (age 17) who were tested at three time points: prior to, immediately after, and 55 min after the Maastricht Acute Stress Test. To ascertain stress-induction, self-reported, physiological, and hormonal measures were collected prior to, immediately after, and 20, 30, 40, and 55 minutes after stress-onset. Preliminary analyses of the self-report and blood pressure measures indicated a successful stress-induction. We also predicted that stress-induced cortisol levels are associated with increased freezing. Finally, we will explore the association between stress-induced freezing and affective symptoms (e.g., anxiety) to gain a better understanding why adolescence is a phase of increased vulnerability for stress symptoms.

### **P-25 Developmental trajectories of neural circuits supporting emotion regulation differ in adolescent depression**

Kaja LeWinn<sup>1</sup>, Irina Strigo<sup>1</sup>, Colm Connolly<sup>1</sup>, Tiffany Ho<sup>1</sup>, Eva Henje Blom<sup>1</sup>, Olga Tymofiyeva<sup>1</sup>, Alan Simmons<sup>2</sup>, Tony Yang<sup>1</sup>

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Poor emotion regulation (ER) is a hallmark of depression. The neural circuitry underlying ER develops rapidly in adolescence, coinciding with increased depression incidence during this time. Less is known about the extent to which adolescent depression may result from the delayed development of ER neural circuits. Thirty-eight depressed adolescents (27 female) and 27 controls (18 female) (age 13-18) underwent functional MRI while completing a validated ER task. They were asked to "reduce" (i.e. reappraise) or "maintain" their emotional response to negative images. We used linear mixed effects (LME) models to examine activation associated with reappraisal "success" (i.e. reduction in self-reported negative affect during "reduce" trials compared to "maintain" trials) across groups (i.e. main effect of reappraisal), and between groups (MDD\*reappraisal interaction). We also identified regions important for ER that show different developmental trajectories in the context of depression (Age\*MDD\*reappraisal interaction). Main effect of task showed that reappraisal success was mediated by the sgACC, dlPFC, amygdala and OFC across groups. Some of these regions were also associated with an overall effect of group on reappraisal success (e.g. amygdala). In contrast, other regions were associated with group in a three-way interaction that included age (e.g. left sgACC, OFC), suggesting that these regions may follow different developmental trajectories in the context of adolescent depression. We further explore behavioral correlates and group differences in functional connectivity.

## **P-26 Using the dot-probe in field-based research on low-income childrens emotion regulation**

*Cybele Raver*<sup>1</sup>

<sup>1</sup>New York University

Affective neuroscience has yielded powerful laboratory methods such as the dot probe procedure to detect the role of trauma exposure in shaping emotional regulatory (ER) processes. This presentation outlines methods and findings from 3 studies deploying this valuable method to test the deleterious consequences of violence exposure as well as the potential benefits of intervention for child, adolescent, and young adult ER. Methods: Across 3 large studies, we have adapted the dot-probe procedure for administration on laptop computers in participants' homes, schools and community contexts. Guidelines for protocols (e.g. stimuli sets, presentation times, trial number and type, training of assessors, and descriptive data) for the laptop-based dot probe will be presented across samples ranging from 200 to 600 low-income participants residing in urban neighborhoods. Analyses and Implications. Three sets of analyses will be briefly presented from past and current research projects to illustrate ways that dot probe methods contribute to powerful evidence of the role of violence exposure for ER. Opportunities and challenges for integration of dot probe data with geocoded crime data as well as parent- and child-reported violence exposure will be presented. Discussion will also include the potential benefits of dot probe in estimating the impact of socioemotionally-focused intervention on participants' attention bias. Implications for moving the fields of neuroscience, developmental science, and prevention science forward will be discussed.

## **P-27 Development of the neural correlates of emotional interference in a verbal working memory task**

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Various aspects of executive functions continue to mature during adolescence. Working memory, the ability to maintain, manipulate and update information in a mental workspace, shows increase in capacity until mid-adolescence, associated with increased frontoparietal cortex activation. The present study investigated developmental differences in the impact of affective distractors during a working memory task. Twenty three adult (22-33 years old) and 28 adolescent (12-14 years old) female participants were scanned while performing a numerical n-back task (0-back and 2-back) with either no distractor, or with distracting happy or fearful faces presented either side of the stimulus. Results showed greater activation in adults than adolescents in 2-back vs. 0-back blocks in the parietal cortex and superior frontal cortex bilaterally, and greater activation in adolescents than adults in the presence of distractors in the occipital cortex and left fusiform gyrus. Region of interest analyses further indicated that across groups, the left orbitofrontal and right inferior frontal/precentral cortex were more sensitive to the presence of distractors in 0-back than 2-back blocks, while the right amygdala showed greater activation in the presence of distractors in adolescents compared to adults. This study therefore provides further evidence of protracted neural development of the executive control system during adolescence, showing that adolescents are less able to limit neural responses to distracting affective stimuli.

### **P-28 Working memory for emotional facial expressions and associations with child maltreatment.**

*Else-Marie Augusti*<sup>1</sup>, *Annika Melinder*<sup>1</sup>

<sup>1</sup>University of Oslo

Interactive Specialization (IS; Johnson, 2001; Johnson, 2005) proposes a significant interaction between children's experiences and their development in various domains. Research on executive functions (EF) development has evolved from considering EF as purely "cool" and de-contextualized abilities, to "hot" EFs which takes into account the contextual characteristics within which goal directed, purposeful cognition takes place (Zelazo, Anderson, Richler, Wallner-Allen, Beaumont, & Weintraub, 2013). The present study seeks to understand the relationship between children's personal experiences, namely child maltreatment, and the ability to regulate and actively act upon emotional information relevant for social and emotional adaptation, in one out of three EFs, working memory. Twenty 8-12-year-old ( $M = 9.80$ ,  $SD = 1.47$ ) maltreated children, and 21 age-matched controls ( $M = 9.57$ ,  $SD = 1.50$ ) were tested on the working memory task Emo-n-back (Landr $\bar{e}$  et al., 2009). In this task children had to identify two similar, subsequently presented, facial expressions (i.e., fear, happiness, sadness, neutrality) by pressing a computer button. It is hypothesized a main effect of emotion, qualified by a maltreatment by emotion interaction, with maltreated children showing poorer working memory for all the above-mentioned facial expressions. The study results will be discussed in relation to how highly negative personal experiences may be associated with behavioral outcomes on a measure related to the ability to keep social-affective information in working memory.

### **P-29 Emotional expressions in young children and their primary caregivers in post-intervention institution**

*Maria Solodunova*<sup>1</sup>, *Daria Chernego*<sup>1</sup>

<sup>1</sup>St.Petersburg State University

This research was a part of the first Intervention Project in Russian institutions that included structural changes and caregivers' training. Method Participants included children from 3 months to 6 years old with no major health and neurological issues and their primary caregivers from one of the institutions (St. Petersburg, RF). Children's and caregivers' facial emotional expressions were measured BEFORE and AFTER the Intervention by the Dyadic Affect Manual (Osofsky, Muhamedrahimov, Hammer, 1998). Results 1. Children in the institution develop specific model of emotional expressions in interaction with caregivers: they increase intensity of positive and decrease intensity of negative emotions. 2. BEFORE the Intervention boys demonstrate emotional models with using stereotype movements during separation with caregivers. AFTER intervention boys and girls don't differ from each other. 3. BEFORE the Intervention caregivers show less intensive emotions in interactions with boys in comparison with girls. AFTER the Intervention there are no differences between 'caregiver-girl' dyads & 'caregiver-boy' dyads. 4. BEFORE the Intervention caregivers demonstrate higher positive tone with younger children. AFTER the Intervention intensity of caregivers' emotional characteristics doesn't depend on children's age. Conclusion Post-intervention observations showed an "emotional attunement" in the type and intensity of emotions between children and caregivers. We hope that post-intervention children will be more successful in the future adaptation to the new social environment.

### **P-30 Development of Infants in Association with Timing of Early Institutionalization**

*Daria Chernego*<sup>1</sup>, *Maria Solodunova*<sup>1</sup>

<sup>1</sup>Saint Petersburg State University

This study presents the data of an impact of early deprivation timing on development of infants in the typical and post-intervention institutions. The study sample included two groups of typically developed children from an orphanage with an implemented intervention program with training and structural changes, n=15, and from an orphanage with no intervention, n=21. Children were assessed longitudinally at age 3 and 9 months by the Battelle Development Inventory, BDI. The analysis of the BDI Total Score of general development, based on subscales for Personal-Social, Motor, Adaptive, Communication, and Cognition, was conducted. The stay in the orphanage by 3 months of age was from 1 to 3 months and length of stay in the orphanage by 9 months was from 7 to 9 months. The research revealed that an increasing the time in the orphanage from 1-3 to 7-9 months led to a significant decrease in DQs for children from no intervention Baby Home, but not for children from Baby Home after implemented intervention. Moreover, if at age 3 months, the two groups of children were not significantly different, then at age 9 months children from no intervention Baby Home had a significantly lower DQs mean. What the results of this study prove is that residence timing of 7-9 months in a depriving social environment of institution in early age has a negative effect on child mental development. Improvement of the orphanages' social-emotional environment leads to positive outcomes on child development.

### **P-31 Auditory discrimination in sleeping preterm infants**

*Marina Vasilyeva*<sup>1</sup>

<sup>1</sup>Sain-Petersburg State University

Auditory discrimination during active sleep was studied in preterm infants and their fullterm counterparts using the brain's automatic change-detection response, the mismatch negativity (MMN) response of the event-related potentials. Subjects were healthy preterm (32-36 weeks, N=14) and fullterm (38-41 weeks, N=20) infants of the first month of life. Acoustic stimuli with large deviance in passive oddball paradigm were used (1000 Hz standard ( $p = 0.85$ ) and 2000 Hz deviant ( $p = 0.15$ ) tones). Research data revealed distinctive features in morphology and specificity in parameters of mismatch response components in children at early ages. Contrary to results from adults infant's components were manifested in two positive peaks (fullterm group) or in one negative peak (preterm group), and were greater in amplitude and longer in latency. A significant positive correlation was observed between infant's conceptual age and amplitude, and significant negative correlation was found between infant's conceptual age and latency of the MMN component. Results indicated infant's mismatch response undergoes several developmental changes during first weeks of postnatal life and allowed proposing specificity in parameters of infant's mismatch components represented proceeding maturational changes in auditory cortex at early ages.

### **P-32 Attachment security is related to infants' neural processing of animated parent-child interactions**

*Szilvia Biro*<sup>1</sup>, Renske Huffmeijer<sup>1</sup>, Mikko Peltola<sup>2</sup>, Lenneke Alink<sup>1</sup>, Marinus van IJzendoorn<sup>1</sup>, Marian Bakermans-Kranenburg<sup>1</sup>

<sup>1</sup>Leiden University, <sup>2</sup>University of Tamepre

Attachment security has been shown to bias infants' attention allocation to and expectations about social interactions (Johnson et al, 2010; Biro et al, 2014). Little is known, however, about the relation between the quality of infants' early interactions with primary caregivers and the neurophysiological responses involved in processing social interactions. In the current study, we investigated the hypothesis that the attachment quality biases infants' emotional-motivational brain processes, in particular the relative hemispheric asymmetry in frontal brain activity. Greater relative right frontal activity is associated with regulating of "withdrawal emotions" such as distress, while a greater relative left frontal activity is associated with "approach emotions" such as joy and interest. Ten-month-old infants watched animations that involved the separation of two abstract characters, a larger and a "crying" smaller one. The separation was followed either with the larger character returning ("responsive caregiving") or with the larger character going further away ("unresponsive caregiving"). Frontal alpha asymmetry was calculated for the separation and outcome part of animations. At 12 months, infants' attachment security was assessed using the Strange Situation Procedure. The study is ongoing. In the first 49 infants with complete data, we found that secure infants, relative to insecure infants, responded to the "responsive" outcome of the animations with greater left frontal activation,  $F(1,47)=4.7$ ,  $p=.036$ , which suggests a stronger approach-like motivational state.

### **P-33 The impact of emotional facial expressions on auditory change perception in 8-month old infants**

*Silke Telkemeyer*<sup>1</sup>, Katja Liebal<sup>2</sup>, Isabell Wartenburger<sup>1</sup>

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Recognizing facial expressions of emotion is essential for social communication. Adults show increased attention towards negative emotional facial expressions compared to positive faces (Baumeister et al., 2001). This negativity-bias could be evolutionary adaptive: others expressing negative emotions might indicate danger which results in increased attention. This bias might be already observed in infants as results of Nelson & de Haan (1996) reporting increased ERP amplitudes for fearful compared to happy faces in 7-month-olds could suggest. Our aim was to further characterize underlying electrophysiological processes and their development. We expected that perception of negative facial expressions modulates attention even across different modalities. While measuring EEG, we visually presented video-blocks of fearful, happy, and neutral faces to 26 healthy 8-month old infants. Simultaneously an auditory mismatch-paradigm with syllables (/ba/, /da/) was presented. We compared the amplitude of the auditory mismatch negativity (MMN) in response to the non-emotional syllables as a function of the three emotion conditions. In contrast to our assumptions auditory MMN was increased during happy but not fearful compared to neutral faces in fronto-central electrodes around 200-250 ms. The results show that emotions can modulate attention across modalities. The increased MMN for happy faces might be explained with the familiarity effect, which was also assumed by Grossmann et al. (2007) who found increased ERPs for happy compared to angry faces in 7-month-olds.

### **P-34 Comparing the use of assumption-free and HRF models in the analysis of infant fNIRS data**

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In recent years, functional Near-Infrared Spectroscopy (fNIRS) has become more widely used as a method to study infant brain activation through the measurement of hemodynamic signals during a variety of experiments. For fMRI research, powerful statistical methods, mostly based on the General Linear Model (GLM) have been developed. Although GLM-based analysis methods employing the canonical hemodynamic response function have been validated in adults (e.g. Plichta et al., 2007), hemodynamic responses in infants have been reported as more variable, often delayed and sometimes negative (Minagawa-Kawai et al., 2010; Kotilahti et al., 2010). Consequently, models employing the canonical hrf might not be suitable for the analysis of infant fNIRS data. Furthermore, fNIRS measures both oxy- and deoxy-hemoglobin concentrations, where the deoxy-hemoglobin response does not follow the shape of the canonical hrf. In the present study, we employed fNIRS (using NIRx NIRScout, 8 sources and 8 detectors, S-D distance of 2 cm) to assess temporal and parietal cortex activation in 5-7 month-old infants in response to dynamic social compared to dynamic non-social stimuli (Lloyd-Fox et al., 2009). Statistical analysis of the fNIRS data was done using models with (hrf, hrf with temporal- and dispersion derivatives) and without (finite impulse response, averaging) a-priori assumptions about the shape of the hemodynamic response. Finally, these methods were evaluated in terms of statistical power and their ability to account for the variability in the shape of the infant hemodynamic response.

### **P-35 Integrating neuroscience into developmental psychopathology: New frontiers in experimental preventive interventions**

*Christine O'Farrelly*<sup>1</sup>, Paul Ramchandani<sup>1</sup>, Daphne Babalis<sup>1</sup>, Marian Bakermans-Kranenburg<sup>2</sup>, Sarah Byford<sup>3</sup>, Julia McGinley<sup>4</sup>, Susannah Murphy<sup>5</sup>, Stephen Scott<sup>3</sup>, Alan Stein<sup>5</sup>, Marinus van IJzendoorn<sup>2</sup>, Jane Warwick<sup>6</sup>, Hilary Watt<sup>1</sup>

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Behavioural problems emerge early in childhood and can have enduring effects on mental health. Little is understood about the processes by which risk for psychiatric problems become embedded biologically, but emerging evidence has identified methylation of key genes as one potential mechanism. Confirmed associations have been found between methylation levels of genes such as NR3C1 and BDNF and the quality of early caregiving behaviours and response to other stresses in utero and early childhood. The study of gene expression in randomised controlled trials (RCTs) that manipulate caregiving provides an ideal, yet uninvestigated, context to elucidate the biological processes that accompany behavioural development. Healthy Start, Happy Start, a RCT of an evidenced based parenting intervention aimed at reducing behavioural problems in young children targets this gap. 300 families of 1-3 year old children with high levels of behavioural problems will be randomised to receive Video-Feedback to Improve Positive Parenting and Sensitive Discipline (ViPP-SD), or treatment as usual. ViPP-SD involves six home sessions aimed at increasing sensitivity and improving discipline. Buccal swabs for DNA extraction and methylation and measures of parent-child interaction and child behavior will be collected at baseline, midway, and post treatment. Analysis will examine whether treatment effects in interaction produce altered patterns of gene methylation in key genes and associated changes in child behaviour. This pioneering approach may provide valuable applications for primary prevention.

### **P-36 Maternal risk status predicts autonomic nervous system reactivity and recovery in infants**

*Jill Suurland*<sup>1</sup>, Kristiaan Van der Heijden<sup>1</sup>, Hanneke Smaling<sup>1</sup>, Stephan Huijbregts<sup>1</sup>, Stephanie Van Goozen<sup>2</sup>, Hanna Swaab<sup>1</sup>

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The ability to regulate emotion and arousal develops during infancy and is critical for appropriate and adaptive social behavior throughout life span. Maturation of the autonomic nervous system (ANS) is proposed to be fundamental for emotional and behavioral regulation. Exposure to early adversity is associated with ANS reactivity to stress, increasing risk for psychopathology. So far, studies of exposure to early adversity in infancy have focused on parasympathetic (PNS) or global ANS activity; studies including specific measures of both PNS and sympathetic (SNS) activity are absent. This study examined heart rate (HRT), parasympathetic respiratory sinus arrhythmia (RSA), and sympathetic pre-ejection period (PEP) in response to and during recovery from stress in six-month old infants. The sample included 42 high-risk (HR) and 79 low-risk (LR) infants and their mothers, who participated in the Still Face Paradigm (SFP). Classification of risk status was based on WHO-criteria (e.g. presence of maternal psychopathology and social adversity). HR infants showed greater PNS (RSA) withdrawal and more SNS (PEP) activity across the SFP than LR infants, specifically during the recovery phase. Moreover, in HR infants, the increase in HRT during recovery was both PNS- and SNS-mediated, reflecting a failure to regulate stress with the PNS. These findings underline the importance of specific measures of PNS and SNS reactivity and recovery, and indicate that risk status is associated with maladaptive regulation of stress early in life reflecting increased risk for later psychopathology.

### **P-37 Prenatal reflective functioning, postnatal maternal caregiving behavior and infant aggression.**

*Hanneke Smaling*<sup>1</sup>, *Stephan Huijbregts*<sup>1</sup>, *Jill Suurland*<sup>1</sup>, *Kristiaan van der Heijden*<sup>1</sup>, *Stephanie van Goozen*<sup>2</sup>, *Hanna Swaab*<sup>1</sup>

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The concept of maternal reflective functioning (RF) has been gaining increasing interest as a possible intermediate mechanism in associations between a wide range of perinatal risk factors and poor child outcomes. We conducted three studies of maternal RF. The first study compared prenatal RF in a high-risk and low-risk group (N=162, M=22.22 years, SD=2.39; 83 classified as high-risk), and investigated which risk factors were predictive of prenatal RF in the high-risk group. The high-risk group had fewer RF-skills:  $F(1, 160) = 41.56, p < .001$ , and their RF was predicted by substance use ( $r = -.25$ ), social support ( $r = .32$ ), and educational level ( $r = .23$ ). Our second study examined whether prenatal RF influenced maternal interactive style with her six-month-old infant (N=133, 54% male), in addition to any predictive effects of accumulated risk to adversity. Results showed that accumulated risk and prenatal RF were related and predicted shared variance in maternal behavior towards her child 6 months post partum. Moreover, prenatal RF mediated the relationship between accumulated risk for early adversity and maternal sensitivity during mother-child interaction. The third study investigated the relation between prenatal RF and infant externalizing behavior (N=96, 54% male), and found that prenatal RF was predictive of a high infant aggression trajectory between the ages of 6 and 20 months. Taken together, the results of these three studies show that maternal RF is a promising target for early intervention programs in at risk families.

### **P-38 Examining associations among prenatal stress, maternal antioxidant status, and temperament in 30-month-olds**

*Lianna Lipton*<sup>1</sup>, *Kelly Brunst*<sup>1</sup>, *Michelle Bosquet Enlow*<sup>2</sup>, *Srimathi Kannan*<sup>3</sup>, *Rosalind Wright*<sup>1</sup>

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Background: Prenatal stress impacts fetal neurodevelopment through enhanced oxidative stress. Low antioxidant intakes also influence neurodevelopment. Few studies have examined their joint effects. Methods: We examined associations among prenatal stress, antioxidant intakes from food and supplements, and child temperament in a pregnancy cohort with ongoing recruitment (n=79 mother-child dyads available for analyses; 28% Black, 24% Hispanic). In mid-pregnancy, mothers reported negative life events on the Crisis in Family Systems survey; higher scores indicate higher stress. Prenatal antioxidant intakes below the median from a food frequency questionnaire were categorized as low. Negative Affectivity was assessed on the 36-item Early Childhood Behavior Questionnaire at 31.6 + 1.7 months. Linear regression was used to assess associations between prenatal stress and negative affectivity adjusting for maternal age, race, and education, and child sex and age. Effect modification by antioxidant status was examined in stratified analyses. Results: In the full sample, higher stress was associated with increased child negative affectivity ( $\beta = 0.08, p = 0.14$ ) but was not statistically significant. In stratified models, the effect of higher stress on negative affectivity was only significant among children of mothers who reported low prenatal intakes of vitamin C ( $\beta = 0.21, p = 0.02$ ), zinc ( $\beta = 0.18, p = 0.04$ ), and selenium

( $\beta=0.22$ ,  $p=0.02$ ). Discussion: Higher prenatal stress was associated with increased negative affectivity in toddlers born to mothers with lower prenatal antioxidant intakes.

### **P-39 Rethinking my baby's needs - a functional emotion regulation strategy? Neural correlates of maternal affect regulation in response to infant stress signals**

*Hannah Behrendt*<sup>1</sup>, Kerstin Konrad<sup>2</sup>, Christine Firk<sup>2</sup>

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Early maternal care plays a crucial role in the child's development. Mothers, who react sensitive to their infant's needs, support the development of adaptive emotion regulation skills, which constitute an important basis of stress reactivity and resilience. Previous studies indicate that depressive mothers show less sensitivity and reduced neural activity in parental brain regions in face of infant distress. The reduced sensitivity in caregiving behavior of depressive mothers seems to be, in turn, imprinted in the offspring's neurobiology. Therefore, children of depressive mothers present a high-risk group for the development of psychopathology in later life. We investigated this critical period of brain development by comparing primiparous mothers with and without postpartum symptoms of depression and their 6-to-8 month old infants. The main aim of the current project was to expand previous research on maternal affect regulation in response to infant stress signals using functional magnetic resonance imaging (fMRI, N=62). In particular, we investigated whether depressive versus healthy mothers were able to up or down regulate their affect and neural response to infant cry stimuli by using emotion regulation strategies (cognitive reappraisal, self-distraction). Preliminary findings replicate typical activations in parental fronto-limbic emotion regulation networks and show, moreover, different activation patterns in brain regions associated with deliberate top-down modulation of negative emotions. Differences between depressive and healthy mothers will be discussed.

### **P-40 Emotional Reactivity and Parenting Sensitivity Interact to Predict Cortisol Output in Toddlers**

*Clancy Blair*<sup>1</sup>

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Chronic elevations in stress hormones can affect the development of neural circuitry that underlies the regulation of behavior. To address questions about conditions under which stress hormones might be elevated, and whether such elevations are a "good" or "bad" thing, we examined cortisol output in response to emotion induction in N=1021 24-month-old children participating in a prospective longitudinal study of children and families in two regions of high poverty in the US. Multilevel analysis indicated that observed emotional reactivity to a mask presentation but not a toy removal procedure interacted with sensitive parenting (assessed by an observational procedure) to predict cortisol levels in children. For children experiencing sensitive parenting, cortisol output was positively related to emotional reactivity. For children experiencing low levels of sensitive parenting, cortisol output was unrelated to emotional reactivity despite the fact that these children were as reactive to the emotion induction as children experiencing high sensitive care. Findings indicate the role of sensitive care in the coherence and organization of development. A central principle of developmental science concerns the integration of diverse influences on behavior as they

are "fused in ontogeny" and shaped by the context in which development is occurring. Sensitive caregiving is understood to provide a context for development that enables flexible and organized regulation of physiology and behavior as needed in response to specific contingencies.

### **P-41 Risk, resiliency, and early child development: a community based study**

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Background Understanding risk and protective factors for early child development can inform prevention and early intervention. This study examines risk factors for development delay, as well as the role of resiliency within the context of poor maternal mental health or socioeconomic adversity. Methods Women participating in a prospective cohort study (n=3200) completed 3 questions in the perinatal period up to 1 year post birth. Maternal depression, anxiety, stress, social support, and parenting efficacy were measured using standardized tools. The child's development status at one year was measured using the Ages and Stages Questionnaire. The relationship between risk factors, resiliency, and early child development was examined using multivariable logistic regression and chi square tests with statistical significance set at  $p < 0.05$ . Results Seventeen percent of children were classified as developmentally delayed at one year of age. Prenatal depression, preterm birth, low community engagement, and non-daily parent-child interaction were risk factors for delay while protective factors in the context of adversity included relationship happiness, parenting competence, community engagement, social support, and daily parent-child interaction such as reading and imitation games. Conclusions The study results suggest that maternal and infant outcomes would be improved, even for vulnerable women, through identification and intervention to address poor prenatal mental health, and through normalizing engagement with low cost, accessible and supportive community resources.

### **P-42 Sleep Deprivation and Disturbances in Neural Functioning in Adolescence**

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Sleep disturbances have been associated with distinct neural changes that are implicated in numerous psychological and cognitive problems. Yet, studies with youth are limited. The present study utilized a novel within-subject experimental design to examine whether acute sleep restriction in typically developing adolescents contributes to differential cortical and limbic activity (measured by fMRI; 7T scanner) during several tasks. We hypothesized that sleep deprivation would reduce activity in cortical regions involved in cognitive control and emotion regulation, elevate activity in limbic regions involved in emotion reactivity and reward processing, and reduce functional connectivity between cortical and limbic systems. Youth (N=21: 11 boys; Mage= 4.5+.7 yrs) participated in 2 experimental conditions [1 night each of sleep deprivation (M=3.7 hrs) and "normal" sleep (M=7.1 hrs); counterbalanced], separated by 1 week and each followed by an fMRI scan the next morning. Actigraphy data validated adherence to the protocol. The fMRI session consisted of

a resting-state scan and well-established risk-taking, emotion regulation, and inhibition/impulsivity paradigms. Preliminary analyses reveal differences in prefrontal and limbic activity following the 2 sleep conditions. After 1 night of acute sleep deprivation, compared to 1 night of "normal" sleep, youth exhibit greater activation of limbic regions during several tasks and less efficient cognitive processing. Results will be discussed in relation to the role of sleep in CNS functioning and implications for youth adjustment.

### **P-43 Rejection in Bargaining Situations: An Event-Related Potential Study in Adolescents and Adults**

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Rejection is a common experience when bargaining, however the neural correlates of bargaining rejection are not yet well understood. We measured the neural reaction to rejection or acceptance of monetary offers with event-related potentials (ERPs) in the period of emerging and early adulthood when individuals develop social relationships with expectations of reciprocity. Adults (n=18, age 20.6) and adolescents (n=16, age 15.2) played multiple rounds of the Ultimatum Game as proposers. Participants divided coins between themselves and a second player (responder) by making a choice between an unfair distribution (7 coins for proposer and 3 for responder; 7/3) and one of two alternatives: a fair distribution (5/5) or a hyperfair distribution (3/7). Participants mostly made fair offers when the alternative was unfair, but often made unfair offers when the alternative was hyperfair. Strikingly, when participants' fair offers were rejected this was associated with a larger MFN compared to acceptance of fair offers and rejection of unfair offers. Also, the MFN was smaller after acceptance of unfair offers compared to rejection. These neural responses did not differ between adults and adolescents, suggesting that the MFN reacts as a neural alarm system to violation of social expectancies which is already prevalent during adolescence. Currently, we are investigating the role of social status on sensitivity to rejection in a bargaining situation, using the same paradigm measuring ERPs in three age groups (9-11 yrs; 14-15 yrs; 18-21 yrs).

### **P-44 Control your Anger! The neural basis of aggression regulation following social rejection**

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Social rejection is very distressing, particularly during the transition from childhood to adolescence. In some individuals, rejection can lead to aggression. Prior studies have investigated the neural basis of social rejection, but the relation with aggressive behavior has remained unknown. This study examined the relation between social rejection and aggression in a new social evaluation fMRI paradigm. The paradigm was first tested in an adult sample (N=30, 50% male). During the experiment, participants viewed pictures of peers with their reaction to the participants' profile (accept, neutral or reject). Participants were requested to react to the peer feedback by pressing a button, producing a loud noise. The noise blast duration was used as an index of aggression. Rejection led to more aggression (longer noise blast). Social evaluation, being accepted or rejected versus neutral responses, resulted in neural activation in a network of insula, medial prefrontal cortex

(mPFC) and striatum. Specifically, being accepted resulted in higher activation in the mPFC and striatum, whereas activation in the bilateral insula was related to being rejected. In addition, more activation in the right dorsal lateral PFC (DLPFC) during rejection versus neutral feedback resulted in more aggression regulation (shorter noise blast). These data fit with cognitive control models suggesting that DLPFC exerts top down control over affective impulsive actions. We are currently testing this paradigm in a developmental sample (aged 7-13), to investigate the development of aggression regulation.

#### **P-45 Neural responses to social exclusion in adolescents: the influence of social status**

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Social exclusion elicits distress and activation of brain areas involved in the processing and regulation of this distress in adolescents. Popular adolescents frequently exclude their peers, and they are central and influential in the peer group. Accepted adolescents also have a high social status, but they are well-liked and pro-social. The aim of the present study was to examine whether neural responses to social exclusion and inclusion are influenced by the popularity of the excluders, and by adolescents' own popularity and acceptance. Two Cyberball games were administered in an fMRI scanner to 52 adolescents (27 girls) aged 12-16 years: one with a team of highly popular players, and one with a team of average popular players. The players' popularity was manipulated by descriptions of their hobbies, number of Facebook friends and classmates' ratings. Peer nominations were used to assess participants' own popularity and acceptance. We found an increased response in the dorsal and rostral ACC to inclusion by average popular peers, who were also rated as more likeable, compared to highly popular peers. Participants' peer acceptance was positively associated with their IFG response to exclusion by popular peers. These findings indicate that being well-liked by peers influences neural responses to social inclusion and exclusion.

#### **P-46 Neural and behavioral effects of social exclusion on decision quality in adolescents**

*Shannon Peake*<sup>1</sup>, *John Flournoy*<sup>1</sup>, *Jessica Flannery*<sup>1</sup>, *Arian Mobasser*<sup>1</sup>, *Sarah Alberti*<sup>1</sup>, *Philip Fisher*<sup>1</sup>, *Jennifer Pfeifer*<sup>1</sup>

<sup>1</sup>University of Oregon

Making advantageous decisions in social situations is a key developmental challenge for adolescents. Teens with a deficit in this ability may be more likely to make poor choices with potentially serious outcomes. The current study examined individual differences in the neural and behavioral effects of negative social interaction with peers on subsequent decision making. Adolescents (N=53, ages 11-17) underwent fMRI while completing a decision-making task before and after an event of social exclusion by peers. In a modified version of the Stoplight Game, participants decided whether to stop or go for a series of traffic lights. Go decisions resulted in faster times on the game but also increased the chance of a crash resulting in a time delay. Crash probabilities varied based on different onsets of the yellow light. Teens completed self-report measures of susceptibility to social influence and real-world risk behavior. Teens with lower resistance to peer influence made

significantly fewer successful go decisions following social exclusion ( $p=.02$ ) resulting in worse performance on the game ( $p=.05$ ). The drop in advantageous decisions predicted both early initiation and frequency of real-world risk behaviors, including tobacco and marijuana use and sexual behavior (all  $p$  values  $< .03$ ), even after controlling for age. Imaging results explore the role of key regions in decision making and social interaction, including vS, IPFC, insula, and TPJ. Results suggest that an event of social exclusion may influence a teen's ability to make advantageous decisions in uncertain situations.

#### **P-47 Time-resolved analysis of delayed fMRI signal change during social evaluative feedback processing in the adolescent brain**

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Prior neuroimaging work has shown that the medial prefrontal cortex is differentially involved in the processing of social evaluative feedback. Typically, neural activity is modeled by the canonical HRF function within 2.5 sec after feedback presentation. However, this method precludes from finding effects that occur at earlier or later stages during feedback processing. This study employed a re-analysis of neuroimaging data obtained with the social judgment paradigm (Gunther Moor, et al. 2010) using Finite Impulse Response filters (FIR). The FIR function models the BOLD response with less constraints on shape and within multiple time bins to better capture the temporal change in fMRI activity. Additionally, we tested for gender differences in neural activation patterns and examined whether self-reported social anxiety was related to feedback-related brain activity. As expected, FIR results showed activity in brain regions not found using the HRF function, and identified delayed neural responses and associations with social anxiety dependent on gender. For example, increased activity in the subgenual ACC after social rejection feedback was specific for females, as well as a negative correlation between dACC activity and social anxiety. These responses occurred in later time bins after feedback presentation ( $> 2.5$  sec.). This study demonstrates the advantage of using the FIR method by offering an elaborate view on delayed neural activity to social evaluative feedback processing and individual differences therein.

#### **P-48 Longitudinal Links between Negative Family Relationships and Adolescent Cognitive Control-related Neural Processing**

*Ethan McCormick*<sup>1</sup>, Eva Telzer<sup>1</sup>

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Adolescents have an increased need to regulate their behavior as they gain access to opportunities for risky behavior; however, cognitive control systems necessary for this regulation remain relatively immature throughout this developmental period (Luna et al., 2010). While adolescents show general increases in risk taking from childhood, individual differences exist in onset and severity of risk-taking behaviors. One important predictor of individual differences is the quality of adolescent-parent relationships (McNeely et al., 2002; Borawski et al., 2003), such that relationships characterized by conflict and hostility relate to earlier onset and increased severity of risk taking. However, little is known regarding the neural mechanism underlying this relationship. Since adolescents undergo significant neural change, it may be that parent-child conflict impedes or alters development in prefrontal regions subserving cognitive control. To test this hypothesis, twenty adolescents completed



a go/nogo task during an fMRI session at 14 and again at 15-years old, and reported on the levels of conflict and cohesion in their families, as well as their engagement in risk-taking behavior. Adolescents with family relationships characterized by high conflict and low cohesion at T1 showed longitudinal increases in risk-taking behavior. The relationship between family relationships and risk taking was mediated by longitudinal changes in left VLPFC activation during cognitive control, such that adolescents with longitudinal increases in activation showed concurrent increases in risk taking.

#### **P-49 Development of Reward and Cognitive Control Connectivity using Group Iterative Multiple Model Estimation (GIMME)**

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Characterizing the bi-directional interactions of reward and inhibitory control brain systems is imperative to gain a fuller understanding of decision making across the lifespan. Here, we compare and contrast the interaction between key neural regions involved in reward and inhibitory control (e.g., striatum, FEF; correct trials only) in a large (N=90) sample of children, adolescents, and adults as they performed an incentivized antisaccade task. FMRI task data were used to derive functional ROIs, which were then analyzed using an effective connectivity approach called Group Iterative Multiple Model Estimation (GIMME) (Gates et al., 2011). This approach allows for the recovery of effective connectivity maps for both groups and individuals, considering both contemporaneous and lagged relationships, thus allowing a unique examination of both developmental and individual differences in the relationships between key brain regions involved in decision making. Our initial results indicate similarities in task-related neurocircuitry as well as age group by incentive differences in connectivity within incentivized antisaccade task trial epochs (e.g., striatal to FEF ROI connectivity is heightened in adolescents during response preparation during reward vs. neutral trials,  $p < 0.05$ ). The nature and directionality of identified task-related differences will be noted and discussed. These results suggest continued maturation through adolescence of brain systems underlying the integration of rewards with inhibitory control behavior (i.e., "motivation").

#### **P-50 The Relationship between Inhibitory Control and Weight Status in Adolescents: A Pilot Study Incorporating fMRI, Behavioral Measures, and ad libitum Food Intake**

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Previous research suggests a relationship between decision-making and weight status, however little work has focused specifically on adolescence. This novel pilot study assesses sensitivity to different types of reward and inhibitory/self-control in 40 adolescents (20 healthy weight, 20 overweight) ages 12-17. To assess neural sensitivity to different reward types, participants completed a modified card-guessing paradigm while undergoing an fMRI scan. Depending on the trial, participants were able to win monetary rewards, food rewards, or no reward by correctly guessing if a computer-generated number would be higher or lower than 5. Participants also completed two behavioral versions of a modified go/no-go task to assess inhibitory control and sensitivity to reward type. A mouse tracking task was

used to assess self-control; participants rated 76 common foods based on health, liking, and wanting, and then made a binary choice regarding which food option they would rather eat. Self-control was also measured using the Eating in the Absence of Hunger protocol which assesses snack food intake after consuming a standardized meal. General food intake behavior was measured using a 30 minute ad libitum laboratory test meal. Here, we highlight our preliminary results characterizing the relationship between neural sensitivity to reward, generalizability of reward types, impulsivity/self-control, and actual food-intake behavior in obese versus healthy weight adolescents. We discuss implications for adolescent decision-making in food choice behavior.

### **P-51 Risk-taking, perceived risks, and perceived benefits across adolescence: A domain-specific risk-return approach**

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Risk taking behaviors such as risky driving and unsafe sex peak during late adolescence, compared to childhood and adulthood. Such behaviors--although partly considered normative--can be associated with substantial individual and societal costs. Despite strong research interest, relatively little is known about contextual factors and underlying mechanism leading to this inverted-U pattern across transitions into and out of adolescence. We used the newly developed adolescent version of the Domain-Specific Risk-Taking (DOSPERT) scale to investigate apparent risk taking, perceived risks, perceived benefits, and their tradeoff in a sample of 213 12-25-year-olds. Using mixed-effects models, we found mainly curvilinear age effects with a peak in risk taking in mid-late adolescence in the ethical, health/safety, recreational, and social domains, with similar curvilinear patterns in perceived benefits in ethical and health/safety domains. Perceived risks showed less age differences. Perceived risks and benefits were significant predictors of risk taking in all domains, with benefits typically showing stronger effects than risks. Mediation analyses suggested that observed age differences can be explained by age differences in perceived risks and benefits. Our results replicate the developmental inverted-U in risk taking observed in real-life--rarely observed in the lab with risky choice tasks--with age and domain differences prominent in apparent risk taking and perceived benefits, identifying promising entry points for possible intervention and prevention efforts.

### **P-52 Evaluation of a Bayesian cognitive model for adolescent risky decision making in the Stop Light Game**

*John Flournoy*<sup>1</sup>, *Shannon Peake*<sup>1</sup>, *Sarah Alberti*<sup>1</sup>, *Jessica Flannery*<sup>1</sup>, *Arian Mobasser*<sup>1</sup>, *Philip Fisher*<sup>1</sup>, *Jennifer Pfeifer*<sup>1</sup>

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Developmental cognitive neuroscience is at the forefront of research on adolescent risk taking. However, commonly used tasks have relatively low ecological validity (the Balloon Analogue Risk Task [BART]), or confound risky and adaptive responding (the original Stoplight Game). To address this, we redeveloped the Stoplight Game - a simple driving simulation with a series of intersections, the goal of which is to get the lowest time. At each intersection, yellow lights prompt a choice: to stop (the safe option) or go and risk a crash (the fastest option if successful, but slowest if not). Each run comprises 20 intersections of three crash probabilities (.25, .5, .75), with time penalties set so 'go' and 'stop' have equal

expected value. Subtle cues distinguish intersection types, so learning will lead to lower times. The current study tests how social context and exclusion change risky decision making on this task. Diverse participants (N=53, ages 11-17) from local schools underwent fMRI while playing the game alone, and while being watched by peers pre- and post-exclusion from Cyberball. We model the cognitive process underlying behavior on this task, an approach that has been fruitful in describing several latent parameters in BART behavior (e.g., Plescak, 2008; van Ravenzwaaij et al., 2011). We evaluate a modification of van Ravenzwaaij and colleagues' Bayesian cognitive model using simulated Stoplight data, and use the above sample to investigate the role of regions including vS, IPFC, and TPJ, focusing on peer influence and exclusion.

### **P-53 Adolescent Risky Decision Making: Differential Strategies and Underlying Neural Substrates**

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Human decision making is far from optimal. For example, when asked to choose between a sure and risky option of equal expected value, individuals are more likely to choose the risky option in case options are framed as losses, while they are more likely to choose the sure option in case options are framed as gains. At the neural level, this framing effect has shown to be driven by amygdalae activation. Although conceptualized as a universal phenomenon, previous research has revealed that not all individuals are equally sensitive to the framing effect. We hypothesized that this is due to individual differences in decision strategies, where each strategy is associated with a distinct neural profile. We have tested this hypothesis in a two-phase study. In the first behavioural phase of the study, a large sample of adolescents (N=861) performed on a framing task. Latent Class Analysis supported our hypothesis, in that adolescents employed one of nine decision strategies. Importantly, only adolescents that were classified in certain decision strategy groups were sensitive to the framing effect; others were not. In the second phase of the study, a sub-sample of adolescents from five different decision strategy groups that were, and were not, sensitive to the framing effect (N=93) performed on the framing task in the fMRI scanner. We present results of preliminary analyses to test whether different decision strategies are associated to distinct neural profiles in which amygdalae activation is present, or not.

### **P-54 Dealing with uncertainty: Risky and ambiguous decision making across development**

*Neeltje Blankenstein*<sup>1</sup>, Eveline Crone<sup>1</sup>, Anna van Duijvenvoorde<sup>1</sup>

<sup>1</sup>Leiden University

Adolescence is characterized by marked by changes in cognitive and socio-emotional processes, which have been related to changes in risky choice and sensitivity to peers. To study risky choice, often used paradigms involve gambles with known probabilities. In real life, however, risky choices typically involve ambiguous (unknown) probabilities. Although it has been suggested that adolescent risky choice may be driven by a tolerance to ambiguity, factors underlying adolescents' risky choice across decision contexts remain largely unknown. Here, we administered a choice task to a developmental sample (N=162, ages 10-25) that included risky (known probabilities) and ambiguous (unknown probabilities)

choices in an individual and social context. First, we replicated lower risk taking in ambiguous versus risky contexts, and this ambiguity aversion increased with age. Second, expected value (EV) influenced risky choice in risky contexts, and level of ambiguity influenced risky choice in ambiguous contexts. Moreover, sensitivity to these factors increased with age. Last, we observed greater risk taking in the social compared to the individual context. This increase in risky choice was more evident in younger participants. Together, these findings suggest that sensitivity to EV and ambiguity are present from early adolescence, but become more specialized with age, and that social context influences risky choice particularly in early adolescence. These findings enhance insights into adolescent risky decision-making across choice contexts.

**P-55** importance of dynamic, large-scale networks to adolescent self-control rather than the activation or deactivation of specific brain regions.

### **The influence of social approval from peers on cognitive control during adolescence**

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Many distinctive adolescent behaviours, such taking risks with friends, initially seem ill-considered. But they may hold great motivational value for adolescents if they strengthen their social ties with their peers, as adolescence is a period characterised by the increased importance of social relationships and approval from others. Recent work has suggested that adolescents' motivation to engage in goal-directed behaviour is influenced by the social and motivational salience of their goals. Social reward, in the form of approval from peers, may enhance adolescents' ability to exercise cognitive control over their behaviour in order to receive this approval. However, not all peers may influence behaviour in the same way. Therefore, in the present study we utilised methods from the field of social network analysis to examine how social ties between peers influence goal-directed behaviour. Data collection has just been finalised in a sample of approximately 100 adolescents aged 11-13 years. All participants completed an incentive-based go-no go task, which contained feedback in the form of social approval from peers. These peers were selected based on the adolescents' nominations of peers within their social network whom they liked or disliked. Data analysis will focus on how the effects of social approval on task performance differ based on which peers provide this approval, as well as on how the sensitivity to social approval differs between adolescents with different positions within their social network. Results will be presented during the conference.

### **P-56 Positive and Negative Neural Feedback Processing of Risk Decisions Across Social Contexts in Adolescents**

*Jessica Flannery*<sup>1</sup>, *Shannon Peake*<sup>2</sup>, *John Flournoy*<sup>2</sup>, *Sarah Alberti*<sup>2</sup>, *Arian Mobasser*<sup>2</sup>, *Phillip Fisher*<sup>2</sup>, *Jennifer Pfeifer*<sup>2</sup>

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Risky decision-making is an iterative process, constantly synthesizing information from prior experiences to either promote or inhibit future risk-taking decisions; therefore, predicting future risk behaviors first requires an understanding of how risky decisions are processed. The influence of social context on feedback processing is of particular importance in

adolescence, a time of increased risk-taking decisions in the presence of peers compared to children and adults. In particular, peer rejection is associated with higher rates of risk-taking, yet how different social context influences the feedback of risky decisions has been relatively understudied. In the current fMRI study, we adapted the original Stoplight Game (a driving simulation designed to measure risk in the presence of peers) to de-correlate task performance with risk as well as differentiate how varied peer interactions influence neural feedback following the outcome of a risky (or safe) decision. We modeled 4 types of feedback (2 positive: go (no car) or stop (car), and 2 negative: go (car) or stop (no car)) across social contexts (alone, after peer acceptance, and after peer rejection). Preliminary data (N=53, ages 11-17 years old) suggests differential feedback processing following peer acceptance versus peer rejection. After peer rejection (versus acceptance), there was greater middle and posterior cingulate cortex (CC) to both types of negative feedback; and greater caudate, dorsal anterior CC, and middle CC to both types of positive feedback.

### **P-57 The neural correlates of prosocial behavior during observed exclusion in females**

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Humans show prosocial behavior to help others and reduce their distress. Prior studies have shown that after observing social exclusion, people tend to help excluded individuals by donating money to them or by including them in subsequent interactions. While observing social exclusion, areas in the brain associated with social pain (bilateral insula, dorsal anterior cingulate cortex) and mentalizing (medial prefrontal cortex and temporo-parietal junction) are active, but it is not yet known if these regions are also engaged when showing prosocial compensating behavior. The current study aimed to investigate whether people compensate for social exclusion during the observation of social exclusion, and whether brain areas involved in social pain and mentalizing are active during this prosocial behavior. We measured prosocial behavior with the Prosocial Cyberball Game, a four-player adaptation of Cyberball, in a sample of 23 healthy females (18-19 years). During the ball tossing game one player is excluded by the other players, and the participant can compensate by tossing the ball more often to the excluded player. We found that participants compensated for exclusion by tossing more balls to the excluded player than to excluding players. During tosses to the excluded player compared to tosses to the excluding players, we found increased activity in the left TPJ and bilateral insula. This indicates that people show prosocial behavior by compensating for observed exclusion, and that brain areas associated with social pain and mentalizing are involved in this process.

### **P-58 Functional Specialization of the Right Temporo-Parietal Junction in Early Childhood**

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Situated within the default mode network and at the boundary of other networks, the right temporo-parietal junction (rTPJ) is a nexus region that has been implicated in an array of processes such as attention, social perception, and social cognition. In middle childhood, the rTPJ displays functional specialization for mental state representation yet little is known about its functional organization in early childhood. However, early childhood is a key time

to study change in rTPJ organization given the pronounced advances in social cognitive abilities during this age. The lack of studies in early childhood is due to the challenge of acquiring artifact-free MRI data in young children. The current study utilized a novel passive-viewing functional connectivity approach to examine regional rTPJ specialization in 4 (N = 31) and 6 (N= 36) year olds, and adults (N = 22), resulting in high success rates (4s: 71, 81%; 6s: 83, 86%). Participants watched screensaver-like abstract patterns and a clip of an engaging movie, both of which served to hold attention and decrease movement. We used a two-step principal component analysis to uncover local temporal and subsequent global spatial patterns that account for > 5% within-region time series variance. Our results indicate that the adult rTPJ is organized into anterior and posterior eigenimages within the default mode network whereas the corresponding eigenimages in children are more diffuse and distributed into bordering networks. These results provide insight into the progressive functional specialization of this heterogeneous region.

### **P-59 Peer Influence on Prosocial Behavior in Adolescence: Using Adolescent Actors as Peers in an Experimental fMRI Study**

*Jorien van Hoorn*<sup>1</sup>, Eric van Dijk<sup>1</sup>, Berna Guroglu<sup>1</sup>, Eveline Crone<sup>1</sup>

<sup>1</sup>Leiden University

Adolescence is a time of increased sensitivity to peer influence, which creates vulnerabilities but also opportunities. This fMRI-study examined peer effects on prosocial behavior in adolescence, using an adapted public goods game. Participants (12-16 years; N = 61) made decisions in anonymous groups about the allocation of tokens between themselves and the group. Two fictitious spectator groups of peers (adolescent actors) were online during some of the decisions. We used a within-subjects design with three conditions: (1) Alone: no spectators present, (2) Spectators: spectators were present, no feedback displayed, (3) Feedback: spectators provided feedback with likes. Prosocial behavior was analyzed with a 3-factor (Condition: Alone, Spectators, Feedback) RM ANOVA. Results indicate a main effect of condition,  $F(2,118) = 50.08$ ,  $p < .001$ , and age-group,  $F(1,59) = 6.21$ ,  $p = .016$ . Prosocial behavior increased in the presence of peers and even more after feedback from peers. The 12-13 year olds showed more prosocial behavior in all conditions than the 15-16 year olds. At the neural level, whole brain analyses for the contrasts spectator > alone and feedback > alone at the onset of the decision screen showed activation in the social brain network, including the mPFC, TPJ and precuneus. We found developmental differences in the mPFC, suggesting that the mPFC differentiates more between peer effects in 12-13 year olds than 15-16 year olds. These findings suggest that peer presence and feedback increase prosocial behavior, associated with elevated activity in the social brain.

### **P-60 In the Mind of the Beholder: Preconscious cue detection and observed "micro love" within young adult romantic couples**

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This study examined the hypothesis that love within young adult romantic relationships maps onto preconscious bias towards tracking and monitoring positive relationship events. Dual acquisition high-density array EEG was used to assess automatic process of satisfying and unsatisfying "offers" from romantic partners and strangers within a laboratory setting. Afterwards, couples engaged in 30 minutes of videotaped observations involving a series of

discussions. Independent observers reliably coded "Micro love" within the videotaped interactions. Actor-partner models we run with both male and female ERP responses predicting their own behavior in observed interactions, or their partners. ERP analyses suggest that unconscious cue detection of positive relationship events as indicated by elevated P200 in the context of satisfying partner offers (compared to stranger satisfying offers) showed significant partner effects on observations of micro love. Preconscious processing of similar interpersonal events from a stranger was uncorrelated with observed couple interaction. These findings suggest brain-behavior entrainment for loving behavior within emerging romantic relationships in early adulthood.

### **P-61 Is adolescence a sensitive period for face processing?**

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Face processing is an aspect of social cognition that undergoes particularly extended development during adolescence with some studies reporting a dip corresponding to the onset of puberty. This development is thought to be largely driven by environmental input, which might make adolescence a sensitive period for face processing. To investigate the role of environmental input on social cognitive development, a systematic investigation of age differences in the acquisition of face information was carried out. Participants (n=448, age 11-33 years) were divided into three training groups, who underwent between 10 and 20 days of online training in face processing, relational reasoning or numerosity discrimination; the latter two served as active control groups. Participants were tested before training, after completing training and again six months after that. Effects of the three training programmes on face processing performance were measured and compared between age groups (children, young adolescents, mid-adolescents, adults). We predicted non-linear patterns of plasticity between child- and adulthood with participants in mid-adolescence showing less improvement after face-processing training, as compared to control training, than the other age groups. This study provides a better understanding of plasticity of face processing in adolescence and well-controlled data for the effectiveness of computerized socio-cognitive training.

### **P-62 Neural correlates of the development of the evaluation of social vs. non-social information during adolescence**

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Social cognition undergoes profound changes during adolescence, which might in part be determined by the development of two neural networks: the social brain and the executive control network. In a developmental fMRI study, we investigated BOLD signal in 39 participants (aged 11-31 years) while they evaluated and manipulated social or non-social information. In the social task, participants evaluated themselves or a friend, or compared themselves with their friend. In the non-social task, participants evaluated their hometown or another town, or compared the two. The consistency of participants' responses increased with age, and was greater for non-social information. Activation of the relational integration network, including the rostralateral PFC (RLPFC), was observed in the comparison condition of both the social and non-social tasks. Medial prefrontal cortex (MPFC) showed greater

activation when participants evaluated social as opposed to non-social information. There was no further increase in social brain activation when participants compared themselves to their friend as opposed to when they rated either themselves or their friend separately. Developmentally, there was greater activation in the right anterior insula in adolescents compared to adults during the comparison of non-social (as opposed to social) information. This study demonstrates parallel recruitment of the social brain and the executive function network during the manipulation of social information, in adolescents and adults.

### **P-63 To err is? social: The effects of oxytocin on performance monitoring in a social context**

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The majority of human behavior takes place in some sort of social context. As a result, our actions may also affect the people around us. Mistakes are a good example of actions that often have negative consequences not only for ourselves, but also for the people we are interacting with. In a previous fMRI study, we demonstrated that the mentalizing network (including medial frontal cortex and posterior parietal cortex) is more activated when we make mistakes that have consequences for another person compared to mistakes that only affect ourselves. In the current study we investigated whether the electrophysiological correlate of error detection - the so-called error-related negativity (ERN) - is differently involved in these two types of errors and whether oxytocin modulates the performance-monitoring processes involved. Healthy male volunteers (N=24) participated in a double-blind placebo-controlled cross-over study where they performed two versions of a flanker task. Participants were seated next to each other while EEG measurements were obtained. In the Solo version, participants performed the flanker task simultaneously and were told that any errors they made only affected their own individual financial bonus. In the Duo version, participants performed the same task but were now told that errors had negative consequences for both their own bonus and the bonus of their co-actor. In the placebo condition, ERN amplitudes were increased for social mistakes compared to individual mistakes. This increase was, however, absent after oxytocin administration.

### **P-64 Electrophysiological biomarkers of social anxiety: a comparison of right frontal alpha asymmetry and delta-beta cross-frequency correlation**

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Social anxiety disorder (SAD) is a common anxiety disorder characterized by an intense fear and avoidance of social situations. The heterogeneity in the clinical presentation of SAD and its comorbidity with other psychiatric disorders necessitates identification of biomarkers that can guide in early detection, diagnosis, and treatment. For the first time, the current study jointly examined two candidate electrophysiological biomarkers previously associated with SAD: right frontal alpha asymmetry and delta-beta cross-frequency correlation. Previous studies tested these biomarkers only during resting state and anticipation. However, cognitive-behavioral studies posit that social anxiety is related to cognitive biases during both anticipation and post-event information processing. Therefore, we tested the predictive value of right frontal alpha asymmetry and delta-beta cross-frequency correlation for SAD during resting state, anticipation and post-event information processing. Furthermore, we



tested whether these biomarkers are already present during resting state (which would indicate a biomarker at trait level) or only during symptom provocation (which would indicate a biomarker at state level). EEG data was obtained from low socially (n=33) and high socially (n=23) anxious female undergraduates during (1) resting state, (2) while anticipating to give a short videotaped speech, and (3) while recovering from this speech.

### **P-65 Neural control of social emotional actions in adolescence**

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Increased limbic and striatal activation in adolescence has been attributed to a relative delay in the maturation of prefrontal areas resulting in the increase of impulsive reward-seeking behaviors often observed during puberty. However, it remains unclear whether and how this general developmental pattern translates to the control of social emotional actions, a fundamental adult skill refined during adolescence. Using an fMRI-adapted social Approach-Avoidance Task, this study identifies how neural properties of emotional action control change as a function of pubertal development in 14-year-old adolescents (n=47; 21 males). Pubertal maturation, indexed by testosterone levels, shifted the neural regulation of emotional actions from the pulvinar nucleus of the thalamus and the amygdala to the anterior prefrontal cortex (aPFC). Adolescents with more advanced pubertal maturation showed greater aPFC activity when controlling their emotional action tendencies, reproducing the same pattern previously observed in adults. In contrast, adolescents with less advanced pubertal maturation showed greater pulvinar and amygdala activity when exerting the same amount of control. These findings qualify the generic notion of a shift from subcortical to prefrontal processing during puberty, suggesting that the pulvinar and the amygdala are the ontogenetic precursors of the mature emotional control system centered on the aPFC. We are currently testing the transition of the maturational shift of subcortical-prefrontal control by sampling the same participants later in their pubertal maturation.

### **P-66 Evaluating moral dilemmas: developmental changes and individual differences**

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When facing a moral dilemma, in which one has to choose between right and wrong, the ability to reason about an individual's feeling or thought helps in understanding a situation. This study used an Empathy-Dictator Game in a sample of 113 participants (aged 7-13; mean age: 10.94) to test the developmental transition from childhood to emerging adolescence of evaluating social situations by asking them to allocate coins with perpetrators, victims, neutral and prosocial people depicted in images of social exclusion, physical aggression, harm by accident, neutral-, and prosocial situations. Results showed an age-related decrease in coins allocated to perpetrators of social exclusion, physical aggression, and harm by accident, indicating that adolescents were more punishing towards perpetrators than children. Furthermore, with increasing age, participants differentiated more between perpetrators who harmed someone by accident compared to perpetrators of social exclusion, suggesting increasing understanding of motives of others. With regard to individual differences, children and adolescents scoring high on empathy allocated more

coins to perpetrators and victims of harm by accident, victims of social exclusion, neutral and prosocial people. This was not found for situations involving physical aggression or perpetrators of social exclusion. Together, these results illustrate a developmental transition in decision-making in moral and social situations between childhood and adolescence, suggesting more understanding and consideration of motives of others.

### **P-67 The BFF Context: Adolescents' Neural Response to Personally Relevant Social Reward in Relation to Depression and Real-Life Social Experiences**

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Peer social reward gains increasing value during adolescence, and disruption to social and reward functioning is postulated to play an important role in depression. We investigated common neural mechanisms of adolescents' depressive symptoms and real-world social experiences. Community adolescents (N =36, age 14-18, 31% male, 73% European American) completed functional magnetic resonance imaging with an ecologically valid social reward paradigm and experience sampling of mood and behavior over 20 time points across 2 weekends. Participants with higher depressive symptoms showed less response to best-friend positive affect vs. stranger positive affect in a set of regions implicated in reward and social processing, including the precuneus, temporoparietal junction, and ventromedial prefrontal cortex (vmPFC). A region of the vmPFC that responded to peer social reward was also related to both higher depressive symptoms and lower emotional closeness to companions in real life. Circadian modulation of associations between depression and social experiences was evident in the dorsomedial prefrontal cortex, which was also related to lower morning positive affect, and the temporoparietal junction, which was related to greater evening time with peers. Common associations of neural response with depressive symptoms and social experience suggest a mechanism for disrupted social functioning in depression.

### **P-68 The High Risk Social Challenge as a measure of social functioning and social skills in typically developing children and children at risk for developing psychosis**

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We explored the High Risk Social Challenge (HiSoC) as a potential ecologically valid measure of social functioning and skills. In the HiSoC, children are recorded completing a 45-second video clip explaining why they should be selected for an age-appropriate reality television show. In typically developing children ages 8-13, overall rater impression, appropriate affect, and social-interpersonal communication on the HiSoC were, on average, significantly associated with the ability to recognize and convey affect from expressive photographs (a measure of social cognition) as well as to resolve to interpersonal peer conflict (a measure of social functioning). On average, after adding children ages 8-13 at clinical high risk for developing schizophrenia into the sample, several factors of the HiSoC were significantly associated with general social functioning, social skills, social language development, and theory of mind (as evaluated by Reading the Mind in the Eyes and the

Hinting Task), after controlling for age, gender, and IQ. Taken together, these results suggest that the HiSoC is an effective measure of social functioning/skills: in typically developing children, scores on the HiSoC may reflect more nuanced social cognitive processing and relatively complex social skills, whereas in an atypical population with anticipated social and cognitive deficits, the HiSoC may be more sensitive to general social functioning/skills.

## **P-69 The behavioral and neurobiological effects of meeting adolescents' expectations**

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The social landscape changes significantly during adolescence. During this developmental window, individuals are tasked with learning about and predicting the dynamic social world. Research on non-social learning has demonstrated that prediction error signals help individuals learn from unexpected outcomes, a phenomenon that is neurobiologically stronger in the adolescent versus adult mesolimbic system (Cohen et al 2010). However, how the adolescent brain represents expected and unexpected social outcomes remains elusive. To address this question, we developed a novel social prediction error task. Target participants were asked to predict how a friend would rate certain characteristics about them. We then manipulated the friend's responses to be worse than, equal to, and better than what the target expected. We presented expectations and outcomes to the target while they received an fMRI scan. We found a significant difference in response times, such that adolescents were fastest to respond when their expectations were met, compared to when they were missed or exceeded. They also reported feeling more positive when their expectations were met compared to when they were exceeded. Neurobiologically, we found enhanced engagement of mesolimbic circuitry when expectations were met relative to when they were worse than or better than expected. These data suggest adolescents may experience fulfilled expectations as more rewarding than incorrect expectations, even when those incorrect expectations are better than expected.

## **P-70 Developmental differences in the factors that regulate belief updating in dynamic environments**

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To make optimal decisions in dynamic environments, we have to flexibly adjust the degree to which new information is used for belief updating. Such adaptive processes rely on a prefrontal monitoring system that is subject to substantial developmental changes. In this study we used a predictive inference task to investigate developmental differences in the ability to adjust learning rates in dynamic environments. Using Bayesian modeling and regression analyses, we dissociated three factors, surprise, uncertainty and reward that affect learning rates in children, adolescents and adults. Overall, we found lower learning rates in children compared to the other groups, indicating that they tend to underestimate the rate of change in the environment. This effect was particularly pronounced for small prediction errors whereas for surprising outcomes children showed strong learning rate adjustments. We found no developmental differences in uncertainty-driven learning, indicating that age groups were comparable in their ability to use outcome information to

reduce uncertainty. Finally, all age groups showed enhanced learning rates after obtaining reward, even though rewards were non-predictive of future outcomes. This bias was most pronounced in adolescents, which is consistent with findings pointing to enhanced reward sensitivity in this group. To conclude, our results indicate substantial developmental differences in the factors that govern adaptive learning. Future work will focus on providing a normative neuro-computational theory to explain these age-related changes.

### **P-71 Neural activations during fairness decisions in response to emotions in boys with aggressive conduct disorder**

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Individuals with conduct disorder (CD) persistently violate the rights of others or major age-appropriate social norms, and are marked by impairments in social processing. Although many studies found that youths with CD have difficulties in processing the affective reactions of others, not much is known about how they make social decisions in response to emotional expressions of others during social interactions. In the current study, we therefore investigated the neural mechanisms underlying fairness decisions in response to communicated emotions of others in aggressive boys with CD (N = 32) recruited from forensic settings, and typically developing (TD) boys (N = 33), aged 15-19 years. Participants received written emotional responses (angry, disappointed or happy) from peers in response to a previous offer and then had to make fairness decisions in a version of the dictator game. Behavioural results showed that the CD boys did not differentiate between the different emotions that were communicated by others, whereas the TD boys reacted relatively less fair in response to happy reactions than the CD boys. Whole-brain neuroimaging results ( $p < .05$  cluster-corrected) revealed that when receiving happy versus disappointed and angry reactions, the CD boys showed less activation than the TD boys in the temporoparietal junction (TPJ), an important region for social cognitive abilities such as perspective taking and empathy. These results suggest that boys with CD have difficulties with processing explicit emotional cues from others on behavioural and neural levels.

### **P-72 Effort discounting in children exposed to prenatal smoking**

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Smoking during pregnancy is associated with decreased academic achievement in children - an association that may be related to the effects of nicotine on the developing mesolimbic dopamine system. Effort discounting, the disinclination to expend effort toward the pursuit of rewards, is one candidate behavioral phenotype associated with mesolimbic dopamine system functioning that may contribute to decreased academic achievement. The current study hypothesized that prenatal nicotine exposure would be related to greater effort discounting in a dose-dependent manner. To test this hypothesis, 407 8-year old children were recruited from a longitudinal epidemiological study of rural families and completed a decision-making task wherein they played a computer-adaptive card game that required them to actively make decisions about how much cost in terms of time (waiting), effort (alphabetizing lists), or uncertainty (probabilistic reward) they were willing to

expend/tolerate for differing amounts of reward (points). Placed within a multilevel logistic regression model, the children's choices provided for both assessment of between-child differences in discounting and how the patterns of responding were related to the number of cigarettes mothers smoked during pregnancy. Results revealed that greater nicotine exposure was associated with greater effort, but not delay or probability, discounting, independent of a variety of control variables (e.g. child gender and IQ, maternal use of alcohol and illicit drugs during pregnancy, and family risk).