# 2016 Poster Abstracts

## Day 1, Thursday September 8

### 1-A-1 Adolescents' inhibitory control: Keep it cool or lose control.

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Inhibitory control (i.e., the ability to resist automatisms, temptations, distractions, or interference, and to adapt to conflicting situations), is a core ability for cognitive and socio-emotional development. Discrepancies in previous findings impel to determine (a) whether cool inhibitory control (in affectively neutral contexts) and hot inhibitory control (in affectively charged contexts) follow the same developmental pattern and (b) the degree of specificity of these two types of inhibitory control at different age. The present study suggests (a) that cool and hot inhibitory control abilities develop differently from childhood to adulthood - with a linear developmental pattern but an adolescent-specific one for respectively cool and hot inhibitory control abilities - and (b) that they progressively become more domain-specific with age.

### 1-A-2 Time-resolved EEG predicts classification of words and pictures in the infant brain

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Multivariate analysis methods (decoding) capture statistical dependencies between patterns of neural activity and experimental stimulus manipulations. They are applicable to a wide range of neural signals (such as fMRI, MEG, EEG, or fNIRS), and provide increased sensitivity over standard analysis methods. The potential of multivariate analysis methods for infant research is just beginning to be realized. Towards that end, we adapted established decoding methods (Cichy, Pantazis, & Oliva, 2014) to analyze infant EEG data at 6-9 and 12-15 months in a word-picture paradigm (Bergelson & Swingley, 2012), with adult EEG data as a benchmark. Infants were presented with 8 (adults with 16) different types of pictures, words, or matching and mismatching word-picture pairs while EEG data were recorded at 1000Hz from 128 or 32 channels. We applied millisecond resolved decoding to predict each stimulus, both between- and within-subjects, from EEG data. Decoding accuracy in adults for the pictures condition replicated previous studies (70% binary classification at 200 ms post-stimulus). Analysis of preliminary data from 6-9 month-olds revealed above-chance classification accuracy, indicating that decoding methods can uncover time-resolved representations in the infant brain. The time course of stimulus-evoked representations was less robust and delayed in infants compared to adults, suggesting that representational learning and development involve a general increase in efficiency and a specific tuning of early processing stages to higher-order categories.

## 1-A-3 The "Triple Threat": Influence of Peers, Excitement, and Reward on Cognitive Control Capacity in Adolescents

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Adolescence marks a time of increased impulsive behavior when the capacity for cognitive control is susceptible to socioemotional influences (Cohen, Breiner, et al., 2016). Thus, social cues can trigger impulsive actions, overriding goal-directed behavior during adolescence. This adolescent specific effect in behavior is paralleled by greater activity in reward related circuitry (Chein et al., 2011; Somerville et al., 2011). While studies examining the effects of incentives and peers typically examine these them independently, they rarely are in real-life. The goal of this study was to examine changes in cognitive control under conditions that may better reflect real world situations for teens. We tested the impact of the perceived presence or absence of a peer when performing an impulse control task (Cohen, Dellarco, et al., 2016) that consisted of positive social cues under a state of excitement. We found that under excitement when detecting smiling faces in the presence of peers, adolescents showed diminished cognitive control relative to when alone, and to other age groups. This was paralleled by greater activity in the orbitofrontal cortex in teens relative to adults in the peer condition. These data suggest the combined "triple threat" to self control of peers, excitement and positive cues may lead to greater anticipation of reward and increased impulsivity during adolescence but not in other age groups. This research has important implications for law and policy regarding diminished cognitive capacity during the adolescent years in emotionally charged situations.

## 1-A-4 Indistinct neural representations for addition and subtraction problems in the posterior parietal cortex predict arithmetic scores in primary school children with mathematical learning disabilities

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Children with mathematical learning disabilities (MLD) exhibit deficits in developing adequate numerical and arithmetical skills in the context of otherwise normal intelligence and age-appropriate education. Moreover, contrary to Typically Developing (TD) children who, by grade 3 are able to transition to efficient retrieval strategies for addition problems, children with MLD continue to rely on laborious counting strategies for both addition and subtraction problems. This suggests that cortical neural representations between these two arithmetical operations might fail to adequately develop in MLD. Using multivariate representational similarity analyses during addition and subtraction problem-solving in a population of 3rd-graders, we show that compared to TD peers, children with MLD exhibited greater representational similarities between these two arithmetical operations in functional brain systems subtending language, semantic as well as quantity processing. Notably, greater representational similarities between addition and subtraction problems within the right intraparietal sulcus (IPS) in the posterior parietal cortex were uniquely and significantly related to poorer standardized arithmetic scores in MLD. Together, these results provide novel insights into neural representational deficits in MLD, suggesting that failure to properly differentiate between addition and

subtraction problems, particularly in quantity processing regions of the posterior parietal cortex, might be at the core of their difficulties in acquiring grade-level-appropriate arithmetic.

## 1-A-5 Developmental Increases in Cortical Resting-State Variability

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There is compelling evidence that greater integration of functional brain networks and their relation to behavioral development continue to specialize through adolescence. However, these studies do not characterize age-related changes in the dynamics (i.e., variability) of cortical interactions. Using MEG to maximize temporal resolution, we hypothesized developmental increases in variability between large-scale brain networks at rest. We collected 5 minutes of eyes-closed resting-state MEG data from 68 subjects, ranging in age from 14-31 years. For a measure of variability, a phase-locking value (PLV) was calculated for each cortical ROI pair. A single PLV was derived for each subject by averaging over all ROI pairs at each frequency. Regression models were then fit to the data at each frequency interval to test for significant age effects. Supporting our first hypothesis, there was a significant developmental decrease in resting-state PLV, indicating developmental increases in whole-brain variability at rest, most prominently in the 4-14Hz frequency range. After conducting regional analyses, we found this effect followed a posterior-to-anterior gradient, such that the greatest rate of increased variability occurred within frontal regions, specifically between higher-order cognitive networks. Age-related increases in variability of resting state alpha oscillations in frontal regions suggest the transition from adolescence to adulthood may be characterized by access to a greater arsenal of executive regions supporting enhanced preparation for executive functioning.

## 1-A-6 The Relationship Between Cognitive Control Over Reward and Risk-taking is Explained by Age

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Adolescent-onset risk-taking presents a major public health problem, and understanding the cognitive processes involved in this behavior is of primary importance. The dual systems hypothesis proposes that an imbalance between early-maturing reward networks and later-maturing frontal control networks drives youth risk-taking (Somerville & Casey, 2010). Consequently, it is important to examine the role of cognitive control over rewarding stimuli in risk-taking across age. Participants (N=133, 8y-25y) completed child, adolescent, or adult versions of the domain-specific risk-taking (DOSPERT) scale to measure risk-taking. Participants also completed the conditioned appetitive response inhibition task (CARIT) while undergoing fMRI scanning. The CARIT consisted of two stages. First, reward was manipulated using a monetary incentive delay(MID) task. Participants received money for responses to rewarded stimuli and no money for responses to neutral stimuli. Second, the previously rewarded(PR) and previously neutral(PN) MID stimuli served as no-go stimuli in a go/no-go task. Failures in cognitive control over reward were measured as errors of commission to PR >errors of commission to PN. Cognitive control over reward and risk taking were correlated in the whole sample, as was age and risk taking (all p's<.05). Interestingly, after controlling for age, cognitive control over reward no longer predicted risk taking (p>.05). This surprising finding implies that while both cognitive control over reward and risk-taking change with age, different mechanisms may drive these two processes.

## 1-A-7 Modulation of the default mode network during naturalistic viewing - a developmental study

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During early childhood (between 4 and 6 years), children show a progressive trajectory of increasing social-cognitive abilities marked by an improvement in explicit theory of mind. While behavioral work has provided insights into children's social-cognitive development, less is known about the corresponding neural changes that support these abilities. This is likely due to the difficulty in acquiring artifact-free fMRI data in young children. Naturalistic viewing (movie watching) is ideally suited for this age group due to minimal task demands and stimuli that encourage sustained attention, both of which minimize head motion. The current fMRI study in 4- (N=40) and 6-year old (N=38) children, as well as adults (N=24), investigates reliable inter-subject correlations (ISC) during two contrasting passive viewing conditions: a socially engaging movie and one devoid of social context (abstract patterns). Our results highlight a main effect of condition such that ISC was higher during the socially engaging movie condition compared to the abstract patterns. While we saw minimal whole-brain main effects of age, we detected an age by condition interaction such that the difference in ISC was greatest in adults in 3 of the 4 sub-networks of the default mode network (defined from Yeo et al., 2011) - networks that have also been implicated in social-cognitive processing. Our results are consistent with current theories of age-related network specialization (Johnson, 2011) and extend the investigation of the brain development during early childhood into more ecologically valid contexts.

## 1-A-8 Adaptive Control and the Avoidance of Cognitive Demand Across Development

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Adults often avoid cognitive demand. To test how such biases develop, we investigated how well children and adults track cognitive demands and whether they adaptively coordinate their behavior to reduce demand. Adults and 11-12- and 6-7-year-old children completed a task in which they chose between two decks of cards depicting toys to sort based on either their color or shape. These two card decks differed in the frequency of color/shape rule switches. Both children and adults preferentially selected the less demanding deck (with fewer switches), and higher individual switch costs in terms of reaction time were associated with greater preferences for the less demanding deck across groups ($t=5.6$; $ps<.001$). All groups preferred the less demanding deck overall, but younger groups exhibited quicker and greater overall preference for the less demanding deck. However, although most participants reported that their preferred deck was the easier deck, the majority of participants provided motoric explanations for their preferences and did not overtly report that the less demanding deck had fewer rule switches when asked. Pupillometry will also be used as a complimentary assessment of individual differences of deck difficulty and as a predictor of deck preferences. This study provides insight into the development of sensitivity to and meta-cognitive awareness of cognitive demands and responses to such demands.

## 1-A-9 Relations between source memory and hippocampal volume in early childhood

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Episodic memory improves rapidly during early childhood. Previous work has demonstrated that between 5-7 years, children?s ability to recall details of previous events increases more rapidly than at other ages. However, the neural mechanisms underlying this improvement are unclear. The present study sought to address this gap by examining relations between children?s ability to recall details of a previous event (a hallmark of episodic memory) and hippocampal volume (a structure known to be critical for memory in older children and adults). A total of 113 4-8-year-old children completed a source memory task during which they recalled who taught them a novel fact one week prior and a structural MRI scan. Freesurfer and Automatic Segmentation Adapter Tool were used to derive hippocampal volumes; demarcation of head, body, and tail subregions was completed manually using standard anatomical landmarks. Preliminary results suggest that children?s ability to accurately recall a fact and its source were positively correlated with age. In addition, source memory was also positively correlated with volume of the hippocampal body in both the right and left hemispheres, even after controlling for overall brain size. Subsequent analyses will examine whether developmental differences exist in these associations during this period. This work extends previous literature on structure-function relations in memory to a developmental period that shows significant change.

## 1-A-10 Neural mechanisms underlying working memory for emotional faces across development

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The ability to hold in mind information about the identity and emotional states of others is critical to guide social behavior. Although age-related changes in the neural circuitry underlying working memory are well documented, little is known about how the ability to hold in mind and update more complex social information develops or the neural mechanisms underlying this development. In the present study, a sample of 60 children and adolescents (age 8-19 years) performed a delayed match-to-sample task for emotional faces while undergoing fMRI scanning. Engagement of fronto-parietal regions and the fusiform gyrus increased linearly with age, and greater activation in these regions was associated with better performance. Recruitment of the salience network, including the dorsal anterior cingulate and anterior insula, when the emotion of the probe face did not match the emotion held in memory was observed during a limited developmental window in early adolescence. Taken together, these findings indicate meaningful developmental variation in working memory for complex social information and in the neural mechanisms supporting this process. The emotional states of others are particularly salient during adolescence, resulting in patterns of neural recruitment during working memory for complex social information that are specific to this period.

## 1-A-11 Event-related oscillations and memory retrieval in the developing brain

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The aim of this study was to compare the neuronal oscillations associated with selective memory retrieval in children and adults. Selective retrieval refers to the capacity to isolate specific information from memory when stimuli are related to other stimuli or contexts in equiprobable ways. Neuroimaging studies in adults have shown that this type of retrieval is achieved via interactions between the midventrolateral prefrontal cortex and posterior cortical areas. Participants were 18 children aged from 7 to 11 years old and 13 adults. EEG was recorded from 64 electrodes using a Biosemi system while participants performed a visual retrieval

and control task. The EEG signal was analyzed in the time frequency domain by convolution with complex Gaussian Morlet's wavelets and the effect of retrieval processing on oscillatory activity was assessed by nonparametric Quade analysis. Children's success rate was lower on shape (73%) and color (80%) retrieval trials than on control (87%. Adults had the same accuracy in control and retrieval trials. Specific changes in induced oscillatory activity were observed in children during retrieval. Gamma responses (33Hz) were significantly enhanced compared to control at right frontal site. Alpha responses (10 Hz) were diminished compared to control at right parietal site. In adults, whereas the activity in control was similar to children, there was no change in mean power with retrieval. These findings suggest a different neuronal processing in children that may reflect the maturation of neural networks involved in selective memory retrieval.

## 1-A-12 Eye Movements Relate to Developmental Differences in Cued Task Switching Performance

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Large differences between adults and children have been observed in behavior and neural control networks during task switching performance. We tested whether age differences extended to eye movements and whether performance differences related to individual differences in working memory (WM) and behavioral problems. We examined 50 adults (18-27 years old) and 47 children (8-16 years old) during cued task switching under high WM demand. Children's fixation duration on the cued task feature before target onset was associated with worse accuracy ($r=-0.85$, $p<0.01$), whereas longer fixation on the possible response choices was associated with better accuracy ($r=0.69$, $p<0.01$). Adults showed a similar eye gaze performance relationship (r feat=-0.4, $p<0.01$). Individual characteristics related to differences in both task performance and eye movements. Better WM (digit span backwards) related to better performance in adults ($r=0.31$, $p=0.03$) but not children, and gaze pattern in both age groups (r child-feat=-0.3, $p=0.05$; r adult-feat=-0.33, $p=0.04$). Also, children's externalizing behavior problems (CBCL) related to decreased accuracy ($r=-0.35$, $p=0.02$) and less ideal eye patterns (r feat=0.33, $p=0.03$; r choice=-0.38, $p=0.01$). Overall, those who fixated longer on the cued feature rather than possible responses did worse, indicating younger children may struggle at the rule decoding stage. Prolonged cued feature processing was associated with decreased WM ability and behavioral problems, even in the absence of diagnosed difficulties.

## 1-B-13 Social influence on adolescent ambiguous and risky decision-making

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Adolescence is a life period associated with an increase in risk-taking behavior, especially in the context of peers. Risk-taking behavior can be expressed in many ways, such as drinking alcohol, reckless driving and risky sexual behavior. Two factors that are important for the propensity for risk-taking are attitudes towards ambiguity and risk. Ambiguity refers to decisions with unknown probabilities of outcome whereas risk is defined as decisions with known probabilities of outcome. Based on two recent studies, it appears that adolescents are more tolerant for ambiguity than adults (Tymula et al., 2012; Blankenstein et al., 2016). A critical question that remains unanswered is how the social context shapes risk-taking behavior in adolescence in risky and ambiguous decisions. In the current study we used an economic choice task to establish the effect of social context on risky and ambiguous economic decisions. Participants made a series of decisions between a safer and a riskier gamble. Decisions are made in two contexts, a solo context and a social context in which

participants are informed about other participants' choices. Most real life decisions are ambiguous and we therefore hypothesize that adolescents are especially influenced by social context when making ambiguous decisions.

## 1-B-14 Cognitive Components Underpinning the Development of Model-Based Learning

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Reinforcement learning theory distinguishes a "model-free" decision strategy that simply fosters repetition of previously rewarded actions, from a "model-based" strategy that recruits a mental model of the environment to select goal-directed actions. Whereas recruitment of model-free learning is evident across development, reliance upon model-based learning appears to increase from childhood to adulthood. However, the cognitive processes underlying the development of model-based learning remain poorly characterized. Here, we examined whether improvements in cognitive processes underlying the construction and flexible recruitment of mental models predict developmental increases in model-based choice. In a cohort of child, adolescent, and adult participants, we examined whether the ability to infer sequential regularities in the environment ("statistical learning") and the ability flexibly integrate distant concepts to solve novel problems ("fluid reasoning") predicted age-related improvements in model-based choice. All age groups demonstrated statistical learning ability, but age-related improvements in performance did not mediate the relationship between age and model-based choice. In contrast, fluid reasoning improvements fully mediated the age-related increase in model-based strategy. These findings suggest that the ability to learn the sequential structure of the environment is not sufficient to promote model-based choice, and that gradual development of fluid reasoning may be a critical component process underlying the emergence of model-based learning.

## 1-B-15 Brain-behavior relationships between social exclusion or over-inclusion and subsequent decision-making in adolescents

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Adolescents' decisions may be influenced by heightened sensitivity to social context. Brain regions implicated in processing social exclusion are thought to reflect conflict monitoring and affective pain processing (dACC/vACC); social cognition (rTPJ, vmPFC); and cognitive control (vlPFC, lateral OFC). However, little is known about the relationship between neural activation during social exclusion or over-inclusion and decision-making in these contexts. 64 adolescents ages 11-18 played runs of Cyberball with virtual peers followed by rounds of a driving simulation (the Yellow Light Game), during which they were observed by these peers. We used an event-related fMRI adaptation of Cyberball to simulate social exclusion and over-inclusion in separate runs, each interspersed with periods of fair play. Parametric modulators identified BOLD signal related to increasing exclusion or inclusion events. Preliminary analyses of brain-behavior relationships suggest several findings of interest. Heightened vlPFC/lateral OFC activation while processing increasing social inclusion was associated with better outcomes in the Yellow Light Game. Meanwhile, higher resistance to peer influence was associated with a cluster including the SMA and dACC. Activity in this cluster was subtly diminished with increasing social exclusion and more strongly reduced with increasing social inclusion. We discuss potential contributions of peer influence on decision-making from a general effect of violated peer social expectancies and neural processes unique to social exclusion or over-inclusion.

## 1-B-16 Social context as a moderator of neural responses to outcomes of risk decisions across community and foster care adolescents

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Monitoring and evaluating the consequences of our behavior is important for learning from past events and for action selection in an uncertain environment. Crucially, both positive and negative outcomes (i.e., reward and punishment, respectively) differentially influence our future behavior. Previous studies have found that adolescents increase risk-taking decisions in the presence of peers. Social rejection, specifically, is highly prevalent in adolescence and associated with higher rates of risk-taking, yet how processing feedback about outcomes is associated with changes in behavioral decisions across social contexts has also been understudied. In the current cross-sectional fMRI study of community adolescents (11-17 years old), participants played The Yellow Light Game - a driving simulation game designed to measure decisions and subsequent outcomes of risk and safe decisions. Participants performed the task three times: alone, in the presence of peers after social inclusion, and again after social exclusion. We modeled good and bad outcomes, as well as examined the additional variance in responses to good and bad outcomes associated with the next behavioral decision (i.e., to go or stop, and to "stay" or "switch"). Preliminary community data (N=65) suggest at the whole brain, increase ventral striatum activity during social exclusion was only associated with task performance following peer exclusion for good outcomes, suggesting peer context influences neural activity to positive and negative outcomes through different pathways.

## 1-B-17 Exploratory decision making becomes more strategic through adolescence

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Adolescence is marked by an increase in self-directed decision-making in novel, complex contexts. These new demands on adolescent decision making often require weighing the value of new options (i.e., exploration) against those that are better known (i.e., exploitation), the classic explore-exploit dilemma. In this study we characterized developmental change in the use of two strategies used to solve exploration-exploitation dilemmas, directed exploration and random exploration. N=147 12 to 28 year old participants completed the Horizon Task (Wilson et al., 2014), a task that presents exploration-exploitation dilemmas in short time horizons (where the information gained through exploration has no utility) and long time horizons (where the information gained through exploration has utility). The strategic use of directed exploration in long over short horizons showed robust changes from adolescence into adulthood, while overall levels of exploration did not vary with age. Adolescents and adults similarly exploited the high reward option in short horizon games. However, in long horizon games, adolescents were more likely than adults to forego the more informative option, favoring the high-reward option instead. This pattern suggests that adolescents place greater value on immediate rewards relative to the value of information that holds potential to boost long-term utility when the known rewards are high. These findings offer a framework to study strategic exploratory behavior that could be expanded to reveal the developmental, hormonal, and experiential mechanisms that shap

## 1-B-18 The Neurobiological Effects of Daily Stress on Risky Decision-Making in Adolescents

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Adolescence is characterized by increased risky decision-making, enhanced mesolimbic response to risk and reward, increased actual and perceived stress, and heightened physiological response to stress relative to other age groups. In adults, acute stress increases risky decision-making by stress-induced increases of dopamine in regions implicated in reward processing and decision-making. In adolescents, acute stress also increases risky decision-making, but the underlying neurobiological mechanisms remained unexplored. In this study, an ecological momentary assessment approach was used to document daily self-reports of stress in adolescents (n=22; ages 15-17 years) and adults (n=22; ages 25-30 years). Participants completed two fMRI visits during which they performed a risky decision-making task: once each when they endorsed a high and low level of stress. Adolescent males took more risks under high stress relative to low stress whereas adult males took fewer risks under high stress relative to low stress. Adolescent males also showed a stress-related decrease in prefrontal activation when making risky decisions from high stress to low stress while adult males maintained prefrontal activation when making risky decisions across stress conditions. Adolescent and adult females did not exhibit stress-related changes in risky decisions. Moreover, greater prefrontal activation under stress was associated with fewer risks taken under stress, suggesting that adolescents may evince greater vulnerability to the cognitive and neurobiological effects of daily stress relative to adults.

## 1-B-19 Social media and the social brain: associations between real-world risk-taking and neural responses to Instagram photographs

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Past research has linked exposure to peers' risk-taking on social media to real-world risky behaviors in adolescence, and viewing risky images online is related to decreased activation of the cognitive control network. We investigated neural responses to risky images posted on a popular social networking platform. Youth (age 13-21) underwent fMRI while using a tool that mimicked Instagram. They viewed a feed of photographs ostensibly submitted by peers, including images depicting behaviors like smoking and drinking. We examined how neural responses to these risky photographs related to participants' individual tendency to engage in real-world risk-taking behaviors, and to appraise these behaviors as more beneficial and less risky. We hypothesized that brain activity correlated with risk-taking would occur in regions associated with current models of adolescent decision-making (e.g., cognitive control and reward circuitry). Instead, correlations were found in regions associated with social cognition (precuneus, mPFC) and visual attention (occipital cortex). Our findings suggest that, while the Dual Systems/Imbalance models of adolescent risk-taking highlight some key brain regions implicated in adolescent risky behavior, other areas, including those that make up the "social brain," are also implicated and should be considered as regions of interest in future work. Furthermore, complex paradigms that incorporate rich social stimuli may yield additional insight into the contribution of multiple neural regions in predicting individual predilection to engage in risky activities.

## 1-C-20 Early brain development predicts deficits in attention and working memory at school entry

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Attention deficit hyperactivity disorder (ADHD) is characterized by inattention and hyperactivity-impulsivity, which can hinder academic progress and diminish self-esteem. Neural networks involved in attention and working memory develop in the first few years of life, during which patterns related to later deficits may be identified to provide opportunities for early interventions. The current study uses the early brain development of selected regions as measured via MRI at neonate, 1, and 2 years of age to predict risk of problems in attention and working memory as measured by Behavior Rating Inventory of Executive Function (BRIEF) and Behavior Assessment System for Children (BASC) parent scores at age 6. Children (n=47) whose Global Executive score was ≥1 SD from the mean were included in linear longitudinal mixed model analyses. Greater growth in cortical surface area (SA) from birth to 2yrs significantly predicted higher deficits in behavioral outcomes at age 6: anterior cingulum SA significantly predicted working memory, hyperactivity, and attention scores (p's≤0.02); right caudate volume and left inferior frontal gyrus SA trended towards significance in predicting working memory scores (p's≤0.065) and right inferior frontal gyrus SA trended towards predicting externalizing problems (p=0.052). These results suggest that kids at higher risk for ADHD show greater growth in several regions in postnatal brain development, earlier than commonly, behaviorally observed. These results inform future risk assessment, which can alert caretakers and promote early intervention.

## 1-C-21 Development of hippocampal-prefrontal cortex interactions through adolescence

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Interactions between the anterior hippocampus and prefrontal cortex underlie the integration of prior experience in goal-directed executive functions that could be critical in development. These regions, as well as the white matter tracts between them, show protracted structural development into and through adolescence, paralleling the increased ability of teens to use flexible, contextually-relevant experience to guide behaviors. We investigated the development of functional connections between the hippocampus and anatomically defined dorsolateral (dlPFC), ventrolateral (vlPFC), and ventromedial (vmPFC) prefrontal cortices, as well as subgenual anterior cingulate cortex (sgACC), in a longitudinal study in which subjects were scanned yearly for up to 10 years (143 subjects, ages 8-32, 456 total scans, mean 3.2 scans per subject). We computed functional connectivity during 30-45 sec periods of fixation occurring between alternating blocks of pro- and anti-saccades using fMRI. We found that bilateral hippocampal connectivity to both left and right vmPFC, as well as sgACC, increased with age. No age-related changes were observed in either dlPFC or vlPFC. Our results suggest that adolescence represents a key time for the development of functional interactions between hippocampal memory systems and executive systems in the medial prefrontal cortex. We will discuss the association of these changes with developing cognitive behaviors.

## 1-C-22 Under-connectivity Between Executive Networks and Cerebellum Predicts Later Development of a Pro-Violent Disposition in Adolescents

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Adolescence is a period of rapid cognitive and behavioral changes characterized by increased risk-taking and aggression. Brain imaging research with functional magnetic resonance imaging (fMRI) has suggested heightened brain activity in emotional regulation and risk-processing regions may underlie behavioral changes

observed in adolescence. In this study, we examined the emergence of future violence proneness in developing adolescents with resting state functional connectivity (rsFC) using a 3T fMRI in 110 adolescents aged 11-13 years old. Data were collected as part of the ongoing Adolescent Development Study (ADS). A 5:49min resting state fMRI scan (TR/TE=2280/30ms, resolution=3mm3) was collected on a 3T Siemens Tim Trio. Standard preprocessing was performed using SPM12; including slice-timing correction, co-registration, spatial normalization, and smoothing (12mm). The Conn toolbox was used to bandpass filter, regress signal related to white matter and cerebral spinal fluid confounds, and remove volumes with excessive motion (framewise displacement>1mm or global signal change z>3). Violence proneness scores were measured using the Drug Use Screening Inventory Revised (DUSI-R) at baseline and at 18 months later. A greater pro-violent disposition at 18 months compared to baseline was correlated with decreased functional connectivity between limbic cerebellar regions and the left and right executive control networks (FDR $p < 0.05$). Our results suggest baseline differences in cerebellar functional connectivity with executive networks may predict future violent behavior.

## 1-C-23 Neurite density index is sensitive to age related differences in the developing brain

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Purpose: White matter development is characterised by increasing white matter coherence and organisation, however fractional anisotropy (FA) obtained via diffusion tensor imaging (DTI) lacks sensitivity to disentangle the mechanisms of organisational differences. Recently, metrics such as neurite density index (NDI) from NODDI modelling have been introduced provide more information than FA, however direct comparison between the sensitivity and specificity of these metrics have not been made. Methods: Diffusion-weighted imaging data from 76 children and adolescents between the ages of 4 - 19 was collected (M = 10.42, SD = 3.99, 36 male). We compared the sensitivity and specificity of NODDI metrics against DTI metrics using an ROC analysis and modelled age-related differences between the metrics in commonly derived white matter tracts. Results: NDI was significantly better at predicting age between younger and older children compared with FA for a number of white matter tracts, namely the cingulum ($p = .001$), uncinate fasciculus ($p = .001$), and left superior longitudinal fasciculus ($p < .001$). Moreover, NDI exhibited a significantly stronger linear relationship with age compared with FA (15/20 tracts), axial diffusivity and radial diffusivity. Discussion: Our results reveal the sensitivity and specificity of NDI to detect age-related differences in paediatric white matter microstructural alterations, compared with DTI metrics. This knowledge provides justification of implementing NODDI metrics as more accurate alternatives to DTI metrics in developmental studies.

## 1-C-24 Developmental differences in hippocampal contribution to episodic memory in 4- to 8-year-old children

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We aimed to investigate whether hippocampal activation during episodic memory encoding differs as a function of age and hippocampal subregion during early childhood.A sample of 31 4- to 8-year-old children were divided via a median split into young (n = 16, Mean age = 6.37 years, SD = 0.84) and old (n = 15, Mean age = 8.02, SD = 0.56) groups. During encoding, fMRI data were collected while children viewed and were instructed to remember 120 stimuli and cartoon characters they were paired with. During retrieval children were asked to make item and source memory judgments on 160 stimuli. Responses were categorized as hits-

source correct, hits-source incorrect, or misses. Activation of bilateral hippocampal head, body, and tail were calculated for each condition and each subject. Activation differences were compared between hippocampal subregions, conditions, and age groups.For source correct versus source incorrect trials, in the younger group, hippocampal head activation was lower than the activation of body and tail; in the older group, hippocampal tail activation was lower than the activation of body and head. For hit versus miss trials, in the older group, activation differences were observed between hippocampal head and tail in the miss condition.These results suggest there may be developmental differences in functional differentiation along the anterior-posterior axis of the hippocampus in 4- to 8-year-old children.

## 1-C-25 Risk taking, impulsivity, and brain volume in a sample of post-institutionalized youth

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A growing body of literature on the impact of institutional care early in life has established an association between the amount of time spent in an institution with decreased performance on stroop, go/no-go, backward digit span, and other executive function tasks (Merz, Harlé, Noble, & McCall, 2016). Further, recent research has demonstrated that institutionalization predicts smaller right prefrontal cortex volume in adolescents (Hodel et al., 2015). To date, however, little is known about the association between executive function performance in post-institutionalized (PI) children and brain structure. A group of PI children and age-matched controls completed the Balloon Analogue Risk Task (BART), a measure of risk taking propensity, and participated in a structural MRI scan (N = 58). Participant's parents also completed the Health Behavior Questionnaire (HBQ). Decreases in BART performance and increased impulsivity scores on the HBQ related to PI status ($p < 0.01$). Further, exploratory analyses of the prefrontal cortex indicate that improved performance on the BART predicts larger left OFC volume, left ACC volume, and left parsopercularis volume ($p < 0.05$), while HBQ impulsivity scores predict increased left ACC surface area ($p < 0.05$) when controlling for intracranial volume, age at adoption, IQ, and age at assessment. These results provide preliminary evidence for associations between brain structure, risk taking, and impulsive behaviors in PI adolescents. Further, the results may elucidate some of the specific effects of early deprivation on the developing brain.

## 1-C-26 Neonatal cerebellar functional connectivity and early childhood neurodevelopmental outcomes

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To date, limited investigation has been performed regarding early cerebellar functional connectivity (FC) and its role in neurodevelopmental outcomes. This study characterized intrinsic cerebellar and cortico-cerebellar FC in term- and prematurely-born infants and related these measures to early neurodevelopmental performance. Resting state-fcMRI data were acquired in 38 term-born infants (scan postmenstrual age [PMA]: 39±1wks) and at term equivalent PMA in 27 preterm-born infants (birth gestational age 27±2wks; scan PMA: 38±1wks) without brain injury. EPI data were acquired on a Siemens 3T scanner (TR/TE 2910/28ms, 2.4 mm isotropic voxels). Seed correlation was performed using a whole-brain cubing approach (6mm cubes). For preterm infants, regression analyses identified associations between neonatal cortical and cerebellar FC and age 2 Bayley-III measures. Two anti-correlated FC clusters demonstrating differential correlation patterns with supratentorial networks were identified in the cerebellum. Preterm infants showed reduced correlation

magnitudes compared to term-born peers. Regionally-specific neonatal cortico-cerebellar FC measures were related to Bayley motor, cognitive and language outcomes at age 2 years. Intrinsic cerebellar and cortico-cerebellar functional connectivity is well-established by term, with similarity to adult results. Prematurity was associated with reduced cerebellar FC magnitude. Cortico-cerebellar FC related to outcomes at 2 years. Further investigation may yield critical information regarding the cerebellum's role in brain-behavior development.

## 1-C-27 Tissue-iron as a non-invasive indicator of striatal dopamine system neuroanatomy during adolescence

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Animal models suggest that D2 receptor (D2R) density peaks during adolescence in the striatum. However, direct neurobiological evidence in humans is limited. Positron emission tomography (PET) studies can assess striatal D2R concentration only in adults as it is invasive. Tissue-iron, highly concentrated in the striatum, can be non-invasively imaged in an MRI and has been associated with many aspects of the dopamine system, including D2R density, potentially serving as an indirect indicator of D2R levels. We quantified striatal tissue-iron concentrations using R2', in approximately 40 12-30 year olds. We also acquired PET data using [C11]Raclopride (RAC), a selective striatal D2R antagonist, as an indicator of D2R concentration in approximately 25 18-30 year olds. We found that R2' differed with age following a quadratic function, peaking at age 24, in the nucleus accumbens (NAcc) but remained stable in the caudate nucleus (CN). Likewise, in the adult sample RAC binding showed a trend-level increase with age in NAcc following an inverse function, but did not change with age in the CN. Critically, in both areas R2' and RAC binding were positively correlated for the adult sample after removing the effects of age from both measures, indicating that individual differences in tissue-iron concentration reflect individual differences inD2R concentration. These results suggest that adolescence is a unique period of development for limbic striatal neuroanatomy and that tissue-iron as assessed with R2' may indeed function as a non-invasive indicator of striatal D2R concentration.

## 1-C-28 Early emotion dysregulation predicts subsequent connectivity abnormalities in children with Major Depressive Disorder (MDD)

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Children with MDD exhibit emotion dysregulation (ED) and abnormal connectivity in brain areas central to emotion processing. While ED has been linked to atypical connectivity, it is unclear whether early ED can predict subsequent variation in connectivity in adolescence. The present study investigated whether 1) ED at Time 1 (T1; childhood) predicted connectivity at Time 2 (T2; pre-adolescence) in children with or without a history of MDD (2) T1 connectivity predicted T2 connectivity and (3) T2 connectivity predicted later ED and/or depression at Time 3 (T3; adolescence). Participants were 143 children from the Pediatric Depression Study at Washington University who completed the Children Sadness Management Scale (CSMS, higher scores = greater ED) at T1 and two resting state scans at T2. Using seed-based analyses, we examined connectivity between five seed ROI's (bilateral dlPFC, and subgenual ACC, and bilateral amygdala) and four additional ROIs thought to contribute to emotion regulation. We found that greater CSMS scores predicted increased connectivity between bilateral dlPFC and dorsal ACC, right amygdala and left insula, and left amygdala and

right vlPFC, in MDD relative to other diagnoses and controls. T1 connectivity did not predict T2 connectivity in MDD. Greater connectivity between bilateral dlPFC and vmPFC, and, right amygdala and left insula predicted greater depressive symptoms at T3 but not ED. These results suggest that childhood ED predicts connectivity in pre-adolescence, which in turn, predicts depression in adolescence in children with a history of MDD.

## 1-C-29 Diminished connectivity of corticostriatal reward pathways in socioeconomically disadvantaged youth

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Children reared in economically disadvantaged contexts more frequently demonstrate school difficulties, behavior problems, and cognitive deficits. Given its role in both basic motivation and higher-level decision-making, the reward network is an important candidate system to consider in understanding this relationship. In the present study, we tested the hypothesis that high socioeconomic risk is associated with diminished integrity in reward processing neural circuitry in children and adolescents. We performed resting-state functional MRI in 92 adolescents (ages 6-17) and assessed correspondence between functional connectivity in corticostriatal reward pathways and economic disadvantage. Our sample was economically diverse, with dense sampling from low resource areas. Indeed, over 20% of our sample reported annual incomes below the poverty line. We found that children and adolescents living in more distressed communities displayed reduced connectivity between the nucleus accumbens and medial prefrontal and orbitofrontal cortical regions. This is the first study to describe diminished functional synchrony in disadvantaged youth in these key reward-processing hubs during early development. Altered connectivity in reward circuitry during early development provides potential mechanistic insight into associations between early disadvantage and neurodevelopmental problems, including impairments in learning, decision-making, cognitive control, and psychiatric disorders, which occur disproportionately more frequently in children reared in high sociodemographic risk contexts.

## 1-C-30 Multimodal investigation of the preterm neonatal cerebellum: a combined volumetric and fibre tractography MRI study

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Rationale: Cerebellar abnormality is increasingly recognized as a complication of preterm birth. Structural and diffusion MRI analyses have the potential to provide key insights into early cerebellar macrostructural and microstructural vulnerability. Aims: To establish associations between varying degrees of prematurity and cerebellar vulnerability at term equivalent age (TEA), in relation to clinically important perinatal factors. Methods: Preterm (PT, <36 weeks gestational age (GA), n=80) and full-term infants (FT, ≥37 weeks GA, n=40) were scanned at TEA (38-44 weeks GA). Cerebellar whole, hemispheric and vermis volumes were extracted using automated segmentation and probabilistic tractography used to extract the cortico-ponto-cerebellar and dentatothalamic tracts. Results: PT infants had smaller cerebellar whole, left and right hemispheric volumes, but larger vermis volumes compared with FT infants. Tract segment analysis revealed heterogeneity

in microstructural alterations in superior and inferior segments; superior segments displayed higher diffusivities in PT compared with FT infants, while inferior tract segments displayed lower diffusivities and higher anisotropy. Cerebral brain injury and antenatal steroid exposure were major predictors of cerebellar volumetric and tract alterations. Conclusion: Using multimodal MRI, we provide novel insight into cerebellar macrostructural and microstructural differences between preterm and full-term infants early in the neonatal course. Such neonatal MRI 'biomarkers' may serve as predictors of long-term cerebellar development.

## 1-C-31 Brain mechanisms for processing discriminative and affective touch in 7 month-old infants

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Abstract: Affective touch has been linked to affiliative behavior in early stages of infant development, but its underlying brain mechanisms are poorly understood. In children, adolescents and adults, affective touch seems to activate a brain network responsible for processing social-emotional stimuli including the posterior superior temporal sulcus (pSTS). Purpose: This study used fNIRS (functional near-infrared spectroscopy) to examine affective and discriminative touch in 7- month-old infants (n=32). Methods: Infants were given discriminative and affective stimuli to the forearm for 10 seconds followed by 20 seconds of a rest period while they were looking at a mute movie. Brain activation was recorded in somatosensory cortex and pSTS for measures of oxy-hemoglobin and deoxy-hemoglobin. Results: A pattern of increase in oxy-hemoglobin and decrease in deoxy-hemoglobin was observed in the somatosensory cortex for discriminative and affective touch relative to baseline, whereas no pattern was found for the affective condition in the posterior superior temporal sulcus. Conclusion: This is the first report that examined brain activation in the pSTS in response to affective touch in 7 month-olds. Our findings suggest that there is a developmental trend for the process of the different aspects of touch. Seven month-olds show a similar pattern of brain activation in the somatosensory cortex for somatosensory and affective touch, but no activation was found pSTS for the affective touch. In contrast with young children, adolescents and adults, our results suggest that 7 month-old

## 1-C-32 Moment-to-Moment BOLD Signal Variability Reflects Functional Specialization Across Development

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Variability in the BOLD signal during task-based fMRI scanning has been tied to developmental and task-performance differences. However, resting state fMRI (rsfMRI) BOLD signal variability across the lifespan is relatively unexplored. The current study examined voxel-wise moment-to-moment rsfMRI BOLD signal variability across development utilizing two large datasets (NKI-enhanced database - dataset 1: 187 subjects, 6-85 years old, TR = 1.4 seconds, 404 volumes; dataset 2: 191 subjects, 6-85 years old, TR = .645 seconds, 900 volumes). Preprocessing of both datasets consisted of standard procedures as well as despiking, nuisance covariate regression (motion parameters, WM, CSF), and bandpass filtering (0.01 - 0.10 Hz). Voxel-wise BOLD signal variability was calculated using mean square successive differences (MSSD) to identify changes in signal intensity between each TR. Changes in MSSD across age were identified using a general linear model in FSL (FLAME1) with age as a covariate of interest alongside handedness, IQ, and framewise displacement as nuisance covariates. Both datasets demonstrated positive MSSD age correlations within bilateral anterior

insular cortices, fusiform and inferior temporal areas and negative MSSD age correlations for primary visual, sensorimotor, and subcortical areas. These results demonstrate that BOLD signal variability across development generally increases in salience network regions responsible for cognitive flexibility, and decreases in primary visual, sensorimotor, and subcortical areas that likely become more functionally stable with age.

## 1-C-33 Neonatal Functional Connectivity Predicts Behavioral Inhibition at Age 2 Years

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Anxiety disorders are the most common form of psychopathology and often begin in early childhood. Behavioral inhibition (BI), an infant temperament characterized by increased attention to novelty, is a potent risk factor for anxiety disorders. We hypothesized that BI is associated with altered development of the ventral attention network (VAN), given the VAN's role in directing attention to novelty. We related resting state functional connectivity MRI (rs-fc) of the VAN and other functional brain networks at term to BI at age 2 years. Subjects were N=37 infants (n=10 term, mean birth gestational age (GA) 39 wks, mean postmenstrual age (PMA) at MRI 39 wks; n=27 very preterm, mean birth GA 26 wks, mean PMA at MRI 38 wks). BI was assessed with the Infant Toddler Social Emotional Assessment at 2 years. Regression analysis related whole-brain voxel-wise rs-fc of the right ventrolateral prefrontal cortex (VLPFC) at term to BI at 2 years; results were multiple comparison corrected. Exploratory analyses examined relations between rs-fc among 31 regions-of-interest at term and BI at 2 years. Neonatal rs-fc between the right temporal-parietal junction and right VLPFC, two main regions of the VAN, predicted BI at 2 years ($r=-0.55$, $p<.05$). Exploratory analyses identified additional neonatal functional connections that predicted BI at 2 years. Variability in rs-fc of the VAN during the neonatal period predicts BI at 2 years. These results inform the developmental neurobiology of BI, a potent risk factor for developing anxiety disorders.

## 1-C-34 Sleep Deficiency and Default Mode Network Connectivity in Adolescents

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Adolescence is a developmental period characterized by sleep disruption, with only 20% of US adolescents getting optimal sleep. Chronic sleep deficiency can negatively impact adolescent academics, health, and safety. Research in adults indicates that even short term sleep deprivation can impair connectivity in certain resting state networks. The default mode network (DMN), one of the primary resting state networks, has been linked to social cognition and self-monitoring. Over development regions of the DMN integrate into a cohesive network. In adults, longer sleep duration has been linked to enhanced functional connectivity in the DMN and its anticorrelated network (ACN), which has been identified as a task-positive network implicated in attention and inhibitory control. However, the effects of sleep on adolescent DMN development remain largely unknown. The goal of this study was to examine the relation between adolescent sleep and DMN connectivity. Data for 37 adolescents (Mage=16) were analyzed. Seed-based functional connectivity analyses revealed a significant negative correlation between sleep disruption (as indexed with actigraph recorded average number of awakenings over 2-weeks) and DMN connectivity controlling for age, $r(32)=-.42$, $p=.01$. Adolescents experiencing greater sleep disruption showed weaker functional connectivity between the DMN and and its ACN. Weaker connectivity between the DMN and its ACN has been found to negatively influence task

performance. These findings help elucidate links between naturalistic sleep differences and adolescent brain development.

## 1-D-35 How social pressure influences hot and cool inhibitory control in adolescence?

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To apprehend the specificity of risk taking in adolescence, neurodevelopmental models posit an imbalance between the relative maturity of the brain structures in charge of incentive-based behaviors and the immaturity of the brain structures in charge of cognitive control during adolescence. Although previous studies converged in showing that adolescents are hypersensitive to rewards in salient socio-emotional contexts, less is known about the direct influence of social pressure on adolescents' inhibitory control. The aim of the present study is therefore to examine whether hot and cool inhibitory control abilities increase or decrease under social pressure in adolescents and adults. Forty-two 12- to 14-year-old adolescents and forty-five 18- to 24-year-old adults completed two Stroop-like tasks in either a social pressure condition (i.e. in the presence of an expert supposed to evaluated them) or a control condition (i.e. task performed alone). In the Cool Stroop task, participants had to inhibit reading the color-words to identify the ink color they were printed in. In the Hot Stroop task participants had to denominate the emotional expression conveyed by faces from the NimStim database while ignoring the emotion-word displayed underneath. We found that social pressure facilitated hot but not cool inhibitory control in adolescents while we found no significant effect in adults' cool and hot inhibitory control abilities. The present finding expands our understanding of the positive influence of the socio-emotional context on hot inhibitory control in adolescence.

## 1-D-36 Enhanced reward system reactivity buffers risk for depression in adolescents exposed to maltreatment

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Childhood maltreatment is strongly associated with major depression. Reduced reactivity to reward at behavioral and neurobiological levels among maltreated children appears to be a mechanism in this association. Whether youths who exhibit greater reward reactivity are protected from developing depression following childhood maltreatment is unknown. A sample of 57 adolescents (20 maltreatment; Mean Age=16.98 years) completed an fMRI task involving passive viewing of emotional stimuli. BOLD signal changes to positive relative to neutral images were extracted in basal ganglia ROIs. Participants also completed a reward-learning task outside the scanner. Depression symptoms were assessed at the time of the MRI and again two years later. Greater reward reactivity across behavioral and neural measures moderated the association of maltreatment with baseline depression. Specifically, faster reaction time to cues paired with monetary reward relative to those unpaired with reward and greater BOLD signal in the left pallidum protected against depression in maltreated youth. Longitudinally, greater BOLD signal in the left putamen moderated change in depression scores over time, such that higher levels of reward response were protective against increases in depression among maltreated youths. Behavioral and neurobiological reactivity to rewarding and positive cues protects adolescents exposed to maltreatment from developing depression in

adolescence, providing novel evidence for the protective role of reward reactivity in buffering against depression in children exposed to adversity.

## 1-D-37 Positive Affect Regulation Relates to Neural Response in Children: The Case of Dampening

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Blunted reward responding is evident in and may contribute to the onset of major depression. However, it is unclear what mechanisms may contribute to this aberrant reward-related brain activation and confer risk for mood pathology. The current study examined how tendencies to dampen positive affect, an affect regulation strategy that decreases positive affect, are associated with reward responding in healthy children. To do this, we examined neural responses to winning a reward (candy) within the context of a previous win, loss, or neutral outcome. Whole brain regression analyses revealed that dampening was not associated with neural activity during the second of two consecutive win outcomes. However, dampening was associated with blunted right striatum and bilateral thalamic activation during a winning outcome when following a previous loss outcome, as compared to when following a neutral outcome. This finding was above and beyond the influence of current depressive symptoms and remained when controlling for tendencies towards negative rumination. Although dampening was not associated with an inability to sustain reward responding, it was associated with less ability to flexibly upregulate neural reward responding following a loss, possibly leading to the development of affective inflexibility. Dampening positive affect may be one mechanism that contributes to aberrant neural reward responding via affective inflexibility and increases vulnerability to depression in youth.

## 1-D-38 Neural correlates of deliberate emotion regulation in early childhood.

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Deliberate emotion regulation, effortful responses to upcoming or ongoing emotional challenges, is an ability that develops rapidly across early childhood. Clinicians, parents, and preschool teachers often target deliberate emotion regulation as a strategy improve young children's behavior (e.g. "use your words"/"take a breath"). However, at present there is a lack of data showing, in-vivo, young children's neural response to deliberate emotion regulation training, and the brain regions that support this critical ability. The goal of the present study was to test whether young children who received deliberate emotion regulation training and instruction showed increased dorsolateral prefrontal cortex (DLPFC) activation during subsequent negative emotional challenges compared to peers. In the present study, 5-6 year old children completed either a novel, child-friendly deliberate emotion regulation training condition (N = 18) or non-emotion comparison condition (N = 12) before and after a computer game in which they received repeated negative feedback. Throughout the paradigm DLPFC activation was recorded via functional Near Infrared Spectroscopy (fNIRS). Children who completed the deliberate emotion regulation training condition showed less hemoglobin activation in the left DLPFC while anticipating negative feedback ($t(29) = -2.16$, $p < .05$) and greater hemoglobin activation in the same area during negative, but not positive, feedback compared to peers ($t(29) = 2.93$, $p < .05$). Results from this ongoing study suggest that young children respond to brief deliberate emotion regu

## 1-D-39 A Pubertal Shift in the Relation between Diurnal Cortisol and Nucleus Accumbens Activation During Anticipation of Reward and Punishment

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Background: Changes in neural reactivity to reward and punishment during puberty may be due to a shift in the relation between glucocorticoids and dopaminergic pathways of the brain. This study tested the hypothesis that puberty would moderate the association between the cortisol awakening response (CAR) and nucleus accumbens (NAcc) reactivity to reward and punishment. Methods: 97 children (52% female) ages 9-13 years completed a modified Monetary Incentive Delay Task in the scanner. Adrenal (AD) and gonadal (GD) pubertal development was assessed via self-report Tanner Staging. Children collected diurnal cortisol on two weekdays. CAR was quantified as the slope of cortisol rise from waking to 30 minutes post. Results: AD interacted with CAR to predict NAcc activation in anticipation of both reward (b = .231, p=.011) and punishment (b=.252, p=.003). Whereas at AD stage 3 there was a significant positive association between CAR and NAcc activation in anticipation of reward (b=.305, p=.040), at stage 1 there was a marginal negative association (b=-.288, p=.066). Similarly, whereas at AD stage 3 there was a significant positive association between CAR and NAcc activation in anticipation of punishment (b=.279, p=.003), at stage 1 there was a significant negative association (b=-.371, p=.027). There were no significant effects involving GD. Conclusions: The relation between diurnal cortisol and NAcc reactivity to reward and punishment shifts with pubertal development. This shift may potentiate increased risk for psychopathology during adolescence. AD has a unique influence.

## 1-D-40 Resting-state connectome similarity in mother-child dyads and its impact on emotional synchrony

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Children and their parents experience synchrony, or the sharing of social and emotional states. Such social synchrony confers emotional benefits and provides the foundation for youth to adapt to an increasingly complex social environment. Focusing on resting-state intrinsic network connectome, we examined whether dyadic connectome similarity between mother and child influences the similarity of their day-to -day emotional states and adolescents' emotional competence. Intrinsic resting-state networks for both parents and their adolescent child (28 dyads) were identified using independent component analysis (ICA). We built between-functional network connectivity connectome maps and compared neural synchrony patterns of each mother-child dyad. In addition, adolescents and their mothers completed daily diaries for two weeks. From these 14 daily measures, we calculated emotional synchrony, a measure of how much adolescents' and their mothers' daily negative mood fluctuated together. Results indicate that mothers and children who had more similar resting state neural connectomes also had more similar day-to-day emotional synchrony. Furthermore, dyadic resting state syhchrony was associated with adolescents' emotional competence, which suggests that being neurally in-tune with their parents confers emotional benefits. We provide the first evidence that individual differences in neural synchrony are associated with emotional synchrony in what is often our first and most essential social bond, the parent-child relationship.

## 1-D-41 Enhancement of cognitive control in rewarding contexts in adolescence and adulthood

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Developmental studies suggest that adolescents rely more on a reactive strategy (recruiting resources transiently in response to a cue) than a proactive strategy (sustaining these resources in anticipation of the cue). The balance between these strategies shifts towards a more proactive strategy in adulthood. We compared changes in performance in a working memory task as a function of reward in adolescents and adults. After a baseline run without rewards, participants performed the task in a run in which they expected some trials to be rewarded. A mixed blocked/event-related functional magnetic resonance imaging design enabled separation of transient and sustained neural activity associated with reactive and proactive cognitive control. Participants' accuracy for both rewarded and non-rewarded trials of the second run increased with age. Across age groups, participants were faster for the non-reward trials of the second run than the first run, indicating engagement of proactive control, and even faster for reward trials, suggesting an additional reactive engagement of cognitive control. Increased activity in the anterior insula and dorsolateral prefrontal cortex was observed in both adolescents and adults in the reward run compared to the non-reward run. Increased activity in the anterior insula and the anterior cingulate cortex as well as subcortical areas was observed in response to reward trials within the reward run across age. In the context of sporadic rewards, both adolescents and adults combine a proactive and a reactive strategy to maximise performance.

## 1-D-42 Emotion concepts become more distinct across development but the ability to specifically identify one's emotions is low in adolescence

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Humans live in a rich emotional world. Most adults manage this emotional complexity with relative ease, understanding how different emotional "ingredients" (e.g., body sensations, affect, emotion concepts) combine to produce specific emotion types (e.g., anger, joy). However, we know little about how this ability develops. In the current study, a large sample of participants aged 4-25 completed a battery of behavioral tasks measuring emotional understanding and experience. Participants completed an emotional vocabulary assessment, provided similarity ratings of 10 different emotion types, and completed an emotion granularity task measuring the extent to which they parse affective experiences into specific emotion types. We discovered a significant linear increase with age in the extent to which participants separated emotion words based on arousal, suggesting that children understand emotion concepts primarily in terms of valence (positivity or negativity) and learn to differentiate them based on arousal (activation or deactivation) with age. We also observed a significant quadratic relationship between granularity (the ability to specifically identify what emotions one is feeling) and age: Granularity decreased from childhood to adolescence and increased from adolescence to adulthood. Further analyses revealed that granularity was elevated in childhood because children reported experiencing one emotion at a time. Results describe trajectories by which emotion concepts develop and demonstrate how beliefs about emotion affect emotional experiences across the lifespan.

## 1-D-43 Feeling left out or violated social expectations? An fMRI adaptation of Cyberball using parametric modulators

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Adolescence is characterized by increased salience of peer relationships, including greater sensitivity to social exclusion. Brain regions involved in experiencing and regulating exclusion include lateral PFC and ACC, among others. However, some of these regions may be more broadly involved in monitoring expectancy violations. We compared two forms of unexpected social interactions, over-inclusion and exclusion, using a novel fMRI adaptation of the Cyberball paradigm designed to explore the specificity of neural responses to social exclusion. 64 adolescents aged 11 to 18 years underwent two runs of an event-related Cyberball paradigm, in which fair play was randomly interspersed with either over-inclusion or exclusion. We used parametric modulators to investigate the effect of increasing number of consecutive trials of exclusion and inclusion. Conjunction analysis of these parametric modulators revealed that neural activity in multiple regions was associated with both increasing inclusion and increasing exclusion: a large medial prefrontal cluster encompassing the dorsomedial PFC, ventromedial and dorsal ACC, as well as bilateral ventrolateral PFC, left angular and right superior temporal gyri. Meanwhile, activity in motor cortices diminished with successive inclusion trials. In comparison to prior research, our findings suggest that brain activity in much of the medial and lateral PFC associated with this task reflects violations of social expectations, given that participants receive the ball more or less than they expect in both inclusion and exclusion conditions.

## 1-D-44 Preschool physical activity influences activation in emotion regulation brain regions at school age

*Diana Whalen[1], Kirsten Gilbert[1], Andy Belden[1], Joan Luby[1], Deanna Barch[1]*

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Mounting evidence supports the value of physical activity for reducing mortality and preventing chronic disease through direct and indirect modulations of brain functioning and health. Most work has focused on physical activity during childhood as a crucial yet undervalued determinant of cognitive and neural functioning. However, little is known about the impact of physical activity during preschool on school age emotion-related brain functioning. Using a large sample (n=149) of children enrolled in a longitudinal study of early-onset psychopathology, this study explored relations between preschool physical activity participation and school-age neural reactivity to emotional stimuli. Caregivers reported on their children?s participation in organized physical activity at ages 3-6 and children?s functional activation to emotional faces was recorded via an fMRI scanning session at ages 7-12. Preschool physical activity predicted greater neural activation in emotion regulation regions (e.g., middle frontal gyri, precentral gyrus, postcentral gyrus) to sad and angry faces at school age, even after accounting for co-occurring poverty and psychiatric disorders. These findings indicate that preschooler?s participation in physical activity is associated with a greater ability to engage brain networks involved in emotion regulation when presented with negative stimuli several years later, potentially facilitating future emotional health and well-being.

## 1-D-45 Development of Neural Sociometer: Role of DLPFC in tracking accumulated social feedbacks and biasing social evaluative decision

*Leehyun Yoon[1], Hackjin Kim[1]*

*[1]Korea University*

Critical for survival is the capacity to accurately assess how well one is doing and adaptively change one´s behavior based on such information. The present study was aimed to investigate how such a "sociometer" develops in the brain and influences interpersonal behaviors. 60 participants between the ages of 10 and 25 years were instructed to make simple but creative artworks in the first session of the study. After two weeks, they ostensibly evaluated each other´s works while being scanned. In the first phase of each trial, participants received feedback regarding the creativity of their own works from the partner with similar age. Next, they evaluated the creativity of the same partner´s work. Behavioral results showed an age-related increase in evaluation bias regarding others´ works due to accumulated feedback. Specifically, the more favorably one had been evaluated by others, the more favorably he/she tended to evaluate the present partner´s work. FMRI data revealed that DLPFC activity at the time of feedback was positively modulated by a trial-by-trial fluctuation of accumulated feedback in all age groups. At the time of evaluation, however, the degree to which DLPFC activity was modulated by accumulated feedback showed significant positive correlations with age as well as social evaluative biases due to accumulated feedback. Together, the present findings emphasize the sociometer-like function of DLPFC that tracks accumulated social feedback and predicts developmental increase in social evaluative decision bias due to such feedback information.

## 1-F-46 Cortical Plasticity and Specialization In Response to Multimodal Events in Infancy

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Little is known about cortical sensory processing in the infant brain. These issues bear on how multisensory information is coded to support early learning. A total of N = 61 infants (M age = 4.5 m, SD = .41) completed the task. Near Infrared Spectroscopy data were collected from probes over O2 (right middle/inferior occipital) and T4 (right superior/middle temporal). The task was divided into two familiarization blocks (20s), each followed by two 20s test trials. In the Synchronous condition, infants heard a bounce sound when a moving ball touched a screen edge. In the Asynchronous condition, the bounce sound was heard before the ball touched an edge. After each familiarization, infants saw Audio-only and Video-only test trials. Results showed that occipital cortex activated similarly for Audio-Only and Video-Only events after a Synchronous Familiarization, $F(1,48) = .03$, $p = .86$. However, there was greater activation for Video-only events than Audio-only events after an Asynchronous event, $F(1,48) = 3.73$, $p = .05$. Temporal cortex showed greater activation for Audio-only than for Video-only events after a Synchronous event, $F(1,48) = 5.74$, $p = .02$, but not after an Asynchronous event, $F(1,48) = 1.27$, $p = .27$. These data provide evidence for cross-modal plasticity only in occipital cortex. Synchronous multimodal inputs may form an experience-dependent learning signal that supports redundant occipital activation to auditory signals previously synchronized to a visual event. These data also provide evidence of cortical specialization to auditory input in the temporal cortex.

## 1-F-47 Neural Correlates of Reading Improvement in Struggling Readers

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A multi-city, in-school 4th grade reading intervention project aimed to assess the role of attention and executive function in reading comprehension. Participants completed an fMRI visit and a battery of reading

performance measures before and after one-year of intervention to improve reading comprehension. 31 typical readers, 54 pre-intervention, and 29 post-intervention struggling readers passed quality control, and were investigated with regions derived from the reading and task control literature. Struggling readers were further subgrouped based on a >90 standard score on the Woodcock Johnson III Passage Comprehension subtest administered post-intervention. Behavioral analyses of an fMRI sentence comprehension task found that, initially, high-improvement and low-improvement struggling readers were slower and less accurate than typical readers; after the intervention year, high-improvers improved in task accuracy, such that accuracy no longer differed from typical readers. Before intervention, low-improvers had significantly greater activity in left mouth motor cortex than high-improvers during reading. After intervention, both high-improvers and low-improvers showed positive activation in left mouth motor cortex, and high-improvers also showed greater activity in the right fusiform. Our preliminary results highlight regions of plasticity in struggling readers who improve in reading over time. Further, we investigate the consistency of activation differences between subgroups of struggling readers defined using different definitions of reading improvement.

## 1-F-48 Transgenerational transmission of learned fears via observational conditioning

*Jennifer Silvers[1], Bridget Callaghan[2], Kaitlin O'Sullivan[2], Michelle Van Tieghem[2], Nim Tottenham[2]*

*[1]UCLA, [2]Columbia University*

We humans do a great deal of learning by observing others, including what to fear and what to trust in our environment. Observational fear learning may be especially important early in life when children turn to their parents to gather information about their world. Yet, the vast majority of empirical research on fear learning in children has thus far focused on firsthand classical conditioning, which may fail to capture one of the primary means by which children acquire fears. To address this gap in the literature, the present study examined observational fear learning in children and adolescents (age range: 6-17 years) as they watched videos of their parent and an unfamiliar adult undergo fear conditioning. Subsequent to this acquisition learning phase, participants viewed the CS+ and CS- they observed in the videos (test phase). Children and adolescents demonstrated robust observational fear learning, as indicated by changes in their self-reported liking of the CS+ (a geometric shape that was paired with an aversive noise 80% of the observed trials) and CS- (a geometric shape that was never paired with an aversive noise on the observed trials). However, children and adolescents showed enhanced learning via their parent during the test phase. This preferential learning for parent was supported by differential amygdala recruitment. Together, these results suggest that youth preferentially learn fears via observation of their parents and this learning is supported by neural circuitry involved in firsthand (i.e., classical) conditioning.

## 1-G-49 ERP Evidence of Semantic Processing in Children with ASD

*Charlotte DiStefano[1], Elizabeth Baker[1], Andrew Marin[1], Shafali Jeste[1]*

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Children with autism spectrum disorder (ASD) have heterogeneous language abilities, with up to 30% remaining minimally verbal (MV). Use of electroencephalography (EEG) can contribute to our understanding of the neural mechanisms underlying language impairment in ASD, leading to more targeted interventions and better outcomes. Verbal (V) and MV (each N=15) children with ASD (ages 5-11), along with an age-matched typically developing (TD) group (N=12) participated in a semantic congruence ERP paradigm, during which pictures were displayed followed by the expected (match) or unexpected (mismatch) spoken word. The mismatch condition elicited an N400 component in all groups ($F=5.43$, $p=.024$), with a shorter latency in the

TD group (t=-3.15, p=.003). N400 latency was negatively related to receptive vocabulary (r=-.5, p<.001). A late negative component (LNC; 550-900ms) was also evident in the mismatch condition, with a group by condition by region interaction (F=2.5, p=.026). Post hoc analyses revealed that the LNC was present across frontal and central regions in the TD group (p-values .05-.002), in the mid-central region in the MV ASD group (t=2.5, p=.03), and approaching significance in the mid-frontal region in the V ASD group (t=1.99, p=.06). Findings indicate that children with ASD, including those with minimal language, showed EEG evidence of semantic processing. Compared with the TD group, the ASD groups showed a longer N400 latency and weaker LNC, suggesting a delay in processing and more limited integration with mental representations.

## 1-G-50 Preschool executive function deficits: Prediction of school-age ADHD and MDD outcomes and resting state network connectivity.

*Elizabeth Hawkey[1], Joan Luby[1], Deanna Barch[1]*

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Importance: Measures of executive function (EF) in children, such as the BRIEF, distinguish ADHD from control participants, but less work has focused on the relationships to depression and brain network organization. Objective: This study examined how EF relates to symptoms of ADHD and/or depression and whether the BRIEF has predictive utility for a new onset of either. Resting state network analyses examine how connectivity maps to these profiles. Methods: Participants were 247 children, ages 3-6 at time of recruitment, from a longitudinal study of emotion development. The BRIEF Global Executive Composite score was used as the measure of parent reported EF. Logistic and multiple regression analyses examined predictive utility. Network analyses examined network global efficiency, a metric thought to represent integration of network-wide communication. Results: Logistic regression showed that EF predicted onsets of MDD and ADHD (new and recurrence) of ADHD and MDD, controlling for current diagnosis. EF deficits were also significantly associated with increased MDD and ADHD symptoms across time, above current symptoms. All analyses remained significant when controlling for sex, age, and SES. Initial network analyses showed a trend of reduced global efficiency in the salience network, but no association with the FPN and DMN. Work is underway examining additional network metrics and hubs. These findings suggest that early executive deficits are related to the development of both ADHD and depression, and may also predict connectivity of the salience network.

## 1-G-51 Examining the symptomology network of ADHD: A new way to view ADHD symptoms.

*Tim Silk[1], Charles Malpas[1], Richard Beare[1], Vicki Anderson[2], Daryl Efron[2], Philip Hazell[3], Jan Nicholson[4], Emma Sciberras[5]*

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Heterogeneity is a hallmark of ADHD. Diagnostic criteria comprise 9 inattentive and 9 hyperactive symptoms. Symptom count is used for categorical cutoff and dimensional measures of disorder severity, however both rely on binary symptom count of equal weighting, with little attention to the individual make up of symptoms. By only assessing symptom count we might lose important information about the possible contribution of individual symptoms. Rather than as a list of separately summed symptoms, it can be viewed as a network of interacting symptoms. This study will examine the heterogeneity in ADHD and explore a symptomology network of ADHD symptoms. Data was derived from the Children?s Attention Project a community cohort

study of 146 medication naïve children with confirmed ADHD and 212 confirmed non-ADHD controls (6-8 years). In examining the symptom profile configurations, 116,220 combinations of symptoms can qualify for a diagnosis of ADHD. In this sample, 91.8% of the ADHD individuals have a unique pattern of symptoms. Symptom networks did reveal dissociable inattentive and hyperactive symptoms. Hyperactive symptoms were tightly clustered while inattentive symptoms were dispersed with some local clustering. Centrality analysis revealed hyperactive symptoms to be most central to other symptoms. This study demonstrated a novel approach for modelling symptom profile. The finding may help to explain the heterogeneity in the cognitive and behavioural phenotype. Future work will examine whether certain symptoms vary in their impact on comorbidities or functional impairment.

### 1-G-52 Brain Structure in Premature Infants: Liberal vs. Restricted Red Blood Cell Transfusions

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Objective: To assess the neonatal brain structure changes in preterm infants who received red blood cell transfusion for anemia of prematurity. Methods: As part of the larger clinical trial, the neonates are randomly assigned to receive either liberal or restrictive red blood cell transfusions. It is unknown which transfusion strategy is superior for optimal brain development. Analysis of covariance assessed differences in brain region volumes between neonates (n=15) assigned to liberal or restrictive transfusions, controlling for sex and gestational age. As multiple studies established pro-inflammatory profile in neonates who receive transfusions, we included a panel of pro-inflammatory biomarkers. Spearman?s rank correlation was used to determine the relationships between serum levels of pro-inflammatory biomarkers and brain growth. Results: Significant sex-by-group interaction was found. Females assigned to the liberal group had lower volumes of cerebral white matter and cerebellum, whereas, males assigned to the restricted protocol had lower volumes of cerebral white matter. Higher serum concentrations of pro-inflammatory cytokines IL-8 and MCP-1 were associated with lower volumes of cerebral white matter. A lower level of the combination of pro-apoptotic cytokines TNF-α, TNF-β, and a marker of endothelial activation sVCAM-1 was associated with higher volumes of cerebral white matter. Conclusions: Red blood cell transfusions affected brain development in premature infants assigned to liberal or restrictive transfusion protocols via potential inflammatory pathways.

## Day 2, Friday September 9

### 2-A-1 Electrophysiological correlates of intentional source memory retrieval in early childhood

*Kelsey Canada[1], Fengji Geng[1], Tracy Riggins[1]*

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It is well documented that children´s episodic memory abilities follow a protracted developmental trajectory. Previous behavioral research suggests that there is large improvement in source memory during 5-7 years of age and prior developmental cognitive electrophysiology work has suggested that between the ages of 3-6 years there are differences in event-related potentials (ERPs) related to children´s incidental retrieval of source information. However, recent research has demonstrated important differences in the ERP response

between incidental and intentional retrieval of source information during childhood. It remains unknown whether age-related differences exist in ERP responses during intentional retrieval of source information. The goal of the current study is to address this gap. In the present study, 4- to 8-year-old children were shown objects that were associated with characters (e.g., Ariel) and, after a short delay, were asked to recall both the items and the character to which they belonged while ERPs were recorded. To date 30 children have completed testing. Preliminary analysis of behavioral responses suggest that younger children (M=4.18 years) identify fewer items as old (46.4%) compared to older children (M=6.53 years, 62.1%), and, of the items retrieved, younger children remembered less source information (23.1%) than older children (32.8%). These preliminary findings point to potential age related differences in ability to intentionally retrieve source memory. Future analyses will investigate whether these differences are reflected by ERP components.

## 2-A-2 Compromised integrity of executive control and salience networks reflects heterogeneous executive function ability in ASD and ADHD

*Dina Dajani[1], Paola Odriozola[1], Mary Beth Nebel[2], Maria Llabre[1], Stewart Mostofsky[2], Lucina Uddin[1]*

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Autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD) are neurodevelopmental disorders with partially overlapping impairments in executive function (EF). We recently used latent profile analysis to identify three subgroups of children with varying EF abilities (above average, average, and impaired) based on behavioral measures. Here we seek to characterize the neurobiological signature of executive function and dysfunction. A representative subset of a mixed sample of children with ASD, children with ADHD, and typically developing (TD) children was selected to ensure equal group sizes (n=43 in each EF class) that were matched on age, gender, handedness, and motion. Dual regression independent component analysis (ICA) on resting-state fMRI data was used to estimate individual-level spatial maps of 25 components. Group differences in functional connectivity of bilateral executive control network (ECN), salience network (SN), and default mode network (DMN) were assessed using permutation testing. Bilateral ECN and SN integrity were compromised in the impaired EF group compared with the above average group. Specifically, the prefrontal cortex and posterior parietal cortex contributed less to bilateral ECN and the right insula contributed less to SN in the impaired EF group compared with the above average group. There were no group differences in DMN integrity. These findings serve as initial evidence of the validity of using EF ability as a biomarker for identifying pediatric clinical populations that may benefit from early EF intervention.

## 2-A-3 Childhood Music Training, Executive Function and Self-Regulation

*Alissa Der Sarkissian[1], Assal Habibi[1]*

*[1]USC Brain & Creativity Institute*

Executive function (EF), which includes several cognitive processes like inhibition, working memory, and attention flexibility, has been shown to be a strong predictor of academic and social success. These long-term benefits may be related to the role that EF plays in development of self-regulation. A variety of extracurricular activities have been shown to improve executive function in children. One such activity is music training which requires some EF-associated skills, like memory and attention. While strong associations exist between music training and other forms of cognitive function, such as language development, the relationship of music training to EF and self-regulation remains unclear. To address this question, we compared the impact of 2 activities, music and sports training, on EF and self-regulation abilities in 9-10-year-olds who were matched for IQ, gender, and SES. We selected sport training as a comparison because exercise has been shown to promote

complex EF, such as cognitive flexibility and working memory. A standard flanker task was used to measure EF. To assess self-regulation, children completed a delayed discount task with monetary and food rewards. The preliminary results show that children with 2 years of music training performed better on measures of inhibitory control and self-regulation compared to children in the sports group. However, there were no differences in cognitive flexibility. These findings suggest that music training can enhance development of certain EF skills that in turn may improve self-regulation abilities.

## 2-A-4 Comparing child task performance in and out of the scanner

*Laura Engelhardt[1], K. Paige Harden[1], Elliot Tucker-Drob[1], Jessica Church[1]*

*[1]The University of Texas at Austin*

Despite improvements in our ability to collect fMRI data from pediatric samples, the impact of the scanning environment on children's task performance remains relatively unknown. Combating negative arousal and distraction in response to the noisy environment may tax cognitive control and preferentially impair performance on tasks designed to measure executive functions (EFs). Prior experience with the scanner tasks might mitigate these potential decrements in performance, but this question has not been examined thoroughly outside of training studies. The current study evaluates these possibilities by comparing in- and out-of-scanner performance on tests of EF in a sample of 69 twins (31 pairs, 7 unpaired individuals; 35 males) ages 7-13 years. Within-person scores were moderately stable from the lab visit to the MRI visit (mean r=.56), but did not approach commonly accepted test-retest reliabilities. The relationship between in- and out-of-scanner performance was greatest for a working memory task (r=.84). In-scanner accuracy on EF tasks also correlated strongly with scores on a latent EF factor derived from in-lab data of over 800 children. Cross-twin correlations were higher for lab tasks (mean r=.43) than for scanner tasks (mean r=.33). The results demonstrate that in- and out-of-scanner performance is correlated but not synonymous and that familial resemblance in performance varies across task environment. These findings have important implications for fMRI research using neuroimaging results as a proxy for out-of-scanner behavior.

## 2-A-5 Gaze patterns provide insights about the malleability of reasoning skills

*Julia Kang[1], Belen Guerra-Carrillo[1], Silvia Bunge[1]*

*[1]UC Berkeley*

Learning experiences keep our brain in flux throughout our lives, but what mechanisms support the plasticity of higher cognition? Our lab has previously shown with young adults studying for the Law School Admission Test(LSAT), which heavily taxes reasoning, that intensive preparation led to better performance and reduced DLPFC activation during performance of an unpracticed transitive inference test, as well as changes in white matter microstructure and functional connectivity of the fronto-parietal network (Mackey et al, 2012-2015). These results reveal that the circuitry underlying higher cognition is plastic in adulthood. However, they do not pinpoint which cognitive processes are altered by experience. Does practicing reasoning lead people to adopt a different problem-solving strategy, or makes them more efficient at identifying and/or integrating relevant information? To address this question, we collected gaze data from reasoning tasks before and after participants trained for the logical reasoning or reading comprehension section of the LSAT (current N=24). Preliminary results from a transitive inference task suggest that improved performance stems from faster processing of relevant relations, as measured by shorter fixations, and from more efficient integration across relations, as measured by fewer saccades between relations. We tentatively conclude that reasoning practice

is associated with quantitative changes in underlying cognitive skills. A similar approach could be applied to gain a mechanistic understanding of cognitive development and learning in children.

## 2-A-6 Functional brain organization for theory of mind in infants

*Daniel Hyde[1]*

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Human adults and children reliably engage a network of brain regions, including superior temporal sulcus (STS), temporal-parietal junction (TPJ), and various regions of the prefrontal cortex (PFC), when thinking about what others are thinking or theory of mind. How and when functional organization for theory of mind arises, however, is unclear, despite behavioral evidence suggesting that humans may begin tracking the mental states of others' within the first year of life. Here we use the emerging technology of functional near-infrared spectroscopy (fNIRS) to measure the brain response across the inferior parietal, superior temporal, and lateral prefrontal cortex in 7-month old infants as they viewed video scenarios of depicting actresses with different knowledge or beliefs about the location of a hidden object. We observed that regions of the TPJ of infants distinguished between scenarios where the actress held an accurate or true belief about the location of a hidden object from scenarios where the actress's belief about the location of a hidden object was inaccurate or false, mirroring results recently obtained with the same methodology in adults. These results suggest that that the TPJ region of the social-cognitive network is functionally active, engaged spontaneously, continuous for theory of mind by 7-months.

## 2-A-7 Flexible Number Representations Underlie Children's Math Achievement

*Andrew Mattarella-Micke[1], Bruce McCandliss[1]*

*[1]Stanford*

Facility with number symbols is essential for math development in children. While previous research has proposed that either verbal (Hecht, Torgesen, Wagner, & Rashotte, 2001) or quantity (Halberda, Mazzocco, & Feigenson, 2008) representations of number are critical for math, the exact source of this link and its neural basis is unresolved. We propose that the representation underlying number is determined by the goals of cognition: Symbols are what we use them for (Barsalou, 2008). To test this claim, we asked children to compare number symbols based on attention to either verbal or quantity characteristics. Although stimuli were matched across condition, children activated bilateral inferior frontal gyrus (IFG) when they compared verbally, and right intraparietal sulcus (IPS) when they compared by quantity. We calculated two forms of symbolic distance for every trial, based on either quantity or verbal overlap. Behavioral results revealed both distance effects, but only when children attended to the corresponding numerical dimension. Neural distance effects were present overall only in the IPS and only when attending to quantity, but variation in verbal-IFG and quantity-IPS distances both predicted math achievement, reflecting equal and independent contributions from each representation (R-square = .72). Symbolic representations provide a basis for early math, but these representations are flexible and goal-directed.

## 2-A-8 Reduced Neural Engagement During Working Memory in Pediatric Obesity

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In the United States 20% of adolescents are obese, increasing their risk for worse physical, psychosocial, academic, and vocational outcomes. Working memory (WM) and long-term memory (LTM) contribute to academic achievement and psychosocial functioning, but little is known about the effect of obesity on their neural basis. We used functional magnetic resonance imaging to examine WM and LTM in 14-21 year-old healthy weight (HW) and non-diabetic obese participants. WM was assessed with a verbal N-back task with three loads: 1-back ('A' 'A' 'B'), 2-back ('A' 'B' 'A'), and 3-back ('A' 'B' 'C' 'A'). LTM was examined with a subsequent memory paradigm, which included categorization of indoor/outdoor scenes during encoding followed by a surprise recognition memory test outside the scanner. For WM, N-back accuracy showed a Group X Load interaction such that obese participants performed worse than HW participants in the 3-back but not 1-back condition. In the brain, a Group X Load interaction was evident in frontal, parietal, and cerebellar regions such that WH adolescents showed more activation in 3- than 1-back load while obese participants showed more activation for 1- than 3-back load. Obese and HW participants did not differ in recognition memory, but frontal and hippocampal activation during encoding for remembered than forgotten scenes was greater in HW than obese participants. In contrast, obese participants showed greater activation for remembered than forgotten scenes in parietal regions. Thus, the neural basis of memory processing is influenced by obesity in adolescence.

## 2-A-9 Interpersonal Neural Synchronization as a Biological Mechanism for Shared Intentionality in Adults and Children

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Shared intentionality, or collaborative interactions in which individuals have a shared goal and coordinated action roles for which to pursue that goal, is a core component of human interaction. However, the biological bases of shared intentionality and, specifically, the processes by which the individual brain adjusts to the sharing of common goals, remain largely unknown. Using functional near infrared spectroscopy (fNIRS), unique coordination of cerebral hemodynamic activation was found in eighteen adult subject pairs (n=36 subjects) when completing a challenging puzzle together, in contrast to a control condition in which individuals completed identical, but individual puzzles. Further, permutation testing revealed that the time course of neural activation of one subject predicted that of their actual partner, but not that of other subjects completing the identical puzzle in different partner sets. These findings indicate unique brain-to-brain coupling specific to shared intentionality beyond what has been previously found by investigating basic neural fundamentals of social exchange. The completed adult study described above will be presented with data from an ongoing, longitudinal study, investigating the construct of interpersonal neural synchronization in preschool age children (age 4) and their parents.

## 2-A-10 The neural differences and similarities between children with and without learning disorders during arithmetic

*Lien Peters[1], Jessica Bulthé[1], Hans Op de Beeck[1], Bert De Smedt[1]*

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Children with learning disorders (dyslexia, dyscalculia) often have problems with basic arithmetic. Different hypotheses have been proposed on the neural origin of these disorders (number processing deficits in dyscalculia, phonological deficits in dyslexia) but these have never been contrasted in one imaging study.

Therefore, we compared the brain activity of children with dyslexia, children with dyscalculia, children with comorbid dyslexia-dyscalculia and healthy controls in a design that allowed us to disentangle processes (e.g. fact retrieval, procedure use) that might be associated with the specific or common neural origins of these learning disorders. Participants were 62 children aged 9 to 12, comprising children with dyslexia-only (DL), children with dyscalculia-only (DC), children with comorbid dyslexia and dyscalculia (DLDC), and typically developing children (TD), that were carefully matched. All underwent fMRI scanning during which they had to subtract numbers up to 10 presented as dots, digits or number words. As expected, DL children performed poorly on symbolic formats (digits, words) whereas DC and DLDC children showed poor performance on all formats. However, on a neural level, analyses show very few differences between children with learning disorders: TD children show higher activation levels than the three groups of children with learning disorders, regardless of the disorder. These data suggest that, despite differences at the behavioral level, the neural profiles of children with different learning disorders may be more similar than initially thought.

## 2-A-11 A Hierarchical Extension of the LATER Model to examine differences in Inhibitory Control by Development, Reward Type, and Weight Status

*Nicole Roberts[1]*

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The Go/NoGo task, a widely used metric of inhibitory control, is traditionally analyzed by examining accuracy rates and mean reaction time (RT). However, averaging RT potentially masks sources of variation related to experimental conditions and individual differences. The Linear Approach to Threshold with Ergodic Rate (LATER) model describes RT data in terms of two aspects of cognitive functioning: speed of information accumulation (accretion) and caution. It is assumed that during the course of a trial information is accumulated sequentially until a criterion amount of information is reached, upon which a response is executed. Here, we extended the original LATER model hierarchically in order to examine sources of variation related to individual differences, experimental condition, and person-specific predictor variables simultaneously. We applied the hierarchical LATER model to a rewarded Go/NoGo task in a developmental sample (ages 7-17) to examine cognitive differences in accretion and caution. Participant weight status, accuracy rates, and reward type (food, money, neutral) were entered as covariates. We hypothesized that there would be differences in accretion and caution based on development and reward type, and that there would be further differences in reward type moderated by weight status. Our results demonstrate variation in accretion or caution from all covariates in the model, demonstrating the importance of modeling RT data utilizing this approach, and gives further insight into the development of accretion and caution and their role in inhibitory control.

## 2-A-12 The time-course of Theory of Mind processes during adolescence: an eye tracking study

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A number of studies have provided evidence for structural and functional changes in the brain areas involved in theory of mind (ToM) (the "social brain") not only during childhood, but also during adolescence. Recent findings also suggest that the online use of ToM shows a prolonged development into adolescence. In order to investigate further ToM development, we adopted a visual world paradigm to examine how quickly older

children (N=17, age 9-13 years old) and adolescents (N= 18, age 14-18.5) can use knowledge about a character's preferences (e.g. "Helen dislikes vegetables") and desires (e.g. "she wishes to keep this preference secret/open") to make ToM inferences and predict that character's subsequent behavior during discourse, in comparison to adults (N=17, age 25-36). The target sentence described an action performed by the character consistent with his/her preferences (e.g. "When Helen goes to dinner parties she makes a show of eating vegetables/meat"). Results showed that adults start making anticipatory eye movements towards the image (vegetables/meat) consistent with the character's desires from the ambiguous noun ("dinner parties"). In contrast, children and adolescents only showed successful anticipatory use of ToM upon hearing the verb ("eating"). These results suggest that older children and adolescents may not be able to use information about others' mental states as quickly as adults. Individual differences in participants' working memory, inhibition and empathy were also measured to examine their role in the development of higher order ToM processing.

## 2-B-13 A Longitudinal Analysis of the Iowa Gambling Task

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Background: Many researchers have used the standard Iowa Gambling Task (IGT) to assess decision-making in adolescence given increased risk-taking during this period. Most studies are cross-sectional. Of the few longitudinal studies, some make untenable analytic assumptions. Methods: This longitudinal study investigated healthy adolescents' IGT performance across a ten-year span. 189 individuals (ages 9-23) completed a baseline session and were followed at two-year intervals yielding five assessments. IGT deck contingencies were shuffled at each time point to reduce practice effects. Overall performance (OP; good minus bad decisions) and learning rate over trials were measured. Linear mixed effects analyses in R were used to model both metrics as a function of age. Covariates included intelligence (WASI) and affective dispositions (Behavioral Inhibition and Activation System Scales). Time-varying covariates were split into between and within-subject effects. Results: Results indicated minimal practice effects over time regardless of age. A linear effect of age yielded the best fit for both metrics when comparing baseline models (i.e., intercept and age only) of different effects (e.g., quadratic). Age and intelligence positively predicted OP and learning over time. Individual differences in affective approach positively predicted OP but not learning. Brain structural correlates of performance over time are being explored. This study extends prior work by observing linear improvement with age, in relation to affective and cognitive influences, on two IGT performance metrics.

## 2-B-14 The neural correlates of risk and ambiguity processing in adolescent risky choice

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Adolescent risky choice is often studied with tasks that present gambles with known probabilities (risk), but real life primarily presents gambles with unknown probabilities (ambiguity). Prior studies have shown that aversion to ambiguity, but not risk, increases with age. The neural development across adolescence in response to risk and ambiguity however remains elusive. In a first neuroimaging study with adults (N=55, ages 18-29), we administered a choice task presenting a gamble versus a safe option with both risky (known probabilities) and ambiguous (unknown probabilities) choices, and included outcome feedback (gain/no gain after risk/ambiguity). Both risk and ambiguity showed overlapping activation for choice (lateral prefrontal cortex (PFC), medial PFC, insula), and outcome (ventral medial PFC, striatum). Individual-differences analyses

showed that people who were more averse to ambiguity showed greater activation in the medial PFC during ambiguous gambles. We administered the same task to a large adolescent sample (N=213, ages 12-22) to unravel the neural development of risk and ambiguity processing and explore effects of individual differences in risk- and ambiguity-aversion. Neural developmental patterns for risk and ambiguity processing are currently being analyzed. At a behavioral level, preliminary analyses show changes in risk- and ambiguity-aversion with age, but also large variation in behavior across all ages. This study highlights the potential of disentangling risk and ambiguity in studying the behavioral and neural correlates of adolescent risky choice.

## 2-B-15 I want it now! The role of pubertal testosterone in impatience of adolescent boys

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The onset of adolescence is associated with an increase in transgressive behaviors, which are often attributed to increased impulsiveness. This increase is assumed to result from differential maturation of a subcortical affective brain network and a cortical control network.More recently it has been hypothesized that pubertal hormones may specifically modulate the function of the subcortical regions, and increasing reward seeking behavior. However, much is still unknown about how pubertal hormones impact brain and behavior. Here we focus on the role of testosterone in impulsiveness in adolescent males. In an behavioral study (N=72, ages 11-14) we found dissociable effects of age and pubertal testosterone on impatient behavior on an intertemporal choice task. That is, increased sensitivity to immediate rewards was specifically related to an increase in pubertal testosterone, whereas a general reduction of impatience was related to increased age. To gain further insight into these mechanisms, we designed a follow-up study in which we aim to investigate the different effects of age vs. pubertal testosterone on brain function and structure (N = 75, ages 10-15, and N=25, ages 20-30) on several delay discounting paradigms in and outside the MRI scanner. Preliminary results reveal that adolescents showed less activity in the insula in presence of immediate rewards compared to adults, and insula activity was also related to individual differences in pubertal status. We will also present specific effects related to pubertal testosterone.

## 2-B-16 Two Roads Diverge: Context-specific outcomes associated with decreased neural sensitivity to negative feedback during adolescence.

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Decision-making processes rarely occur in isolation. Rather, representations are updated constantly based on feedback to past decisions and actions. Feedback can be grouped into two broad categories: positive feedback that reinforces previous actions, and negative feedback which motivates changes in behavior. The interplay between these forms of feedback is not uniform across development, and some developmental periods are more sensitive to positive or negative feedback. Previous work suggests that adolescence is marked by increased sensitivity to positive feedback (e.g., reward approach) and relatively blunted responses to negative feedback (e.g., punishment avoidance). However, examinations of neural mechanisms supporting this differential sensitivity, and how they relate to adolescence risk taking, are relatively sparse. To address this, we examined differential neural sensitivity to positive versus negative feedback in a risk-taking context using the Balloon Analog Risk Task (BART), and how this differential sensitivity is linked to increased adolescent risk behavior. Fifty-eight adolescents (ages 13-17) completed the BART during an fMRI session and reported on their levels of risk-taking behavior. Results show that reduced medial PFC (mPFC) response following negative

versus positive feedback was associated with increased risk taking. However, reduced mPFC sensitivity to negative feedback was also related to total points that participants earned during the task, suggesting that these neural mechanisms can promote both maladaptive and adaptive outcomes for adolescents.

## 2-B-17 Different strokes: How social context differentially influences inhibitory failures in normative and high-risk adolescents.

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Adolescence has often been noted as a period of increased risk-taking and delinquency. Much of the developmental neuroscience literature has implicated aberrant activation and connectivity patterns of reward-related and regulatory regions as key to inhibitory failure; however, there has been less focus on how social context impacts these processes. Additionally, most samples have not included adolescents actively engaged in high rates of risky, delinquent behavior, leaving some question as to the generalizability of current models. To address these concerns, we conducted a comparative study featuring two samples of adolescents completing an emotionally salient cognitive control task where response and inhibition were required in the presence of socially appetitive or aversive cues. Consistent with prior literature, our sample of normative adolescents (n=25) showed poorer behavioral performance marked by increased disinhibition in the presence of socially appetitive cues, which was positively correlated with hyperactivation of the ventral striatum. The opposite pattern was observed in our high-risk sample (n=24), as behavioral performance was improved while viewing appetitive cues but poorer in the presence of aversive cues. Performance failures for the high-risk sample when viewing aversive cues positively correlated with hyperactivation of the ventral striatum. These divergent findings suggest social context likely creates differential pathways for risk-taking and current models may not integrate enough specificity to predict likely triggers of suboptimal decision-making.

## 2-B-18 The behavioral and neural influences of alcohol and social context on risky choice

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Prior studies suggest that the joint impact of alcohol and peer presence should make adolescents especially vulnerable to risky decision making. However, the mechanisms of these effects remain largely unexplored, particularly with respect to brain function. The present study examined the behavioral and neural effects of alcohol and peer presence on cognitive control and risk taking in 52 youths (aged 21-24, M=21.88). Half of participants received alcohol and half received a placebo drink before completing a go/no-go (GNG) task and a simulated driving task (Stoplight) in the fMRI scanner. We manipulated social context within subjects: participants completed each task once while observed by an anonymous "virtual" peer and once unobserved. Relative to participants in the placebo group, those given alcohol were significantly hindered in their ability to correctly inhibit responses in GNG; however, there were no main or interactive effects of peer presence on GNG performance. In contrast, participants in both alcohol and placebo groups took significantly more risks in Stoplight when observed than when alone. The alcohol group took more risks than the placebo group, both when observed and alone, although this difference was not statistically significant. In preliminary fMRI analyses, we identified regions of control circuitry that showed interactive effects of alcohol and peer presence on risk taking during Stoplight. Results suggest that alcohol and peer context may additively increase risk taking by weakening cognitive control abilities and increasing reward-seeking behaviors.

## 2-B-19 Adolescent Substance Use Predicted by Pre-use Differences in Effective Connectivity

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The Adolescent Development Study (ADS) is a prospective, longitudinal study collecting a range of behavioral and neuroimaging measures on preadolescent children to examine the factors that lead to early initiation and escalation of alcohol use. We report differences in effective connectivity pre-use between adolescents that rapidly progress to substance use 18-months later and those who abstain. 11-13 year-olds were recruited from Washington DC meeting the following inclusion criteria: right handed, safety for MRI, and alcohol/drug naïve. 135 were scanned (3.0T Siemens) including a 5:49min resting state fMRI scan (TR/TE=2280/30ms, resolution=3mm3). Standard preprocessing was performed using SPM12: slice-timing correction, co-registration, spatial normalization, and smoothing (12mm3). Conn toolbox was used to band-pass filter, regress signal related to white matter and cerebral spinal fluid, and remove volumes with excessive motion (frame-wise displacement>1mm or global signal change z>3). ROI-to-ROI analysis was performed using regions implicated in substance use including frontal orbital cortex (FOrb), frontal pole (FP), superior and middle frontal gyrus (SFG and MFG), and cerebellum. Following removal of subjects with excessive motion, a total of 108 adolescents were included with 15 reporting substance use initiation at the 18-month follow-up visit. Non-users had significantly ($p<0.05$ FDR) greater connectivity than users between all of these regions. These results are in line with task-based fMRI studies showing less top-down executive control predicting future use.

## 2-C-20 Machine learning to predict brain maturation in ASD: the ABIDE cohort

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Autism spectrum disorder (ASD) is characterised by social, behavioural and language impairments but little consensus exists on the nature of neuroanatomical alterations in ASD. We modeled anatomical brain maturation to test the hypothesis that neurodevelopmental trajectories are altered in ASD populations. T1-weighted MR images from the ABIDE dataset (n=483; all male; 243 typically developing; 6-25yrs) were processed with Freesurfer 5.3.0 to produce maps of cortical thickness and surface area. In addition, voxel-wise maps of tissue volume were calculated. Spatial ICA was performed on each modality (thickness, area, tissue volume) to yield 50 imaging components (150 total), each with a corresponding subject weighting to act as model features. Brain maturation was modelled in typically developing (TD) subjects using elasticnet regression. Brain maturation predicted age in the TD cohort (5-fold cross-validation, r=0.84; mean absolute error (MAE): 1.77 yrs). Predictive features included: cortical thickness in the superior temporal gyri, cortical surface area in the frontal cortex and tissue volume in superior white matter and thalami. The model of brain maturation estimated in the TD group also significantly predicted age in the ASD cohort (n=240, r=0.86, MAE: 1.58 yrs). There were no significant differences in mean error in age estimation, and no interactions between group and model error. Using a developmental model based on robust markers of brain maturation, we found no significant differences between TD and ASD populations in the ABIDE dataset.

## 2-C-21 Longitudinal associations between early parenting and child cortisol reactivity on hippocampal volume during childhood

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Rodent models indicate that perturbations in the early parenting environment epigenetically program the hypothalamic-pituitary-adrenal (HPA) axis, ultimately leading to elevated levels of cortisol in response to stress and structural changes in the hippocampus. Despite clear pathways through which parenting influences neural development in rodents, examination of these pathways in humans is only emerging. The present study translates the rodent literature by examining the effects of early parenting on later hippocampal structural development in a longitudinal sample of children (n=64), with a specific goal of exploring the mediating role of cortisol reactivity. Observational measures of parenting and children's salivary cortisol responses (AUCg, AUCi) to a laboratory stressor were assessed at 3-5 (Time 1; T1) and 5-10 years (Time 2; T2). Structural MRI was collected at T2. Results indicated that greater T1 positive parenting predicted larger T2 bilateral head volumes. In contrast, greater T2 positive parenting predicted smaller right body volumes, and greater T2 negative parenting predicted larger right body volumes. Greater T1 AUCg (total output) predicted larger right body, right tail, right total, and left total hippocampal volumes. Greater T1 AUCi (total change) predicted smaller bilateral body. Both measures of T2 cortisol reactivity (AUCg, AUCi) predicted smaller left tail volumes. Significant mediation was not observed. Results suggest possible neural mechanisms through which early parenting experiences may shape developmental outcomes in human offspring.

## 2-C-22 Neural Correlates of Social Evaluation and Depression Risk in Adolescent Girls

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Early adolescents experience a neurodevelopmental social re-orientation that heightens sensitivity to social evaluation, especially among girls. Heightened sensitivity may be problematic for girls with depression symptoms, putting them on a trajectory of negative peer experiences that may impact later neurobiological outcomes. As such, the present study examined whether early adolescent depression symptoms predicted late adolescent neural response to peer social evaluation in girls. Furthermore, peer perceptions and peer victimization across adolescence were examined as mediators linking early adolescent depression with late adolescent response to social feedback. Late adolescent girls (N = 108, age 17) completed the fMRI Chatroom social evaluation task, whereby they rated their initial interest (selected, unselected) in chatting with 60 similarly aged peers and subsequently received staged feedback indicating they were accepted, rejected, or not rated by each peer for an online chat. Early adolescent depression (M of ages 9+10) directly predicted dampened nucleus accumbens (NAc) response to being accepted by unselected peers; it indirectly predicted dampened ventrolateral prefrontal cortex (vlPFC) response to being accepted by unselected peers through negative peer perceptions (M of ages 11-16), and dampened vlPFC response to being rejected through frequent peer victimization (M of ages 11-16). Results in the NAc and vlPFC suggest girls with early adolescent depression symptoms have altered neural coding of peer social experiences in a social reward learning network.

## 2-C-23 Cortical Thickness of Prefrontal Regions is Related to Sensation Seeking in Adults but not Adolescents

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Holmes et al. (2016) reported a negative association between self-reported sensation seeking (SS) and cortical thickness (CT) in prefrontal regions among adults. However, this association has not been tested across adolescence, a time when CT decreases. We explored whether prefrontal structures--namely the middle frontal gyrus and anterior cingulate cortex--correlate with a behavioral measure of SS in a sample of adolescents (13-17; n=67) and adults (18-25; n=119). Participants came from samples in New York and Los Angeles. SS was assessed by The Stoplight Game, where participants choose whether to stop safely or run through 20 intersections as a stoplight turns yellow. A higher proportion of lights run indicates greater SS. Correlations--controlling for age, sex, IQ, and site--were run separately for adolescents and adults. Results show that CT in adults shows a positive relation with SS in the left caudal middle frontal and left caudal anterior cingulate. Among adolescents, no region correlated significantly with SS. This suggests that prefrontal regions may not influence SS among adolescents, possibly because subcortical reward regions are stronger drivers of their behavior. Among adults, a thinner cortex, which is often associated with a more developed brain, may undergird mature behavior (i.e., stopping safely). Although we did not replicate the negative association between CT and SS among adults reported by Holmes et al. (2016), our results are consistent with accounts of normative cortical thinning. The relation between structure and behavior may differ with age.

## 2-C-24 The development of white matter microstructure and intrinsic functional connectivity between the amygdala and ventromedial prefrontal cortex

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Functional and structural connectivity between the amygdala and ventromedial prefrontal (vmPFC) regions is compromised in multiple psychiatric disorders. Many psychiatric disorders emerge during adolescence. Thus, it is important to characterize amygdala-vmPFC connectivity changes from adolescence to adulthood. We examined 1) age-associated changes in structural and functional connectivity of amygdala and vmPFC sub-regions, 2) how development of amygdala-vmPFC functional connectivity is related to development of white matter microstructure between the amygdala and vmPFC, and 3) how amygdala-vmPFC maturation is related to anxiety and depression. A longitudinal design (1-3 visits) was used to characterize developmental changes of amygdala-vmPFC connectivity using resting state fMRI and diffusion-weighted imaging (N=246, 10-25 yrs). Functional connectivity and white matter microstructure, as measured by quantitative anisotropy (QA), significantly decreased from late childhood to early adulthood between the amygdala and rostral anterior cingulate, anterior vmPFC, and subgenual cingulate. Functional connectivity between the centromedial amygdala and rostral anterior cingulate predicted QA in these same regions during adulthood only. Finally, a lack of developmental decreases in amygdala-vmPFC QA was associated with greater anxiety/depression during late childhood and early adolescence. Connectivity of amygdala and prefrontal systems may play a critical role in the emergence of mood disorders in adolescence.

## 2-C-25 Childhood violence exposure and neural systems underlying emotional working memory

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Utilizing working memory to hold complex emotional and social information in mind is critical for guiding adaptive behavior. Negative environmental experiences likely impact these abilities, particularly during

development. Although recent work has identified violence exposure as a potent predictor of both emotion processing and working memory deficits, little is known about the impact on underlying neural systems. This study aimed to address this gap by recruiting 60 youth aged 8 to 19 years (M=13.95 years, SD=3.00 years; 50% female; 53% White), half with exposure to physical or sexual violence. Youth completed an emotional face (angry, happy, neutral) working memory fMRI task that required youth to attend to a facial cue (2000ms) and respond to whether the facial probe (2000ms) matched both the cue's face and emotional expression after a 1000-1500ms delay. Behaviorally, violence-exposed youth were less accurate at identifying whether the facial cue matched the probe ($p<.05$). Whole-brain fMRI analyses (FSL cluster-level correction: $z>2.3$, $p<.05$) demonstrated violence-exposed youth had reduced activation compared to non-exposed youth in areas associated with working memory ability during encoding (left middle frontal gyrus and right intraparietal sulcus), and in facial processing regions during the memory test (superior temporal sulcus, temporal-parietal junction). Violence exposure appears to influence the development of neural systems underlying working memory and facial processing, which may explain emotional working memory deficits seen among violence-exposed youth.

## 2-C-26 Long-term effects of LCPUFA supplementation in the first year of life: A multimodal neuroimaging study at age 9

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Infants were randomized to formula with long-chain polyunsaturated fatty acids (LCPUFA) from birth to 12 months. LCPUFA formulas contained 0.32%, 0.64% or 0.96% docosahexaenoic acid (DHA) and 0.64% arachidonic acid. Control formula did not contain LCPUFA. At age 9, 42 children underwent multimodal MR imaging including spectroscopic (1H MRSI), anatomic (VBM), fMRI (Flanker), and resting state (rsMRI), and a behavioral inhibition task (Go/No-Go). 1H MRSI: N-acetylaspartate (NAA) and myo-inositol (mI) were higher in LCPUFA groups compared to control. VBM: The LCPUFA groups had greater white matter volume in anterior cingulate (ACC) and parietal regions compared to control and 0.96% DHA group. fMRI: Trials requiring greater inhibition (Incongruent > Congruent) elicited greater brain activation in LCPUFA-supplemented children in ACC and parietal regions. rsMRI: Children in the 0.64% DHA group exhibited greater connectivity compared to all other groups between prefrontal and parietal regions of the Dorsal Attention Network. Go/No-Go: LCPUFA-supplemented children were more efficient (speed-accuracy tradeoff). Children in the control group made more errors and scored worse on the Inattention Score. LCPUFA supplementation during infancy has residual and/or programming effects observable at age nine. Neurochemical differences are observed in metabolites associated with neuronal integrity (NAA), and brain cell signaling (mI). Attention (parietal) and inhibition (ACC) effects are observed across imaging modalities and cognitive tasks. Sponsor: Mead Johnson Nutrition

## 2-C-27 Brain structure mediates the relationship between low socioeconomic status and ADHD symptoms

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Low socioeconomic status (SES) is associated with greater risk for ADHD (Akinbami 2011). One mechanism through which SES may confer risk for ADHD is by influencing brain structure. Low SES is associated with

reduced cortical thickness across multiple studies (Lawson 2013). Additionally, children with ADHD have reduced cortical thickness in frontal regions (Shaw 2007). The current study examined whether cortical thickness mediates the association between SES and ADHD symptoms. Youth 3-21 years old (N=966) from the PING Study completed a structural MRI. Freesurfer was used to estimate cortical thickness. Parents reported demographics, ADHD diagnoses (self and child), and child ADHD symptoms. SES was measured by parental education; we compared high school graduate or less (HS-) to more than a high school degree (HS+). All analyses controlled for parental ADHD, age, gender, scanner and race. HS- group youth had more ADHD symptoms than HS+ group youth (p=0.01). After FDR correction (p<0.10), SES predicted lower cortical thickness in seven brain regions: the right superior temporal, lateral occipital, inferior temporal, inferior parietal, fusiform, supramarginal, and the left pars orbitalis. A significant indirect effect of SES on ADHD symptoms through cortical thickness was observed for the left pars orbitalis and the right superior temporal gyrus. Socioeconomic disparities are associated with reduced cortical thickness in frontal and temporal regions and these reductions in cortical thickness may account for elevated ADHD risk for children of less well-educated parents.

## 2-C-28 Neonatal brain alterations associated with short term memory at 4 years in children born very preterm.

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Background: Difficulties in immediate/working memory have been described in children who were born very preterm birth (VPT; <32 weeks of gestation). These skills play an important role in learning and everyday activities. Objective: To study whether immediate verbal memory in VPT children at age 4 is associated with brain volume alterations at term equivalent age. Design/Methods: We studied 94 VPT born children (mean gestational age 30 weeks) who are part of an longitudinal study. Structural T2 images were acquired postnatally at term equivalent age using a 3T scanner. All images were non-linearly registered to a specific age-appropriate template and the Jacobian determinant of the non-linear deformation field was calculated, giving an index of local tissue volume changes. At 4 years old, children were retested using the digit span forward test. A multivariate general linear model was created using digit span scores as a fixed factor (4 levels according to the number of digits remembered). Jacobians maps and socio-economic status were used as dependent variables. Results: There was a significant association between digit span scores at 4 years and structural volume abnormalities in bilateral medial inferior temporal gyrus and fusiform gyrus (results FDR-corrected for multiple comparison at P<0.05). Conclusion: Structural brain abnormalities at birth in inferior-medial temporal brain areas are associated with memory abilities at 4. This finding provides further evidence of the importance of temporal lobe areas in the early stages of working memory development.

## 2-C-29 Understanding successful neuroplasticity through high-fidelity imaging of individual perinatal stroke survivors

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Perinatal stroke survivors often only have mild motor deficits and normal, or near normal cognitive abilities making perinatal stroke an excellent model of successful neuroplasticity. Prior attempts at mapping functional networks in perinatal stroke survivors have had limited success because traditional group-averaging approaches were stymied by individual variability in lesions, and distortion of the non-lesioned parenchyma. Recently, we found that detailed definition of functional networks in a highly sampled individual revealed unique topological features not detected in group-average functional network maps (Laumann et al., Neuron, 2015). Here, we present the high-fidelity functional network map of a perinatal stroke survivor with normal cognition and very mild left-sided motor deficits. Resting state functional connectivity MRI (rsfcMRI; ≥ 300 min), and task fMRI data were acquired from a 15-year-old perinatal stroke survivor (PS1) and 10 controls (5F; 24-34 years). Task fMRI included a blocked motor task. The data underwent standard preprocessing. Functional networks were identified in each individual following (Laumann et. al., 2015). PS1's stroke destroyed 25% of the supratentorial brain tissue. The overall topographical patterns of major functional networks (e.g.: default, fronto-parietal and cingulo-opercular) remained intact in PS1, however spatial boundaries were drastically altered relative to the 10 controls. PS1 suggests that major functional networks are highly preserved despite spatial re-localization of specific network regions. Our patient's function

## 2-C-30 Newborn Insula Gray Matter Volume is Prospectively Associated With Early Life Fat Gain

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Childhood obesity is of great concern as obese children are more likely to be obese as adults, and develop obesity-related diseases at earlier ages and of greater severity. The importance of homeostatic brain circuitry, particularly the insula, is well established through structural and functional imaging in obese adults. In this work, we investigate the association between newborn insula gray matter (GM) volume and rate of fat accrual in the first six months of life, an outcome thought to be among the most reliable, valid, and strong predictors of childhood obesity. 52 neonates were assessed using structural MRI within the first month of life and longitudinal Dual X-Ray Absorptiometry shortly after birth and at six months of age. Bilateral insula gray matter (GM) volume was negatively associated with change in body fat percentage (ΔBF%) from birth to six months postnatal age ($R^2$=19%; p=0.001). This finding was replicated using GM concentration (ratio of GM to total insula volume) within the insula, a relative measure of GM volume more independent of age and intracranial volume, as a predictor of ΔBF% ($R^2$=13%; p=0.009;). Furthermore, the observation was spatially consistent with known gustatory regions within the insula, the direction of effect was in concordance with adult findings, the magnitude of effect was substantial, and the results remained significant after post hoc testing of relevant confounding variables. Taken together, insula GM volume assessed at birth holds significant promise as a brain phenotype predicting childhood obesity risk.

## 2-C-31 Within-Network Newborn Functional Connectivity is Associated with Maternal Interleukin-6

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Although interleukin-6 (IL-6) plays a role in typical fetal development, elevated concentrations during pregnancy can alter offspring neural development increasing the risk for poor neurodevelopmental outcomes. Research in this area has primarily been conducted in animal models and focused on specific brain regions in isolation. This study seeks to advance understanding of the implications of elevated IL-6 for neurodevelopment in humans taking a data-driven approach focusing on multiple large-scale brain systems. Using machine-learning with cross-validation we examine the association between mean maternal IL-6 concentrations (averaged over each trimester) and functional connectivity in neonates (N=84; M=25.45 days, SD=12.09 days). We focus on functional connectivity amongst nodes within previously identified networks whose organization may be susceptible to early-life insult. Networks include the Default Mode (DFM), Visual (VIS), Cingulo-opercular (CON), Somatosensory (SSM), Salience (SAL), Frontoparietal (FP), Subcortical (SUB), Dorsal Attention (DAN), Ventral Attention (VAN) and Cerebellar (CER) networks. Significant associations were found between maternal IL-6 and functional connectivity within the VIS, FP, SSM, SAL and DFM networks. This data-driven approach has the potential to increase our understanding of associations between prenatal conditions and complex neurocognitive processes at the systems level. Findings suggest elevated IL-6 is associated with alterations in multiple brain systems involved in both basic sensory processing and higher order cognition.

## 2-C-32 Hippocampal Volume and Sensitivity to Social Context in the Emergence of Depression in Adolescence

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Recent theory (e.g., Schriber & Guyer, 2016) has focused on how brain-based individual differences in social sensitivity shape development in adolescence, when rates of depression skyrocket. Given the importance of the hippocampus in coding affective and contextual aspects of experience, as well as its controversial role in depression pathophysiology, we investigated hippocampal volume as a moderator of social-contextual influences on adolescent depressive symptoms. 209 adolescents (49% female, ages 16-17) reported on their experiences of maternal hostility and warmth, family connectedness, and exposure to crime in their communities. Six months later, hippocampal volumes and depressive symptoms were assessed in a visit involving an MRI scan. Results indicated that hippocampal volume interacted with family closeness and community crime, respectively, to predict depressive symptom severity. Adolescents with larger left hippocampal volumes showed greater sensitivity in their depressive symptoms to the protective effects of family closeness and harmful effects of lower closeness and higher crime. This partially replicated previous findings showing hippocampal moderation of the effect of maternal aggression (Whittle et al., 2011), for which we found only a main effect. Also, results align with evidence localizing structural abnormalities in depression to the left more so than right hippocampus. Taken together, results suggest complex brain-environment interplay in the emergence of depression in adolescence, offering clues about for whom and how social context plays a role.

## 2-C-33 Gray matter maturation is differentially influenced by early-life and pubertal stressful experiences - a prospective longitudinal study

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The early developing brain has been shown to be sensitive to stress, but less is known about the impact of early-life stress on neural maturation during adolescence. Based on animal and human literature we hypothesized that stress may interfere with known patterns of neural development during adolescence, namely subcortical growth and prefrontal pruning. In a prospective longitudinal study, 37 adolescents were followed since 15 months of age. We tested the relative impact of adverse events experienced early in life (until age 5) and recently (between age 14 and 17), involving personal events and social environment on brain changes occurring between age 14 and 17. Personal events were indexed with the Life Events Scale. Social environment was indexed with peer social preference. We focus on changes in gray matter volume (GMV) in the amygdala-hippocampal complex and in prefrontal cortex. Preliminary results show that GMV changes in those regions were differentially affected by early and recent experiences. Early adverse life-events were associated with a relative reduction of the amygdala-hippocampal region and insula. Recent exposure to an adverse social environment was associated with changes in the posterior hippocampus and prefrontal cortex. These findings suggest that brain maturation between age 14 and 17 is particularly sensitive to adverse personal events early in life, and to adverse social events during adolescence. These findings open the way to understand how personal and social adverse events lead to alterations in social and emotional behavior in adults.

## 2-C-34 Affective disorder symptoms during childhood, early- and mid-adolescence are differentially associated with subcortical volumes in later adolescence among females

*Veronika Vilgis[1], Erika Forbes, Alison Hippwell[1], Kate Keenan[1], Amanda Guyer[1]*

*[1]UC Davis*

Considerable evidence shows structural brain alterations in cortico-limbic and striatal regions in adults and, increasingly suggests similar patterns in adolescents with affective disorders. It is less clear, however, whether high levels of depression or anxiety symptoms during distinctive developmental stages may differentially impact the maturation of subcortical structures. We examined subcortical volumes at age 16 in 137 female adolescents who participated in the longitudinal Pittsburgh Girls Study. Structural MRI data was analyzed using Freesurfer. Average severity level of depression and anxiety symptoms during ages 5-9 (childhood), 10-12 (early adolescence) and 13-15 (mid-adolescence) were used to predict subcortical volumes at age 16, controlling for current symptoms. Girls high in depressive symptoms in childhood had a larger right thalamus volume at age 16 than those with low depressive symptoms between ages 5-9. High depressive symptoms in mid-adolescence were associated with a significantly larger left accumbens volume. High anxiety symptoms between ages 13-15 were associated with a smaller left hippocampal and a larger right amygdala volume at age 16 compared to those low on anxiety symptoms. No significant associations between subcortical volumes at age 16 and anxiety or depression symptoms during early adolescence were found. Current depressive symptoms were associated with left putamen volume. The results of the current study suggest that affective disorder symptoms may differentially affect the volume of subcortical structures during specific age windows.

## 2-D-35 A new experimental paradigm to examine Social Evaluation and Aggression Regulation in 7-10-year-old children: A pilot, test and replication study

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Dealing with social evaluations and regulating aggression in the case of negative feedback are important for maintaining social relations. However, the underlying neural mechanisms of aggression regulation following negative social feedback in childhood remain largely undiscovered. We studied the relation between social feedback and aggression in children aged 7-10, by using the social network aggression task. Children viewed pictures of peers with either positive, neutral or negative feedback. Next, participants could blast a loud noise towards the peer, as an index of aggression. We used a pilot sample (N=19) to generate hypotheses, and a test (N=28) and replication sample (N=27) to test hypotheses. In all three samples negative feedback led to more aggression (longer noise blasts). On a neural level, the contrast of all types of social evaluation vs. baseline resulted in activity in, among others, fusiform cortex, amygdala, and medial prefrontal cortex (PFC) in all three samples. A similar contrast on the noise blast event resulted in activity in, among others, anterior cingulate cortex, the right dorsal lateral PFC, the right inferior frontal gyrus, the right insula, in all three samples. In sum, we found replicated differences in behavioral aggression after receiving positive vs. neutral vs. negative feedback. Moreover, our fMRI analyses showed heightened activation of the face processing network in response to social evaluation in young children. We are currently investigating patterns of neural activation specific to negative, neutral and positive feedback.

## 2-D-36 Social Reward and Voice Processing Systems During Cross-Sectional Development

*Amanda Baker[1], Daniel Abrams[1], Aarthi Padmanabhan[1], Paola Odriozola[1], Vinod Menon[1]*

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In childhood, communicative cues in mother's voice convey critical information guiding behavior and learning. Our previous research in children showed that mother's voice activates multiple brain systems, including reward regions. However, little is known about the development of speech processing systems in adolescence, particularly in the context of biologically salient vocal sources, as individuals begin to make a world for themselves outside of the home. We used fMRI to measure brain activity in 48 neurotypical participants (7-17 y/o) while they attended to brief nonsense words produced by their biological mother and two control mothers. We performed a GLM analysis using age as a covariate to examine cross-sectional development of the voice processing system. We also performed a gPPI analysis to examine cross-sectional development of voice-selective superior temporal sulcus (STS) connectivity. Mother's voice, compared to control voices, elicited decreased activity in the brain's reward circuit as a function of age, including reward and social regions such as nucleus accumbens (NAcc), putamen, ventromedial prefrontal cortex (vmPFC), orbitofrontal cortex, amygdala, and anterior insula. Moreover, as age increased, gPPI results showed decreased connectivity between STS and multiple brain systems during mother's voice perception. Results suggest that during development, as the social focus of an individual shifts from caregivers to novel social partners, the rewarding nature of mother's voice is diminished while the reward value for new communication partners is enhanced.

## 2-D-37 Associations between resilience and frontal-limbic brain function during an emotional face task in adults with and without a history of childhood maltreatment

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Childhood maltreatment is a major public-health concern, with approximately 1.25 million children affected each year in the United States (Sedlak et al., 2010). Many victims of child maltreatment experience psychiatric illness, such as anxiety and depression, disorders characterized by disrupted emotion regulation and corresponding atypical functional activity in the amygdala and pre-frontal cortex (Pechtel & Pizzagalli, 2011). However, some individuals show resilient patterns of psychological functioning. To date, few studies have addressed potential associations between frontal-limbic brain function and individual differences in resilience. In this study, 42 adults with a substantiated history of childhood maltreatment, and 41 SES-matched controls underwent MRI scanning during an emotional face- and shape-matching task (Hariri et al., 2002). Participants also completed the CDRISC, a self-report measure of resilience and stress coping. Task-related brain activity and main effects of maltreatment have been reported previously (Jedd et al., 2015). In the current analysis, CDRISC scores were positively correlated with emotion-related activity in the bilateral inferior frontal pole ($p<.005$). Further, a PPI analysis revealed altered functional connectivity between the amygdala and similar bilateral inferior frontal pole regions as a function of resilience ($p<.005$). Results suggest that both maltreatment history and individual differences in resilience influence the development of frontal-limbic emotion-processing circuitry.

## 2-D-38 Tracking Longitudinal Changes of Maternal Influence on Adolescent Neurocognition during Risk-Taking

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Research has begun to examine how social influence can promote adaptive outcomes in adolescence. In particular, work has demonstrated how parents can counter adolescents' predilections towards engaging in risky behaviors (Telzer et al., 2015). However, the dynamics of parent-teen relationships undergo significant change across the course of adolescence (Steinberg & Morris, 2001). We sought to understand how maternal influence on adolescent risk taking changes across the middle school to high school transition. Twenty-three adolescents (9 Female; Mage=14.4 years) completed two fMRI scans, once in 8th grade and once in 9th grade, during which they played the Stoplight Task in the presence of their mothers. Behaviorally, adolescents tended to increase in risky decision making in the presence of their mothers across the transition to high school (MW1=48% of trials, MW2=57% of trials; $t(22)=1.75$, $p=.047$, one tailed). At the neural level, when making risky decisions in the presence of their mother, adolescents showed longitudinal increases in the anterior insula ($t(22)=2.91$, $p<.005$) and bilateral ventral striatum ($t(22)=3.46$ $p<.005$). These results suggest that maternal influence becomes less effective at decreasing risky behaviors across early to middle adolescence. Our observed neural findings suggest this occurs because maternal presence is less effective at dampening the rewarding sensations frequently associated with risk taking. Overall, our results underscore how parental scaffolding of risky decision making may not be uniformly protective across the course of adolescence.

## 2-D-39 Valence modulates visual perceptual discrimination: Evidence from the other-species effect

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Introduction: Frequent experience with human faces contributes to visual perceptual narrowing to own-race and own-species faces (Kelly et al., 2007, 2009; Pascalis, et al., 2002). Recent work suggests perceptual

narrowing may be the result of an attentional bias to face categories that are relevant in an individual?s daily experience (Markant et al., 2016; Wheeler et al., 2011). Attention improves the quality of early vision (Carrasco, 2011), possibly enhancing perceptual discrimination for face categories benefiting from this attentional bias. Here, we ask whether valence can bias attention to enhance face perceptual discrimination. Methods: Across two studies (one behavioral, one behavior & fMRI), 53 participants (Age: M=21 yrs, SD=2 yrs) completed a conditioning delayed-match-to-sample (DMS) task. After a baseline block, we conditioned two species of monkey faces with either a positive or a negative sound, and then repeated the DMS task. Since experience with each species was equal, any difference in perceptual discrimination performance after conditioning could only be the result of the valence association. Results & Conclusions: After conditioning, accuracy increased for positively associated faces only ($F=5.38$, $p=.03$). Preliminary fMRI data show a differential valence activation in the visual cortex ($t=5.08$, $p<.001$) after conditioning with sound stimuli. Thus, valence associations may support enhanced perceptual processing for face categories. This enhancement may act through attentional systems to increase the gain in visual cortex for valence-associated faces.

## 2-D-40 A Preliminary fMRI Study of Emotion Regulation as a Predictor of Suicidal Ideation

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Rates of suicidal ideation (SI) and behavior increase dramatically during adolescence (Nock et al., 2013). To date, we know very little about neural processes that may underlie risk for suicide. However, previous work in adults has implicated function of prefrontal areas underlying emotion regulation (van Heeringen & Mann, 2014). Here we examined whether activation in lateral and medial prefrontal cortex during emotion regulation distinguished adolescents with and without SI. Forty-nine adolescents ages 13-20 (59% female) completed self-report and clinical interviews assessing SI and participated in an emotion reactivity and regulation task (Ochsner et al., 2004). We specifically examined activation for trials in which participants were asked decrease their emotional reaction to a negative image using cognitive reappraisal relative to trials in which they simply viewed a negative image drawn from the international affective picture system (IAPS). Based on existing evidence of regions involved in cognitive control of emotion, we identified seven a priori regions of interest using Freesurfer. These were right and left lateral orbital frontal cortex (r and lOFC), medial OFC, rostral anterior cingulate, and right inferior frontal gyrus. Only activation in the lOFC (OR = .93, $p < .05$) distinguished adolescents with and without SI. Specifically, individuals with SI were less likely to active the lOFC during emotion regulation trials compared to those without SI. Importantly, the magnitude of this effect remained unchanged after controlling for depression, which is a strong pre

## 2-D-42 Context-dependent trajectories of mesolimbic network connectivity throughout adolescent neurodevelopment.

*Vishnu Murty[1], David Montez[1], Will Foran[1], Bea Luna[1]*

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The mesolimbic dopamine system continues to mature throughout adolescence into early adulthood. Neuroimaging has characterized increases in ventral striatal activation across adolescence during reward-motivated behaviors; however, relatively less work has investigated interactions between the ventral striatum and the ventral tegmental area (VTA), the source of mesolimbic dopamine neurons. The current study characterized VTA connectivity with its mesolimbic targets across adolescent neurodevelopment. To determine the developmental trajectory of this system as a function of individuals' goal states, we assessed

connectivity in both neutral and rewarding contexts. FMRI data was collected in 170 individuals ranging in age between 10-30 years old. Participants completed both a resting-state task (neutral context) and a motivated anti-saccade task (rewarding context). Results indicate a significant decrease in VTA-ventral striatal coupling in the rewarding context as individual's approached adulthood ($p < 0.001$). Conversely, there were no differences in VTA-ventral striatal coupling as a function of age in the neutral context (i.e., resting state scan, $p = 0.93$). These findings support a model by which connectivity of the VTA with its mesolimbic targets is relatively stable across adolescence, however, the ability to engage this circuit in motivational-relevant contexts continuous to mature into early adulthood. Future analysis will incorporate VTA network connectivity with other mesolimbic targets including ventromedial prefrontal cortex, hippocampus, and dorsal striatum.

## 2-D-43 Perceived Parental Criticism Influences Salience Network Coherence in Early-Pubertal Girls

*Sarah Ordaz[1], Morgan Popolizio[1], Alexandra Price[1], Catalina Camacho[1], Ian Gotlib[1]*

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Both positive and aversive parenting behaviors during adolescence have been found to contribute to psychosocial outcomes, including levels of internalizing symptoms. Further, emerging evidence suggests that both positive and aversive parenting behaviors contribute to these outcomes by influencing adolescent brain structure. We know little, however, about how parenting behaviors may contribute to internalizing symptomatology through their influence on functional brain networks. In a sample of early-pubertal youth, we examined the relations among various parenting behaviors and connectivity in salience, default mode, and executive control networks. Early-pubertal boys and girls (N=111) ages 9 to 14 years completed resting-state scans. Children reported about their own internalizing symptoms and their mothers' warmth, monitoring, psychological control, and levels of criticism. Salience, executive control, and default mode networks were identified as networks of interest using ICA, and coherence within networks was quantified using dual regression. We selected visual and motor networks as non-relevant networks, in which we predicted no associations with symptom measures. We found that child reports of parental warmth, monitoring, psychological control, and maternal criticism all were associated with levels of anxious/depressed symptoms in girls (ps<.043). Only maternal criticism influenced network function - and specifically function of the salience network in girls (p=.004). Further, salience network connectivity mediated the relation between maternal criticism and anxious/dep

## 2-D-44 The multidimensional construct of impulsivity and its longitudinal relation to testosterone across development: A factor analysis

*Jiska Peper[1], Neeltje Blankenstein[1], Barbara Braams[2], Eveline Crone[1]*

*[1]Leiden University, [2]Harvard University*

Impulsivity is a multidimensional construct covering aspects that develop at different pace. Testosterone has been proposed to be involved in the development of impulse control. However, how testosterone is associated with the different aspects of impulsivity remains elusive. Here, we aimed to characterize the multidimensional construct of impulsivity and examine developmental patterns and/or stability of these dimensions. Self-report measures (Barratt Impulsivity Scale, Behavioral Inhibition (BIS)/Activation (BAS), an Aggression Questionnaire and Neuroticism (NEO-PI)) and two laboratory tasks (Balloon Task (BART) and Delay Discounting) were administered in 230 participants aged 8 to 30 years across 3 time-points (each 2 years

apart). Factor analyses yielded 3 stable factors across all time-points: one ?approach-related? factor (including motor impulsivity, aggression, BAS and delay discounting), one ?avoidance-related? factor (including BIS and neuroticism) and a factor containing risk-taking only. In addition to stability of the 3 factors, age-related increases were found in avoidance-related traits, whereas approach-related impulsivity decreased with age. Higher testosterone was related to lower withdrawal-related traits and higher approach-related behavior associated with impulsivity and risk-taking behavior 2 and 4 years later. These findings underscore the multidimensional nature of impulsivity that is stable within individuals. In addition, separate dimensions of impulsivity follow different developmental trajectories that are related to levels of testosterone.

## 2-D-45 Community crime exposure, neural response to sad faces, and adolescent externalizing problems

*David Weissman[1], Amanda Guyer[1], Kristina Gelardi[1], Paul Hastings[1], Richard Robins[1]*

*[1]University of California Davis*

Children's exposure to community violence is associated with higher incidence of adjustment problems. Adolescents, who are increasingly sensitive to and aware of their extrafamilial social environment, may be particularly vulnerable to these effects. This study examined neural activity during the representation of emotional states as a potential mechanism of the link between community crime and adolescent adjustment problems. Mexican-origin adolescents and their mothers reported the frequency of criminal events in their neighborhoods and schools when they were 11, 13, and 15. When adolescents were 17, they and a parent participated in a neuroimaging scan and reported on their externalizing problems and depressive symptoms. During an fMRI task, they viewed sad faces while either reflecting on their own emotions or attending to a non-emotional aspect of the image. Adolescents exposed to higher levels of crime demonstrated decreased activation in medial prefrontal cortex, left striatum, and right inferior occipital cortex when reflecting on their own subjective sadness. Reduced activation in overlapping regions in left striatum and medial prefrontal cortex is also associated with more externalizing problems. These regions are involved in the brain's social information processing network, which is involved in representing mental states, social cues, and their emotional salience. This alteration in adolescents' neural function may be a result of repeated exposure to threats in their community, which contributes to the development of externalizing problems.

## 2-F-46 Tracing Trajectories of Audio-visual Learning in the Infant Brain

*Lauren Emberson[1], Alyssa Kersey[2]*

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Although infants begin learning about their environment before they are born, little is known about how the infant brain changes during learning. Here, we take the initial steps in documenting how the neural responses in the brain changes as infants learn to associate audio and visual stimuli. Using functional near-infrared spectroscopy (fNRIS) to record hemodynamic responses in the infant cortex (temporal, occipital and frontal cortex), we find that across the infant brain, learning is characterized by an increase in activation followed by a decrease. We take this U-shaped response as evidence of repetition enhancement during early stages of learning and repetition suppression during later stages, a result that mirrors the Hunter and Ames model of infant visual preference. Furthermore, we find that the neural response to violations of the learned associations can be predicted by the shape of the learning curve in temporal and occipital cortex. These data provide the first look at the shape of the neural response during audio-visual associative learning in infancy

establishing that diverse regions of the infant brain exhibit systematic changes across the time-course of learning.

## 2-F-47 Neural Correlates of Auditory and Language Development in Children Engaged in Music Training

*Assal Habibi[1], Hanna Damasio[1]*

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Several studies comparing adult musicians and non-musicians have shown that music training is associated with functional and anatomical brain differences. It is unknown, however, whether those differences result from lengthy musical training or from pre-existing traits or social factors favoring musicality. As part of an ongoing 5-year longitudinal study, we investigated, using behavioral, MRI and EEG measures, the effects of an El-Sistema-inspired music training program on the auditory and language development of children, over the course of 2 years beginning at 6-7. We compared the children in the music group with two groups of "control" children of the same socio-economic background, one involved in sports training, another not involved in any systematic training. Prior to participating, children who began training in music were not different from those in the control groups relative to cognitive, motor, musical, or brain measures. After 2 years of training, we observe that children in the music group, compared to the two control groups, show (1) an enhanced ability in pitch and rhythm perception (2) accelerated maturity of auditory processing as evidence by more developed auditory evoked potentials P1 and N1 and (3) more rapid cortical development in auditory association areas including the right superior temporal gyrus and planum temporale. Our results suggest that music training results in significant brain changes, primarily in the auditory-association regions, in children; such enhanced neuroplasticity may favor faster development of language and reading skills.

## 2-F-48 4-weeks of numerical training improves arithmetic performance and increases neural modulation in children with mathematical learning disabilities

*Samantha Mitsven[1], Teresa Iuculano[1], Vinod Menon[1]*

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Mathematical learning disabilities (MLD) are characterized by deficits in the fundamental skills necessary to form the basis of arithmetic including, deficits in understanding, representing, and manipulating numerical information. Although MLD has been described as a disorder that results from deficits occurring at multiple levels of the information processing hierarchy that underlies successful arithmetic learning, a prominent hypothesis posits that MLD stems from a core deficit in representing and processing numerical magnitude. Here, we assessed the behavioral and neural effects of a 4-week numerical training program, aimed at strengthening the mapping between quantity representations and the symbols that denote them (i.e., Arabic digits), in a population of primary school children with MLD. At the behavioral level, we found that training significantly improved arithmetic performance, as indexed by a standardized test of math fluency. At the neural level, we found increased neural modulation during a symbolic number comparison task, such that, after training, children exhibited greater activation as numerical distance between the numbers being compared decreased (i.e., neural distance effect). Training-related effects were evident in regions that subtend successful numerical problem solving including, regions of the posterior parietal, prefrontal, and ventral temporal occipital cortices. Together, these results suggest that 4-weeks of numerical training can

elicit neural changes, characterized by increased modulation during numerical processing, in children with MLD.

## 2-G-49 Psychological distance and cognitive coping styles among adolescent users of an online mental health forum

*Peter Franz[1], Erik Nook[1], Karthik Dinakar[2], Matthew Nock[1]*

*[1]Harvard University, [2]Massachusetts Institute of Technology*

Psychological distance refers to the temporal and social proximity with which an individual experiences a stimulus, and is shown to be important for emotional self-regulation and for adaptive coping. However, it is unclear how psychological distance may differ between adolescents experiencing different types of emotional struggles. To answer this question, we analyzed over 15,000 online forum posts made by teenagers and young adults with mental health concerns, asking whether psychological distance might vary depending on the issue discussed in the posts. Specifically, we compared psychological distance between the posts made by users endorsing depression, self-harm, and social concerns. We found that psychological distance was lowest in the group discussing depression, and that this effect seemed to be driven by females engaging in ruminative self-reflection. These results are consistent with previous findings on the relationship between self-distancing and rumination, and underscore gender differences in coping styles among adolescents and young adults. Importantly, our findings demonstrate that ruminative thinking may be an important cognitive component the self-regulatory failures that maintain depression among adolescents, and that alleviating rumination could be accomplished by taking a more distanced perspective when reflecting on emotional events. Such a result suggests that emotion regulation strategies that require abstract thinking, such as cognitive reappraisal, may be especially beneficial beneficial for adolescent females experiencing depressive episodes.

## 2-G-50 Cortical morphometry in attention deficit/hyperactivity disorder: contribution of thickness and surface area to volume

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*[1]Murdoch Children's Research Institute, [2]The University of Melbourne, [3]Monash University*

Lower brain volume is a consistent neuroimaging finding in ADHD, however it is not known whether this effect is driven by changes in cortical thickness or surface area, two parameters which are governed by distinct neurodevelopmental processes. We examined ADHD-control differences in cortical thickness, surface area and volume, and tested whether thickness and surface area mediated any observed volume differences. Magnetic resonance imaging (MRI) data was collected from 35 males with ADHD-combined type and 35 typically developing control participants aged 9-17 years. Mediation analysis was performed to determine the relative contribution of thickness and surface area to group differences in cortical volume. Individuals with ADHD had smaller total cortical volume (7.3%), surface area (4.3%), and mean cortical thickness (2.8%) compared to controls. Differences were pronounced in frontal and parietal lobes. Variance in volume as a function of ADHD diagnosis was accounted for at least in part by the relationship between diagnosis and each of cortical thickness and surface area, with regional variation in the relative contributions of these measures. These results suggest that both surface area and cortical thickness play a significant mediating role in determining diagnostic differences in volume, with regional variation in the contribution of thickness and surface area to

those volume differences, highlighting the importance of examining both cortical thickness and surface area in examining ADHD.

## 2-G-51 Developmental Trajectories of Irritability and Associations with Child and Maternal Depression

*David Pagliaccio[1], Deanna Barch[2], Daniel Pine[1], Joan Luby[2], Ellen Leibenluft[1]*

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Irritability is an important dimensional trait that both transcends diagnostic boundaries and varies largely in severity across development. Understanding developmental trajectories of irritability and their determinants and consequences will be critical for studying pediatric psychopathology. The current study examined data from an ongoing longitudinal study following 3-6-year-old children (healthy or with elevated depressive symptoms) for up to 8 annual assessment waves. Severity of irritability was derived from a semi-structured interview assessment of psychiatric symptoms. Latent class mixed models identified three latent trajectories (271 children with ≥2 waves of data). Most children (N=145) exhibited a normative decline from moderate irritability at preschool age to very low levels in late childhood into adolescence. Another class (N=82) exhibited low levels of irritability across development, even in early childhood. The final class (N=44) was highly irritable across development. These classes varied drastically in their rates of maternal depression ($X^2$= 24.5, $p<0.001$, 69% of the high irritability class had a mother with a history of MDD vs. 23% of the low irritability class) and of child pathology. Particularly, being in this high irritability class increased risk for ever receiving an MDD diagnosis (odds ratio=4.7, p=.01), over and above baseline MDD severity and maternal MDD history. In ongoing fMRI analyses, we are examining how irritability relates to neural processing of emotional faces, which prior studies show to key in understanding irritability.

## 2-G-52 Cannabis Use and Adolescent Neurocognitive Development: A Prospective fMRI Study

*Brenden Tervo-Clemmens[1], Finnegan Calabro[1], Beatriz Luna[1]*

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Previous research has shown cannabis use during early adolescence is associated with neurocognitive deficits in adulthood. However, to-date, the majority of functional neuroimaging research examining this relationship has been retrospective. Here we present data from a prospective longitudinal neuroimaging study where participants were initially assessed at age twelve, before use, and then again at age fifteen. By the second time point, approximately 25% (n=24) of the sample had begun using cannabis. At both visits, subjects performed a visuospatial working memory (WM) task during fMRI acquisition. A fast event-related design with partial trials was used to distinguish the BOLD response in encoding, maintenance, and retrieval epochs of the WM task. Those who would go onto use cannabis by age 15 showed lower WM accuracy at time point 1. At time point 2, cannabis users had significantly lower behavioral performance than controls while covarying IQ. Omnibus, trial-wise activation differences in posterior parietal (inferior parietal lobule) and occipital cortices (cuneus) accompanied this behavioral difference. Epoch-based analysis revealed reduced cuneus activation during the encoding period at both time points in the cannabis group. Further, cuneus encoding activation was predictive of WM performance. Our prospective study shows activation differences and WM deficits may be present before the onset of cannabis use. This research has critical implications for clarifying potential effects of, and risk factors for, adolescent cannabis use.

# Day 3, Friday September 10

## 3-A-1 Do executive processes in working memory underlie the association between reading and math ability?

*Marie Banich[1], Kai Wang[1], Daniel Leopold[1], Andrew Reineberg[1], L. Thompson[2], Laurie Cutting[3], Erik Willcutt[4], Stephen Petrill[5]*

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Reading and math disability frequently co-occur, and reading and math ability are modestly correlated. Using a brain-based approach, we investigated whether this relationship may be mediated by the mutual reliance of reading and math on domain-general processes, ranging from visual processing (ventral occipital brain regions) to the association of form to meaning (angular gyrus, anterior temporal regions) to executive processes in working memory (dorsolateral prefrontal cortex). Our approach relied both on meta-analytic techniques via Neurosynth as well as functional neuroimaging data collected on 107 adolescents, each of whom performed 3 tasks, one in each of these domains: reading comprehension, numerical estimation, and working memory (N-back). In Neurosynth we selected topics associated with each domain, determining regions specific to each. We examined the overlap in reading and numerical meta-analytic activation compared to the overlap of all three domains. We created similar overlap maps with our empirical data. Both sets of results suggest that the overlap in activation between brain systems supporting math and reading ability occur mainly in regions of cortex that support executive processes in working memory, such as dorsolateral prefrontal cortex. Additionally, some overlap was observed in posterior visual processing regions and cerebellum. These results highlight the need to consider the role of domain general mechanisms that may underlie seemingly different cognitive processes that are critical to education.

## 3-A-2 White Matter Tract Integrity is Related to Cognitive Ability in Early Life

*Jessica Bullins[1], Barbara Goldman[1], Sarah Short[1], Rebecca Knickmeyer[1], Martin Styner[1], John Gilmore[1]*

*[1]University of North Carolina at Chapel Hill*

Mounting evidence suggests white matter (WM) integrity is related to cognitive ability in children and adults. However, little is known about how WM fibers support cognitive development in early life. We studied the relationship between WM microstructural properties and cognitive ability in infancy. Tract-based diffusion properties (FA, RD, AD) were computed using diffusion tensor images from healthy subjects at birth (N=246) and 1 year of age (N=152). Subjects were tested at age 1 using the Mullen Scales of Early Learning to derive an Early Learning Composite of general ability (ELC). Functional mixed effects models assessed diffusion properties in relation to ELC. More mature microstructural properties along bilateral corticofugal, corticothalamic, uncinate tracts (UNC), and left cingulum bundle (lower RD and AD, higher FA; $p \leq 0.05$) in neonates and 1-year-olds related to higher ELC at age 1. Neonatal tract integrity of the right superior and left inferior longitudinal fasciculus (SLF, ILF), and right arcuate tracts related to ELC at 1-year (lower RD, higher FA; $p<0.05$). At 1 year, WM integrity along the right ILF, right inferior fronto-occipital fasciculus (IFOF), and right temporo-parietal arcuate related to ELC (all $p<0.05$). More mature tract properties along major WM bundles at birth and 1-year is related to future and present cognitive ability. Tracts detected as markers of ability are

important for primary sensory, sensory integration, and higher-order cognitive functions. Results suggest WM integrity in early life is important for cognitive ability.

## 3-A-3 Cortical folding individual differences associated with cognitive ability in adolescence

*Yu Sun Chung[1], Christopher Hyatt[1], Michael Stevens[1]*

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There are cortical folding changes from gestation through young adulthood that parallel well-described maturation of cognition. However, few studies have sought to determine relationships between age-related differences in folding and cognitive ability. We investigated age- and gender-specific cortical folding patterns by examining the associations between the local gyrification indices (lGI) of cortical folding derived from FreeSurfer and cognitive measures (i.e., Wechsler Abbreviated Scale of Intelligence and CPT-II commissions, omissions, d'prime, and variability) in healthy adolescents (n=241, ages 12-24, 116 females). Although we found a main effect of IQ showing that intellectual ability was positively associated with bilateral caudal middle frontal cortex lGI, most of the significant findings involved age- or sex-interactions. For example, we found age x CPT-II interactions showing positive associations between each variable of the CPT-II and lGI in the precentral gyrus, superior and inferior parietal cortex. These relationships were most notable in the youngest adolescents. Also, several notable sex-specific findings were noted (e.g., the higher the IQ in females, the greater the lGI in left lateral orbitofrontal and inferior parietal cortex). The findings support recent emerging evidence for the functional significance of cortical gyrification (Gregory, Kippenhan et al. 2016). This study extends prior findings by demonstrating that relationships between specific cognitive tests and lGI change over maturation, and show sexual dimorphism.

## 3-A-4 The effects of uncertainty on concurrent information processing from late childhood to adulthood

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Information processing is often slowed in uncertain situations, in part because it is not possible to engage proactive cognition and in part because uncertainty can lead to heightened anxiety and activity in the amygdala. However, research has not elucidated whether child, adolescent, and adult information processing is similarly impacted by uncertainty. To investigate the developmental trajectory of uncertainty-sensitivity, 110 participants ranging in age from 9-22 underwent functional brain imaging (fMRI) while performing an incidental response task to images that were embedded within predictable or unpredictable timings. As expected, unpredictably timed trials were slowed in response relative to predictably timed trials. Younger participants were relatively more slowed in reaction times by uncertainty, an effect that reduced in magnitude with greater age. Additionally, late adolescents were the least slowed by uncertainty as predicted by a quadratic function that minimized around the age of 17. Paralleling these behavioral findings, amygdala, posterior insula, and superior temporal gyrus activity was significantly reduced in adolescents compared to children and adults. These findings inform the mechanisms of how environmental cues of predictability differentially shape behavior over development.

## 3-A-5 Neonatal Regional White Matter Microstructure Correlates with Cognitive Inhibition and Shifting Efficiency in Very Preterm Children at Age 5 Years

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Neonatal white matter abnormality is linked to executive problems in very preterm children (VPT <30 weeks gestation) but links between regional white matter microstructure and inhibition and shifting outcomes are unknown. At term-equivalent age, diffusion tensor imaging measured white matter microstructure in 86 VPT and 13 full-term (FT) infants. ROIs were placed on native diffusion parametric maps. Group differences in mean diffusivity (MD) and fractional anisotropy (FA) were examined in general linear models adjusted for clinical factors. At age 5, the Shape School assessed inhibition and shifting (VPT n=65, FT n=33) with results adjusted for sex and social risk. MD and FA were then related to inhibition and shifting efficiency in VPT children. VPT infants had higher MD in the bilateral frontal and temporal lobes and centrum semiovale, corpus callosum and right optic radiation (p≤.03); and lower FA in the bilateral frontal lobes and centrum semiovale, right inferior temporal lobe and corpus callosum (p≤.01) compared to FT infants. At age 5, VPT children had lower inhibition and shifting efficiency scores (p<.01). Inhibition was negatively associated with MD in the right optic radiation (p=.04), left orbitofrontal lobe (p=.03) and corpus callosum (p=.04); and positively associated with FA in the right orbitofrontal lobe (p=.04) and right centrum seimovale (p=.03). Shifting was negatively associated with MD in the right superior temporal lobe (p<.01). Results suggest early disturbances in regional white matter microstructure underlie poor executive skills in VPT children.

## 3-A-6 Developmental emergence of precuneus as a functional core of the default mode network

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Development of neural functional connectivity (FC) has often been studied using resting state data and, separately, during task performance. Prior work in adults has found the precuneus to be a hub for mediating between task and rest, but we do not yet know how neural FC changes between task and rest across development. We used fMRI data from 220 participants between the ages of 8 and 25 during two cognitive tasks and a resting state scan. This large sample was split into 4 task-rest subsets for replication validation. Within each subset, we used independent component analysis to identify whole-brain networks, applied dual-regression analysis to calculate a map of FC with each network, and compared the network FC maps for each participant at task and at rest. Our results replicated and extended previous adult findings: during task, compared to rest, precuneus exhibited both increased FC with the right and left frontoparietal networks (FPNs) and decreased FC with the default mode network (DMN). Critically, we found the increase in precuneus-FPN FC during task was developmentally emergent: 8- to 11-year-olds did not exhibit any differences in precuneus-FPN FC at task compared to at rest. Conversely, decreased precuneus-DMN FC during task compared to rest was present by age 8 and remained constant across development. All results replicated across split samples. Our findings indicate that the functional role of the precuneus in mediating task and rest states is immature in childhood and does not fully emerge until after age 11.

## 3-A-7 Maternal Health Behaviors and Fetal Functional Neural Connectivity Networks In Utero

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Forming neural networks is a critical undertaking of human gestation. Information about processes by which brain networks coalesce over fetal life is only just becoming available with development of non-invasive MRI techniques for measuring neural functional connectivity (FC) in utero. Early studies show that intra-hemispheric, cross-hemispheric, and long-range connectivity become stronger with advancing fetal age. It is possible that poor maternal prenatal health behaviors, such as poor dietary and exercise practices, can negatively influence the integrity of prenatal neural functional networks, but this critical idea has yet to be tested. Here, we examined FC in 71 fetuses with mean age 33.0 weeks (range = 24.43 to 39.57). Using a seed-based connectivity regression we assessed the impact of maternal diet and exercise on neural FC. We found that healthful eating was associated with stronger bilateral brain connectivity, and that maternal exercise was associated with increased connectivity of sensory and association cortices. These are the first data to show that maternal dietary and exercise practices during pregnancy may influence the organization of neural networks across gestational development. The data suggest that poor health behaviors may impede, or simply delay, typical neuroconnecitonal developmental processes with potential significance for long-term health and behavior.

## 3-A-8 Gain Stabilization of Cognitive Brain States Underlies Working Memory Development

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Working memory is the ability to retain information online in order to guide goal directed behavior. Its protracted maturation continues into young adulthood. We present results from a longitudinal developmental fMRI study conducted over 8 years in a sample of 118 subjects between the ages of 8 and 31 demonstrating that the stabilization of behavioral performance in working memory tasks during adolescence is the result of increasingly consistent expression of whole-brain task related brain states. We find evidence that gain signals affecting initial aspects of working memory encoding and sensorimotor processing have stabilized prior to adolescence, while variability of gain signals affecting the more cognitive maintenance and retrieval states continued to decrease through adolescence. We establish that trial-to-trial variability in the reaction time and accuracy of eye-movements during a memory guided saccade task arise from fluctuations in the amplitude of expression of task-related brain states, or brain state variability. We demonstrate that behavioral variability decreases in tandem with brain state variability across adolescence, and that individual developmental trajectories of reaction time variability are related to individual trajectories of brain state variability. Together, these results provide innovative and compelling evidence that underlying the maturation of cognition through adolescence is a stabilization of gain signals affecting already available cognitive processes.

## 3-A-9 Developmental differences in hippocampal-prefrontal mediated memory updating

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How we learn depends on what we know. In adults, related knowledge is brought to mind during encoding and updated through hippocampal (HPC)-medial prefrontal (MPFC) processes; yet, how the interactions between knowledge and learning shift over development remains unknown. Both regions undergo continued structural change well beyond childhood. Previous research thus begs the question: if our underlying neural

systems are maturing through middle childhood and beyond, are younger learners able to capitalize on their existing knowledge during new learning in the same way as adults? Here, participants aged 7-30 encoded object-object associations across three study repetitions during high-resolution fMRI scanning. Participants also learned related pairs, which included one object that had been studied previously. We hypothesized that adults would preferentially retrieve related knowledge and engage updating regions during overlapping pair encoding, while children would fail to reactivate related content and use similar processes to encode all pairs, irrespective of their overlap status. We found differences in HPC and MPFC engagement across ages during overlapping encoding, suggesting developmental shifts in how we learn information related to prior knowledge. We also found evidence for processing of related visual information during overlapping encoding only in adults. These results suggest that the mature brain more readily reinstates related knowledge during learning to form flexible memories, a notion that has broad implications for how we understand cognitive development.

## 3-A-10 Association between Reaction Time Variability and Resting State fMRI in Young Adults with ADHD

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The correlation between cognitive control network and default mode network (DMN) is attenuated in ADHD. The neuropsychological correlates of dysconnectivity remain understudied. We examined the relation between DMN and fronto-parietal network (FPN) connectivity and out of scanner reaction time variability (RTV) in young adults with a childhood history of ADHD (n=22; 72.7% male) compared to a local normative comparison group (LNCG; n=15; 67% male) who participated in the MTA. Independent components analysis was used to identify the DMN and FPN and these regions were masked. Positive associations between the masked regions were extracted for each subject, and transformed using Fishers r-to-Z transformations. Using ANCOVA controlling for site, sex, age, handedness, and IQ, DMN-FPN connectivity was attenuated in ADHD compared to LNCG [F(6,29)=4.3, p=.05,.23±.22 vs .42±.28]. Multiple regressions showed DMN-FPN connectivity significantly predicted RTV (β=.59, p=.02) after controlling for covariates; neither diagnosis (β=-.02, p=.94) nor the diagnosis by connectivity interaction (β=-.54, p=.14) were significant predictors. However, correlations conducted separately by group indicated that DMN-FPN connectivity was significantly positively correlated with RTV for ADHD (r=.44; p<.05) but not LNCG (r=.00; p=.50). Results suggest that more segregation between DMN-FPN networks is associated with less RTV. Additional work with a larger sample is needed to explore the possible interaction between RTV and DMN-FPN connectivity in ADHD.

## 3-A-11 The impact of size on the development of numerical estimation in early school years.

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Before entering school, children possess abilities to estimate the number of items in a set. However, sets of objects carry information regarding non-numerical dimensions of magnitudes (size, density) that can impact children's numerical judgments, in line with the reported overlap of brain regions coding for these dimensions. Ninety-three children (57 kindergartners, m.a. = 5.6 y.o.; 36 1st graders, m.a. = 6.7 y.o.) performed a non-symbolic numerical comparison task ("which set has more dots?"), whereby number could either be congruent or incongruent with the size of individual items (the more numerous set contained bigger or smaller dots than the other set, respectively). The number/size incongruence impaired children's performance across both

grades ($F(1,73) = 2.34$, $p < 0.001$). However, while their average performance did not differ significantly, the two groups were differentially impacted by the number/size incongruence, depending on the difficulty of the numerical task ($F(2,146) = 3.03$, $p = 0.05$). While kindergartners were equally impacted by the size of the items in all difficulty levels, first graders showed a strong impact of item size only for the least numerically discriminable stimuli. Additionally, the individual measure of the amplitude of the impact of size on the numerical judgment was associated with a measure of spontaneous focusing on number. Altogether, these results highlight the importance of taking into account the sensitivity to non-numerical dimensions of magnitude when investigating the development of numerical representations in childhood.

## 3-B-12 Parents versus peers: Characterizing the neural correlates of conflicting social influence on adolescent attitudes

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Family and peer relationships become particularly salient during adolescence insofar that teens are willing to conform their attitudes to those of others. However, no previous study has examined how conflicting social influence from parents and peers differentially affects adolescents' perceptions of both positive and negative behaviors. In this study, 31 adolescents (12-14 years old) and their parents provided their evaluations of positive (e.g., keeping a friend's secret) and negative (e.g., having unprotected sex) behaviors. One week later, participants completed a social influence task while undergoing fMRI, where they were shown parental and peer ratings that differed from their original ratings on those behaviors and had to choose which person they agreed with more. Adolescents exhibited greater inferior frontal gyrus and dorsolateral prefrontal cortex activation when making decisions about negative behaviors compared to positive behaviors. Adolescents also showed greater activation in regions implicated in reward processing (ventral striatum) and conflict monitoring (dorsal anterior cingulate cortex) when agreeing more with peers than parents. These findings suggest that it may be more cognitively effortful for adolescents to endorse negative versus positive behaviors. Although conforming to peers' over parents' opinions may be a rewarding experience, adolescents may feel more conflicted when doing so. Thus, the source of social influence (parents versus peers) is especially important for determining adolescents' engagement in positive and negative behaviors.

## 3-B-14 The influence of pubertal hormones on frontostriatal coupling during top-down regulation of motor versus reward response

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The developing brain is influenced by pubertal hormones (Sisk & Foster, 2004) with implications for adolescent risky behavior. Pubertal shifts in motivational systems may be a factor in difficulty exerting top-down control during adolescence. The purpose of the current study was to examine associations between pubertal hormones and frontostriatal coupling during cautious decision-making (regulation of reward response) and impulse control (regulation of motor response). Fifty-five adolescents (ages 14-18 years; 52% female) provided salivary assays analyzed for pubertal hormones (testosterone, estradiol, and DHEA). Participants underwent functional magnetic resonance imaging (fMRI) while performing the Driving Game, a modified version of the Stoplight Task (Chein et al., 2011). In the Stoplight Task, individuals stop (cautious choice) or go (risky choice) at yellow lights in pursuit of monetary reward. The Driving Game includes an inhibition component (stopping

for unexpected red lights). Regulation of reward response and motor response are examined in a single paradigm. A repeated-measures ANOVA revealed significant differences in reaction time by trial type [F(2.85, 88.21)=34.16, p<.01]. Main effects during cautious choice and response inhibition elicited activation in the DLPFC, with a lesser extent of activation during inhibition. Analyses will test whether pubertal hormones are associated with frontostriatal coupling. PPI analyses will be conducted with DLPFC timeseries as physiological predictor and cautious choice-response inhibition as task predictor.

## 3-B-15 Healthy Eating Decisions Require Efficient Dietary Self-Control in Children: A Mouse-Tracking Food Decision Study

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Learning how to make healthy eating decisions, i.e., resisting unhealthy foods and consuming healthy foods, enhances physical development and reduces health risks in children. Although healthy eating decisions are known to be challenging for children, the mechanisms of children's food choice processes are not fully understood. The present study recorded mouse movement trajectories while 18 children aged 8 to 13 years were making decisions on whether to eat unhealthy and healthy foods. When children rejected unhealthy foods, mouse trajectories were characterized by large curvatures toward an eating choice in the beginning, late shifting time toward a rejecting choice, and slowed response times. These results showed that children exercised greater cognitive efforts with longer decision times to resist unhealthy foods, suggesting that children's dietary self-control plays a major role in rejecting the temptation to eat unhealthy foods. Developmentally, older children attempted to exercise greater cognitive efforts for consuming healthy foods than younger children, suggesting that development of dietary self-control contributes to healthy eating-decisions. Also, healthy weight children with higher BMIs were more likely to choose to reject healthy foods. Overall, findings have important implications for how children make healthy eating choices and the role of dietary self-control in eating decisions.

## 3-B-16 The Mesolimbic Dopamine Pathway is Sensitive to Early Life Adversity

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While the influence of adversity on the calibration of the stress system is well-established, less is known about how adversity impacts the mesolimbic dopamine pathway (MLDP). Developmental theory suggests that the MLDP is sensitive to early life experiences; however, few studies have directly investigated the relationship between adversity and the MLDP in children.The overall objective of this study was to examine whether adversity predicts differences in 9-12 year old children's reward-learning; and further, to test whether the association between adversity and reward processing is explainable by differences in the MLDP's response to rewards. We collected measures of reward-learning, adverse experiences, and brain activation from 50 children. Adversity was associated with impulsive decision-making as measured by a delay discounting task, and potentiated reward-learning as measured by a probabilistic learning task. The neuroimaging results showed greater blood-oxygen-level dependent (BOLD) responses in striatum, ventromedial prefrontal cortex, and subiculum when participants received rewards compared to when they missed receiving rewards. Children who experienced more adversity had greater BOLD responses in the subiculum when receiving rewards. Finally, a mediation analysis confirmed that the relationship between adversity and reward-learning

was mediated by activity in the subiculum. These findings demonstrate that the MLDP is indeed sensitive to the experience of adversity through its functional and anatomical links with the subiculum--a key region in stress regulation.

## 3-B-17 Peer influences on adolescent risk taking: Comparing a community and foster care sample.

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Adolescents in foster care exhibit substantially higher rates of risky behaviors compared to adolescents who are not in foster care. Peer influences are thought to play an important role in risk taking among adolescents. Given the higher rate of social rejection experienced by adolescents in foster care, we hypothesized that peer influences on risk taking would be more pronounced, especially when rejected by those peers, in adolescents in foster care compared adolescents who are not in foster care. To test this hypothesis, we collected fMRI data from 75 adolescents who were recruited from the community and are currently collecting data from adolescents in foster care (n = 26). In both samples, we administered a risky decision task across three different social conditions: (1) while alone, (2) while watched by peers, and (3) after being excluded during a virtual ball-throwing game by the same peers. Preliminary findings suggest that adolescents in foster care demonstrate differential decision-making compared to the community sample, particularly after social exclusion. While adolescents from the community sample showed an increase in risk taking after social exclusion ($t(74) = -3.90$, $p < .001$), adolescents in foster care showed no change in risk taking compared to when they were alone ($t(23) = -0.44$, $p = .66$). Community adolescents robustly engaged frontostriatal circuitry during this decision-making task. Potential neural mechanisms associated with the behavioral differences between the samples will be discussed.

## 3-B-18 Asymmetric effects of friends' gains and losses on adolescent risky decisions

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While prior work has demonstrated that peers shape adolescent risk-taking behavior, the specific decision features that give rise to peer-induced shifts in riskiness remain unclear. Here we investigate the modulatory role of friend outcome on adolescents' risk aversion to ask whether adolescents' risk aversion is differentially enhanced or attenuated when their friend stands to gain or lose as a consequence of taking a risk. Participants (N = 142; ages 12-25) brought a friend to the lab to complete an economic decision-making task consisting of a series of choices between a safe option (e.g., winning $5) and a risky, but potentially more rewarding, option (e.g., 75% chance of winning $25). Friend outcome was manipulated by having the participant's friend either gain money, or lose money, if the participant selected the risky option. Computational models fitted to participants' choice data quantified the degree to which a friend's gain or loss biased risk preferences relative to trials when friend outcomes were not at stake. The prospect of friend loss induced greater risk aversion in all participants, and this shift was most robust for older adolescents. Conversely, the prospect of friend gain promoted greater risk seeking, an effect that increased with age into adulthood. These results show that whether peers stand to benefit or suffer differentially tunes adolescents' willingness to take risks. That adolescents are most impacted by the prospect of friend loss may reflect a heightened motivation to preserve social bonds during this phase of life.

## 3-B-19 Friend versus foe: Neural networks of prosocial decision-making with peers

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Adolescents spend the majority of their time with their peer. Peers, and friends in particular, are known to play a salient role in adolescents' social decisions. Adolescents can act in more prosocial or selfish ways depending on who their interaction partner is. In the current study we aimed to examine prosocial behavior and its neural correlates in interactions with peers. Participants (N = 50, Mean age = 14 years) took part in a functional magnetic resonance imaging study where they were asked to make decisions regarding distributions of coins in three economic exchange paradigms. Participants made decisions for four different groups of peers: liked (i.e., friends), disliked classmates, neutral classmates, and unfamiliar peers. In line with expectations, participants were more prosocial towards friends and more selfish towards disliked peers than towards neutral and unfamiliar peers. Decisions for friends were associated with heightened activation in the ventromedial prefrontal cortex (vmPFC) and temporoparietal junction (TPJ); prosocial decisions for friends were specifically associated with heightened activation in putamen and the superior temporal sulcus (STS). These findings suggest that, possibly, mentalizing processes and value estimations of the relationship might underlie decisions involving friends. Decisions for disliked peers did not show significant heightened brain activation. These findings will open pathways to better understand the underlying processes of prosocial behavior in adolescence.

## 3-C-20 A new neonatal parcellated brain atlas: The Melbourne Children's Regional Infant Brain (M-CRIB) atlas.

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Investigating neonatal brain structure and function can offer valuable insights into behaviour and cognition in healthy and clinical populations. Key in such investigations are atlases that provide standardised identification of brain regions. Several parcellated neonatal atlases exist, though strong demand remains for manually segmented ground truth data with detailed cortical definition. Compatibility with adult atlases is also favourable for use in longitudinal investigations. We aimed to replicate the Desikan-Killiany (2006) adult cortical atlas in neonates, and to complement this scheme with subcortical and cerebellar segmentations. Participants were 10 healthy term-born neonates (4 female, 6 male; gestational age at scanning 40.29 - 43.00 weeks, M = 41.71, SD = 1.31). High-resolution T2- and T1-weighted MRI scans were utilised. Tissue classification was performed using MANTiS (Beare et al., 2016) on T2-weighted images. Manual tracing was then performed volumetrically using ITK-SNAP. Thirty-four cortical areas per hemisphere were traced, along with four basal ganglia nuclei, thalamus, cerebellum lobes and hemispheres, and other structures including hippocampus and amygdala, providing 100 regions in all. T2- and T1-weighted structural templates were generated, and parcellated probability maps were constructed. The probability maps and structural templates comprising the M-CRIB atlas will be publicly available. This atlas provides valuable neonatal ground truth data, and will help facilitate a broad range of investigations into infant brain structure and function.

## 3-C-21 Prospective Associations between Maternal Interleukin-6 Concentrations during Pregnancy and Newborn Amygdala Volume and Connectivity

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Exposures to maternal infection and excess stress during pregnancy represent intrauterine conditions that have been associated with an increased susceptibility for schizophrenia and autism. Here, we test the hypothesis that in utero exposure to elevated maternal interleukin-6 (IL-6) concentration predicts alterations in newborn limbic circuitry with a specific focus on amygdala anatomy and connectivity. Participants were recruited in early pregnancy and maternal blood samples were collected in each trimester. Newborns (N=85 mother-child dyads) underwent anatomical, diffusion tensor imaging (DTI) and functional connectivity (rs-fcMRI) magnetic resonance imaging (MRI) during natural sleep. Prospective associations between average maternal IL-6 concentrations throughout pregnancy and newborn amygdala volume and functional connectivity, and fronto-limbic FA, were examined. Higher maternal IL-6 concentrations were associated with larger right amygdala volume (p=.002), increased amygdala functional connectivity to right anterior insula and bilateral caudate (p-corrected<.05), and reduced FA in bilateral uncinate and left fornix (p-corrected<.05). These results provide converging evidence across multiple modalities for alterations in limbic-circuitry in the context of elevated in utero inflammation. The circuitry identified is highly relevant for psychopathology across the lifespan, and these results may therefore facilitate increased understanding of the connections between prenatal immune stress and offspring risk for mental health disorders.

## 3-C-22 Ages differences in Focal and Nonfocal prospective memory tasks: An ERP study

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Prospective memory (PM) is an essential function of memory in everyday life because it is involved in carrying out planned activities at specific times in the future (Einstein & McDaniel,1990). This ability is essential in young children for fulfilling many school related activities such as remember to do their homework or to bring materials to school. Performance in PM tasks increases from childhood to adulthood (Zimmermann & Maier, 2006) and age differences in PM seem to depend on whether the PM task involves non focal or focal target events. Behavioral evidence suggests that relative to older children, 6 to 7 years-old are more negatively affected by PM cues outside their center of attention (Kliegel et al.,2013). Indeed, ERP studies using non focal tasks have found mean-amplitude differences between adults and children (10-years old) in the N300, a component related to cue detection ( Mattli, Zöllig & West, 2013). In the current study we assess the PM of two groups of children (6-and 10-years old) in two PM tasks (focal and nonFocal). The aim of the study was to evaluate the difference between the neural correlates of focal and non-focal PM task in young school children to determinate if the cue PM detection (N300 component) contributes to age differences in PM performance during childhood.

## 3-C-23 Pubertal Timing Is Associated With White Matter Tract Development In Late Adolescence

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Pubertal timing appears to play a critical role in shaping adolescent development (e.g., Keenan et al., 2014). Evidence suggests that pubertal hormones may influence structural brain development, though no research has investigated how pubertal timing may reflect differences in neural organization, such as white matter (WM) tract myelination. Myelination is reflected by increasing fractional anisotropy (FA) and decreasing mean diffusivity (MD) of water molecules (Hasan, 2007). We examined the relationship between girls' pubertal status at early ages and WM architecture (FA and MD) in late adolescence. In a subsample of 100 girls from the Pittsburgh Girls Study, pubertal status was assessed with the Petersen Physical Development Scale (PDS; Petersen, 1988) at ages 9-11, and FA and MD values were derived using a diffusion-tensor imaging (DTI) scan at age 17. Tract-based spatial statistics were performed to analyze the association between composite PDS scores and FA and MD values. Results indicated that girls further in pubertal maturation at age 9 showed significantly higher FA at age 17 in the inferior fronto-occipital (IFOF), uncinate (UF), superior longitudinal (SLF), and inferior longitudinal (ILF) fasciculi, and anterior thalamic radiation (ATR) ($t(99)=3.32\text{-}5.08$, $p < .05$). Further, faster pubertal progression at ages 9, 10, and 11 was associated with decreased MD in the IFOF, UF, ILF, SLF, and corticospinal tract ($t(99)=2.48\text{-}5$, $p < .05$). These findings are among the first to show that pubertal timing may be associated with neural transmission in late-adolescence.

## 3-C-24 Fetal total intracranial volume growth using longitudinal MRI across the third trimester

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The 3rd trimester through the neonatal period is characterized by rapid brain growth. However, longitudinal magnetic resonance imaging (MRI) studies of fetal brain volume have been limited. Increased understanding of normal, fetal brain growth could help define patterns of abnormal brain development in clinical populations. The aim of this study was to investigate fetal volumetric brain growth from the 3rd trimester through the neonatal period using longitudinal volumetric MRI. 9 typically-developing fetuses underwent longitudinal volumetric MRI at 30-32 weeks post-menstrual age (PMA), at 34-36 weeks PMA, and, after birth, at 40-44 weeks PMA. Imaging was performed on a 3.0 T scanner (Siemens Skyra) using a 32 channel body or head coil. Total intracranial volume (TIV) was estimated by manual segmentation using BioImage Suite. TIV included cerebrospinal fluid, gray and white matter, cerebellum, and brain stem. Linear regression was used to correlate PMA and TIV. The average TIV was 234.8 ml for the first fetal scan (31.1±1.2 wks PMA, N=9), 304.3 ml for the second fetal scan (35.0±0.7 wks PMA, N=8), and 413.8 ml (41.6±1.6 PMA, N=5). TIV exhibited a significant linear association with PMA from 30 weeks to 44 weeks ($r=0.94$, $R2=0.88$, $p<0.001$). TIV increased at an average rate of 7.6% per week and doubled in size during this period. These longitudinal data suggest that the brain grows linearly and doubles in size through the perinatal period. Future studies should continue to investigate fetal brain growth using longitudinal MRI, especially in clinical populations.

## 3-C-25 Fiber pathways supporting early literacy development in 5-8-year-old children

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The development of fluent reading is an extended process that requires the recruitment of a comprehensive system of perisylvian brain regions connected by an extensive network of fiber pathways. In this cross-sectional study we focused on those fiber pathways supporting early literacy in typical 5-8-year-old children. We related quantitative metrics of fiber pathway microstructure to early literacy measures of phonological awareness and decoding. We found that a) the ventral pathway supported by the inferior longitudinal fasciculus (ILF) becomes increasingly important for the processing of phonological information as skills in phonological awareness and decoding are acquired; b) as children become more efficient, these skills become less associated with the dorsal arcuate fasciculus (AF) pathway and with the vertical occipital fasciculus (VOF) pathway connecting ventral and dorsal visual streams, and; c) there is evidence for a shift from bilateral involvement in early literacy to a left-lateralized recruitment of brain regions involved in reading. These findings are important for characterizing the typical developmental trajectory of fiber pathways supporting early literacy so that atypical patterns in children at-risk for reading delay can be readily identified and described in future research studies.

## 3-C-26 Childhood Poverty Predicts Neural Connectivity to Negative Faces in Adolescent Girls

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The interpretation of others' emotional facial expressions is related to both wellbeing and psychopathology (Bourke et al., 2010). Adults who experienced childhood adversity often have emotion processing deficits and altered brain connectivity among relevant regions (e.g., amygdala, ventrolateral prefrontal cortex; Kim et al., 2013; Taylor et al., 2006), but less is known about adolescence. Analyses included 79 girls from the longitudinal Pittsburgh Girls Study. Poverty status reflected if girls' families had ever received public assistance in childhood (ages 5-9). During a functional MRI scan girls (age 17) viewed 48 facial expressions (sad, angry, happy, neutral) and rated a non-emotional feature, nose width, from 1=not at all to 5=very much so (Guyer et al., 2011). PPI analyses were conducted in CONN 15.h (Whitfield-Gabrieli & Nieto-Castanon, 2012), controlling for adolescent poverty status, race, and IQ. While viewing negative (i.e., sad, angry) faces (versus fixation), adolescents who experienced childhood poverty had more positive co-activation between the left amygdala and right inferior frontal gyrus (IFG), right inferior temporal gyrus, and right lateral occipital cortex ($F(16, 57)=2.52$, $p<.05$), compared to their peers. No differences were found for happy faces versus fixation. Greater positive coactivation of the amygdala and IFG suggests greater effort required to inhibit responses and maintain attentional control to negative emotional stimuli (Hampshire et al., 2010), adding to the literature on the long-lasting neurobiological effects of childhood poverty.

## 3-C-27 Developmental trajectories of cortical thickness, gray matter volume, and surface area in children and young adults with Phenylketonuria

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Phenylketonuria (PKU) is a recessive disorder characterized by disruption in the metabolism of the amino acid phenylalanine. Previous studies suggest that brain volume is reduced in individuals with PKU relative to controls. Recent work characterizing gray matter developmental trajectories for controls found that cortical thickness, gray matter volume, and whole brain surface area differ in their pattern and timing; however, little is known about gray matter developmental trajectories in individuals with PKU. To address this gap in the

literature, the present study compared age-related changes in average cortical thickness, gray matter volume, and whole brain surface area in children with PKU aged 7 - 19 years (N = 32, 18 male) and controls aged 7 - 21 (N = 66, 31 male). Structural brain data were obtained using high-resolution magnetic resonance imaging (MRI) and semi-automatic cortical reconstruction in FreeSurfer. Results of exploratory linear regression analyses designated age as a predictor of cortical thickness [$F(1,90) = 30.89$, $p < .001$], age and gender as predictors of gray matter volume [$F(1,90) = 18.71$ and 17.77, respectively; $p < .001$], and gender as a predictor of surface area [$F(1,90) = 23.09$, $p < .001$]. Regarding surface area, the interaction between group and age trended towards significance [$F(1,90) = 2.98$, $p < .10$], suggesting that age may be associated with reduced surface area in controls and increased surface area in individuals with PKU. These results underscore the utility of evaluating brain structure from a developmental perspective.

## 3-C-28 Structural brain correlates of resilience in adults with a history of childhood maltreatment

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Childhood maltreatment is a severe environmental stressor associated with higher risk for psychopathology and altered brain structure and function in adulthood. However, not all children who experience maltreatment develop psychopathology. Rather some individuals are resilient in spite of adversity. To date there is very little research on the neural correlates of resilience. In the current study, 81 adults (44 with histories of child maltreatment) completed a structural MRI scan. Participants were recruited in childhood from high-risk, low socioeconomic backgrounds. Participants completed the Connor-Davidson Resilience Scale, a self-report measure that assesses successful stress-coping ability. Regions of interest included subcortical structures (hippocampus, amygdala) and the prefrontal cortex. After controlling for age, sex, and intracranial volume, maltreatment predicted reduced volumes in right rostral middle frontal [$F(1,78)=4.67$, $p<.05$] and paracentral gyrus [$F(1,78)=7.40$, $p<.01$]. However, once resilience was included in the model the main effects of maltreatment were no longer significant. Resilience was a significant predictor of both left [$F(1, 74)=5.09$, $p<.05$] and right [$F(1, 74)=7.15$, $p<.01$] prefrontal volume, with a positive correlation between resilience and volume. There were no interactions between maltreatment and resilience, nor did we observe significant effects in the amygdala or hippocampus. These results suggest that, when groups are equated on socioeconomic risk, resilience may be a stronger predictor of brain development than maltreatment alone.

## 3-C-29 The Impact of Diabetes and Wolfram Syndrome on Functional Connectivity

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Wolfram Syndrome is an autosomal recessive genetic disorder characterized by juvenile onset insulin dependent diabetes, optic atrophy, deafness, and neurodegeneration. White matter tracts are severely compromised in Wolfram syndrome (WFS). Diabetes alters functional connectivity in non-WFS patients. However, nothing is known about how the demyelinating effects of WFS impact functional connectivity independently of diabetes. We used resting-state functional connectivity magnetic resonance imaging (rs-fcMRI) to study 22 Wolfram patients (ages 5-30) and two matched control groups: healthy (HC) and type 1 diabetes (T1C).Within-network and between-network correlation strength was compared between groups. For within-network analyses, WFS had lower correlation strengths in several networks compared to both control

groups (WFS<HC and T1C), with some networks showing higher correlations in T1C than HC (WFS<HC<T1C). For between-network correlations, WFS generally had higher correlation strengths compared to HC and T1C (WFS>HC and T1C). T1C also showed decreased correlation strengths compared to HC between the visual and language networks (WFS>HC>T1C). Both sets of analyses indicate that WFS dramatically alters rs-fcMRI but in ways that are qualitatively different from the distinct impact of diabetes.

## 3-C-30 Strong positive and strong negative resting-state correlations best predict individual maturity

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Resting-state functional connectivity (RSFC), the intrinsic correlation of fMRI activity between regions in the brain, is thought to reflect a history of co-activation across the lifespan. While the field has primarily focused on the strongest positive relationships, some suggest that the weakest inter-regional relationships may also provide relevant information about brain organization. Weak relationships are though to act as "local bridges" that serve as critical links between separated functional modules. We aimed to test explicitly the relevance of changes in the weakest resting-state correlations to brain maturity in typical development. Using a developmental resting-state fMRI dataset (N=129; ages 7-31; 69/60 male/female), we divided each individual's set of RSFC correlations into ten separate windows from extreme negative to extreme positive. We used multivariate machine learning to test how well RSFC in each of the ten correlation windows predicted an individual's chronological age. To minimize the effects of head motion on resting-state correlations, we used global signal regression and motion censoring to remove artifactual differences in RSFC. We found that patterns of the strongest positive and the strongest negative resting-state correlations, rather than weak correlations, accounted for the most age-related variance. While the role of negative relationships in network organization is not well understood, it appears that strong, negative resting-state correlations contribute to the development of mature functional brain organization.

## 3-C-31 The Impact of Family Environments on Brain Development in Late Childhood

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Background: The impact of adverse family environments on brain development is well established, however little attention has been given to the impact of non-abusive parenting behaviors. The influence of family environments is likely to be pronounced during periods of rapid brain reorganization, such as late childhood. The aim of the study was to investigate the association between non-abusive parenting and the development of structural brain networks in late childhood. Methods: Observation data were collected from a cross-sectional sample of 160 mother-child dyads (91 female children, M age 8.2 years, SD 0.3 years) recruited across Melbourne, Australia, from areas that scored within the lowest quartile on a measure of socioeconomic status. Parenting measures were determined from two lab-based interaction tasks, completed by dyads that were video recorded and subsequently coded. T1 weighted images were acquired from children in a 3T TIM Trio Siemens scanner and processed using FreeSurfer. Results: Structural brain networks were based on structural covariance (SC) of cortical thickness using sparse regularized methods. Children were grouped based on the distributions of the parenting variables and SC was determined for each group. Analyses showed significant associations between observed parenting variables and child SC properties. Conclusion: These

results suggest that parenting may affect structural brain networks in late childhood and extend current knowledge about environmental influences on structural connectivity in a developmental context.

## 3-C-32 Neural Correlates of Executive Functioning in Children Engaged in Music Training

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Playing music, especially in an ensemble, is a complex task that simultaneously engages various sensory-motor processes and draws heavily on cognitive skills generally associated with executive function (EF), including working memory, sustained attention, and the ability to adjust to changing task demands. However, while music training has been positively associated with enhanced cognitive abilities including language skills and verbal memory, the relationship between music training and EF remains unclear; the few studies that have investigated this relationship have yielded conflicting results. To explore this question and as part of an ongoing 5-year longitudinal study, we investigated the effects of music training on the behavioral and neural correlates of EF using a standardized Color Stroop Task. We used fMRI and behavioral tests to compare children in the music group with two groups of "control" children of the same general cognitive abilities and SES, one involved in sports training, another not involved in any systematic training. Despite no significant differences in the accuracy or response time during the Stroop Task, children with music training showed significantly greater activation in the pre-SMA/SMA and IFG during inhibition (incongruent versus congruent trials) compared to control groups. Age and verbal IQ could not account for these differences. The results suggest that music training influences how the brain responds during tasks that probe inhibition. Findings from this study can help clarify the uncertain relationship between musical abilities and EF.

## 3-C-33 Hubs in the Fetal Brain Network

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Background. Advances in neuroimaging and functional connectomics have lead to discovery of critical relay centers, highly connected regions, or hubs, in the connectional architecture of the human brain. These network hubs are highly conserved across individuals and have been observed as young as in infancy. It is possible that these hubs emerge as networks begin to form in utero, but that possibility has yet to be examined. The current study addresses this question and aims to determine the location of neural hubs in human fetuses. Method. Fetal resting-state fMRI data (N=72) was used to construct connectivity matrices for 197 discrete brain regions. The 10 regions with highest degree and betweenness centrality (BC) were identified for the overall group as well as separately within younger (GA<35 weeks) and older (GA>35 weeks) fetal subgroups. Results. We discovered that within the connectional functional organization of the human fetal brain there are key hubs, or regions that are uniquely, highly connected. Consistent with prior reports in infants, visual and motor regions were identified as connectivity hubs. We also found robust evidence for network hubs in inferior temporal, prefrontal, insula, and cerebellar regions. Also, older fetuses had more network hubs located in prefrontal regions than younger fetuses. Conclusion. This is the first study to show that both primary and association brain regions demonstrate centrality in network organization beginning in fetal life. These network hubs may be important building blocks for later life neural connectivity.

## 3-C-34 Microstructural white matter integrity differentially predicts verbal and spatial working memory in children

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The current study used a longitudinal design to investigate relationships between white matter integrity and working memory during childhood. 25 healthy children aged 7-18 years (M =11.6) underwent neuroimaging and cognitive testing. Diffusion tensor imaging (DTI) was used to obtain mean diffusivity (MD) and fractional anisotropy (FA) for 7 ROIs: prefrontal cortex, centrum semiovale, putamen, thalamus, hippocampus, parahippocampal white matter, and parietal-occipital cortex. Measures of working memory included a digit span task and verbal and spatial recognition span tasks. Working memory was re-evaluated at 1.5 and 3 years follow-up. Correlations were obtained between baseline DTI values and working memory scores from all time points. At baseline, performance on digit span and verbal recognition span tasks was significantly correlated with high FA and low MD in subcortical regions only, whereas performance on the spatial recognition span task was correlated with high FA and low MD in frontoparietal and subcortical regions. Performance on the digit span and verbal recognition span tasks at follow-up was significantly correlated with baseline white matter integrity in both frontoparietal and subcortical regions after controlling for age; however, no significant correlations remained between baseline white matter integrity and spatial recognition span performance at follow up. Relationships between white matter integrity and working memory may involve dynamic recruitment of brain regions across development.

## 3-D-35 Sex Differences in the Impact of Early Life Stress on Prefrontal Regulation of Negative Stimuli

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Early life stress (ELS) has severe adverse consequences for mental health; however, there are important sex differences in the effects of ELS. For example, females are twice as likely as males to become depressed following ELS. We examined sex-specific effects of ELS on neural circuits underlying emotion processing and regulation. 55 boys and 75 girls, matched on pubertal stage (Tanner Stage 3 or below), completed an Affect Labeling task in the scanner, demonstrated to index the processing and regulation of emotional stimuli (Hariri et al., 2000). Participants' exposure to ELS in early life was assessed using a modified version of the self-report Traumatic Events Screening Interview for Children (TESI-C; Ribbe, 1996). We conducted a whole-brain, voxelwise analysis examining the interaction of sex and exposure to ELS. All results were thresholded at $Z>2.3$, $p<.05$. We found a significant interaction of ELS and sex in IFG/MFG while participants labeled negative emotions. Whereas females showed a positive association between IFG/MFG recruitment and ELS ($b=2.50$, $p<.001$), males show the opposite pattern ($b=-1.27$, $p=.04$) Only in females was greater recruitment of bilateral IFG and MFG associated with stronger amygdala reactivity during emotion labeling conditions. These findings suggest that there are sex-specific effects of ELS on regions involved in the regulation of emotion responding. Females exposed to ELS may need to exert more prefrontal control to regulate subcortical responses. These differences may contribute to sex differences in psychopathology that emerge in puberty.

## 3-D-36 Adaptive adjustment in cognitive control over reward in adolescence

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Theories of adolescent risk-seeking suggest a dynamic interplay in the ability to exercise cognitive control for appetitive cues. Prior work has found that adolescents can be impaired at exerting control over stimuli whose appetitive qualities are central to the stimulus itself. A critical open question is whether adolescent control limitations persist for cues that were once rewarding, but no longer signal reward. We asked if a previous reward history is sufficient to perturb adolescents' cognitive control. Inhibitory control for cues with and without previous reward association was assessed with the Conditioned Appetitive Response Inhibition Task during fMRI. 130 participants (ages 8-26) performed an inhibitory control task with 2 no-go cues, prior to which one cue was operantly conditioned to form a reward association, while the other was never associated with reward. We found an interaction between age and previous-reward (PR); beginning in adolescence proportionally more errors were made to the PR cue. Adolescents recruited the striatum less than children and adults when successfully withholding a response for the PR cue compared to the neutral cue, consistent with adolescent fMRI studies showing reduced striatal signals to relatively smaller rewards. Though the intrusion of reward on control emerged during adolescence, this interference was attenuated in adolescents in the absence of continued reinforcement, whereas it persisted for adults. This suggests a potential adaptive mechanism in adolescence, whereby strong reward responses can be tempered by rapid adaptation.

## 3-D-37 Developmental emergence of frontostriatal connectivity mediates flexible upregulation of cognitive control under high stakes

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Development of frontostriatal circuit function through adolescence is thought to result in unique integration of reward prospects and cognitive control demands. Prior work has shown that reward cues can improve adolescents' behavioral performance in tasks when they know exactly when and how to act. But often we are faced with a variety of cognitive demands that require flexible implementation in the heat of the moment, as we must monitor and select our behavior to act optimally in different situations. The aim of this study was to test whether adolescents could selectively upregulate frontostriatal systems to enhance flexible cognitive control when high and low rewards and punishments were at stake. 88 participants aged 13-21 underwent fMRI during an incentivized go/no-go task with low and high stakes conditions. First, a high (+$1.00/-$0.50) or low (+$0.20/-$0.10) stakes cue was shown. Next, a series of go's (required response) and no-go's (required witholding response) were presented. There was a significant age by stakes interaction whereby adults improved during high stakes but adolescents did not. This effect was mediated by developmental changes in functional connectivity between the ventral striatum and vlPFC that was selectively enhanced during high stakes with age. This indicates that the ability to capitalize on stakes in the heat of the moment may be an especially late developing feature of goal directed behavior.

## 3-D-38 Striatal Function in Emerging Adolescence: Who is in the Driver's Seat, Age, Reported Puberty, or Hormones?

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Many studies now document an adolescent peak in ventral striatal (VS) response to reward feedback. However, it is unclear whether VS responses to loss feedback and operant/guessing cues also increase from childhood through adolescence. Further, although gonadal hormones have been linked to VS response, it is

unclear whether increases in gonadal hormone levels or self-reported pubertal stage explain relationships between age and VS function. To investigate these topics 78 psychiatrically healthy girls (8-15 years) of psychiatrically healthy mothers completed an fMRI scan while playing a simple gambling task. Girls also provided measures of pubertal development and a saliva sample to assay gonadal hormone levels. Voxel-wise regression revealed a quadratic effect of age on VS and dorsal cingulate response to both monetary gain and loss feedback, peaking at ~12 years. Conversely VS response to the guess cue decreased linearly with age. Further, neither gonadal hormone levels nor self-reported puberty mediated quadratic effects of age on VS response to gain/loss feedback. However, girls with higher levels of estradiol showed greater response to gain versus loss within the VS and anterior cingulate. These results collectively suggest that while gonadal hormone levels do relate to striatal function, current hormone levels and self-reported puberty do not mediate quadratic effects of age on response to gain/loss feedback. Further, quadratic relationships between age and VS response are specific to gain/loss feedback, and not to striatal function more generally.

## 3-D-39 Age-varying associations between sensation-seeking, impulse control, and daily cigarette-smoking during adolescence and young adulthood

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Sensation-seeking and impulse control are constructs at the core of dual systems models of adolescent risk-taking. Little research has examined how the associations between sensation-seeking, impulse control, and daily cigarette smoking may change across adolescence and young adulthood. Using data from the National Longitudinal Study of Adolescence to Adult Health (Add Health), time-varying effect models (TVEM) were implemented to estimate how the associations between sensation-seeking and impulse control (predictors) and daily smoking (outcome) varied from adolescence into young adulthood (ages 12 to 34). Sensation-seeking was significantly associated with daily smoking during adolescence and in the late 20s and early 30s, although the association was strongest during adolescence. Impulse control was consistently significantly associated with daily smoking, with the strongest association emerging during the mid-20s to early 30s. The results provide a more nuanced perspective of when during development the components of dual systems models of brain development may be most related to daily cigarette smoking. Understanding age trends in the associations between sensation-seeking, impulse control, and daily smoking may inform the tailoring of prevention efforts to reduce the public health burden of cigarette smoking.

## 3-D-40 Lateral prefrontal cortical thickness mediates the relationship between age and regulation of craving

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Previous work has shown that emotion regulation processes are supported by prefrontal (PFC) systems (Ochsner & Gross, 2005). While it is known that PFC undergoes dramatic structural changes across development, the effects of these developmental changes on appetitive reactivity and regulation remain to be discovered. In the present study individuals ages 6 to 23 were scanned while completing a task in which they applied a cognitive regulation strategy to decrease the appetitive value of foods. On trials assessing food

cravings, participants were asked to imagine that the food was directly in front of them and to focus on its "hot" features, such as how it might taste or smell. On trials assessing cognitive regulation ability, participants were asked to imagine that the food was far away from them, and to focus on "cool" features, such as its color and shape. In addition to completing the behavioral task, participants underwent a structural MR scan. We found that ventromedial prefrontal cortex thickness was associated with craving and this relationship attenuated with age. Additionally we found that ventrolateral and dorsolateral prefrontal cortex thinning mediated the relationship between age and successful regulation of craving. Taken together these results add to our understanding of how structural maturation of the brain supports changes in affective reactivity and regulation across development.

## 3-D-41 Early MDD severity associated with developmental changes in functional connectivity of subgenual cingulate

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Major depressive disorder (MDD) is characterized by persistent feelings of sadness and guilt, as well as by rumination. Many studies have found that depressive symptoms are associated with increased activity of the subgenual cingulate cortex (sACC), a region implicated in self-referential emotional processing. The current study investigated whether severity of MDD in preschool ages predicts changes in the functional connectivity (FC) of the sACC across late childhood and early adolescence. 52 children with MDD history, (38 preschool-onset), and 34 children with no MDD history performed three longitudinal sessions of an fMRI passive emotional face-viewing task, each separated by ~1.5 years. For each scan session, contrasts for each emotional face type to baseline were used to create psychophysiological interaction (PPI) FC analyses using sACC as a seed. Individual PPI results were entered into a repeated measures 3 (scan) x 5 (face) ANOVA. Regions showing a main effect of scan were transformed to ROIs, and values for Sad vs Baseline were extracted from these ROIs for all scans, as were anatomically defined bilateral amygdala ROIs. These values were used as dependent variables in a multi-level regression model to determine whether core depression severity scores from preschool age predicted changes in sACC FC across time. In both left parahippocampal gyrus and right amygdala, FC with sACC became more negative across time with higher MDD severity, controlling for sex and age at scan 1. This suggests that early MDD severity may influence later development of sACC connectivity.

## 3-D-42 Atypical development of amygdala functional connectivity in autism: a cross-sectional study

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Functional connectivity (FC) of the amygdala with cortical and subcortical regions has been shown to underlie many social and affective processes that are affected in individuals with autism spectrum disorder (ASD). Little is known, however, about the intrinsic functional organization of networks associated with the amygdala in individuals with ASD and how these develop across the lifespan. Here, we use resting state fMRI to characterize seed-based amygdala FC to the whole brain in a cross-sectional sample of 53 typically developing (TD) individuals and 53 individuals with ASD (ages 7 to 38). Individuals with ASD showed hypoconnectivity of

the bilateral amygdala with visual processing regions, including the lateral occipital cortex and fusiform gyrus, compared with TD controls. An interaction was found between age and group in connectivity of the amygdala with the medial prefrontal cortex (mPFC), hippocampus, parahippocampal gyrus, thalamus, striatum, anterior cingulate cortex, insula, and fusiform gyrus. In children and adolescents with ASD, a negative relationship emerged between social symptoms of ASD, measured using the Autism Diagnostic Observation Schedule, and connectivity of the bilateral amygdala with the mPFC, such that higher amygdala-mPFC connectivity was associated with reduced severity of reciprocal social interaction. These findings demonstrate that atypical intrinsic amygdala connectivity is evident in individuals with ASD, undergoes extensive changes across development, and may be linked to the deficits in social and affective processes seen in ASD.

## 3-D-44 Prosocial behavior in childhood and its neural correlates: A pilot, test and replication study

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Prosocial behavior is an important component of social life, as it enables us to help and comfort others in distress. Studies have shown that the observation of social exclusion might elicit prosocial behavior in young children, but the neural mechanisms are yet unknown. We studied the behavior and neural correlates of observing social exclusion and subsequent prosocial compensating behavior in three samples: a pilot sample (N = 19) to generate hypotheses, and a test (N=27) and replication sample (N=26) to test these hypotheses. In all samples participants (aged 7-10) played a four-player Prosocial Cyberball Game in which participants could toss balls to three other players. When one player was excluded by the other players, the participant could compensate for this exclusion by tossing the ball more often to the excluded player. We found that children in all three samples showed prosocial behavior by tossing significantly more balls to the excluded player than to the other two players. On a neural level, we compared the event of the tossing of the ball to any of the players to receiving the ball from any of the players, and found activity in the left postcentral gyrus and right supplementary motor area. This finding was replicated in all three samples. Activity specific for prosocial events is currently being investigated. To conclude, we replicated that children show prosocial behavior upon observed exclusion by compensating for that exclusion. Exploration of neural correlates of prosocial behavior during the Prosocial Cyberball Game is in progress.

## 3-D-45 The effects of early adversity on amygdala-prefrontal circuitry during emotional face processing in children and adolescents

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Early adverse caregiving represents a potent stressor that has been associated with heightened emotional reactivity and risk for internalizing problems. Previous research shows that previously institutionalized (PI) youth with a history of institutional care show heightened amygdala reactivity and altered amygdala-mPFC connectivity when viewing negative stimuli (e.g. fearful faces). However, the effect of early adversity on neuro-affective processing across positive, negative and neutral stimuli has not been well delineated. In the

current study, 37 PI children and adolescents (ages 6-18) and 39 comparisons completed an emotion matching fMRI task designed to probe the neural processing of happy, angry and neutral facial expressions. Participants viewed a target facial expression (e.g. angry) and chose which of the two following facial expressions (e.g. angry, neutral) matched the emotion of the target. Results showed that PI youth had greater amygdala reactivity relative to comparisons regardless of valence. PPI analyses at the whole-brain level revealed a significant Group x age interaction, such that the PI group showed altered age-related changes in amygdala-vmPFC connectivity to Happy faces relative to comparisons. Importantly, amygdala-vmPFC connectivity to Happy faces is associated internalizing symptoms within the PI group, with stronger positive connectivity predicting fewer internalizing problems. The current results highlight the role of amygdala-prefrontal circuitry in predicting risk versus resilience for internalizing problems following early adversity.

## 3-F-46 Learning to inhibit: A pedagogical intervention to overcome systematic difficulties in fundamental academic learnings in primary school

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We will first present new findings here suggesting that some systematic difficulties in school are due to problems with the component of executive functions known as inhibitory control. Examples of the kinds of cognitive challenges that require inhibitory control in school are a) whether to use a singular or plural tense verb when the subject of a sentence is "the friends of my sister" or "the dog of the neighbors" (Lanoë et al, 2016), b) to discriminate letters with mirror-image counterparts (b/d or p/q, Ahr et al., 2016; Borst et al., 2015), or c) to solve arithmetic word problem such as "Bill has 20 marbles. He has 5 more marbles than John. How many marbles does John have?" (Lubin et al., 2013; in press). We will present data showing that pedagogical interventions based on training the inhibition of misleading strategies (or reasoning biases) not only improve logical reasoning to a greater extent than ones based solely on verbal logic per se (Houdé, 2007; Houdé et al., 2000; Houdé & Moutier, 1996; Moutier & Houdé, 2003) but also help children in the classroom overcome systematic difficulties to a greater extent than traditional curricula (Lubin et al., 2012).

## 3-F-47 Parents' decontextualized talk during early childhood predicts the neural bases of narrative processing in later childhood

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Early parental language input quantity and quality strongly predict children's later language development. Among different measures of input quality, parents' decontextualized utterances about abstract topics uniquely predict children's language outcomes, stronger than parental background factors and parental input quantity. Little is known about relations between early parental input and the neurobiology of language. We assessed parental language input quantity and quality during naturalistic parent-child interactions of 17 dyads at child age 30 months. When children were 7-9 years old, we administered a narrative comprehension task in a scanner using fMRI. We found that the higher was the amount of decontextualized talk children received at 2.5 years of age, the higher was the recruitment of bilateral middle and superior temporal cortices. The lower was the amount of decontextualized input, the higher was the recruitment of bilateral superior/inferior parietal, premotor cortices, and angular gyrus. In narrative processing, the former set of regions are involved in semantic processing, synthesis of ongoing story, whereas the latter are involved in visuo-spatial mental

building. No significant relations between neural activation and parental socioeconomic status or parent input quantity were observed. Our results add to the existing literature examining the role of experience in shaping the neurobiology of language. They suggest that children respond adaptively to their early environments by relying on different neural systems to succeed at academically-relevant tasks.

## 3-F-48 Natural language processing of fMRI reveals cognitive learning induced changes in brain circuit dynamics

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Although it has been argued that learning shapes cognitive development by altering brain structure and function, to date very few studies have examined learning-related changes in functional brain dynamics in children, especially in academic domain like mathematics. Progress in the field has been hampered by a lack of appropriate computational techniques to investigate functional brain dynamics in fMRI. Here we overcome limitations of extant methods by developing and applying novel natural language processing-based statistical learning technique to uncover math learning related changes in dynamic/time-varying functional interactions of large-scale brain circuits important for mathematical cognition in children. Thirty-five children in grade 3 (ages 8-9y), a critical period for acquisition of basic mathematical skills, participated in an 8-wk of one-to-one math tutoring designed to strengthen arithmetic fluency and number knowledge. A significant improvement in the accuracy and speed of math problem solving was observed with tutoring. Critically, the improvement in performance was accompanied with more frequent functional coupling between the numerical processing circuit anchored in the intraparietal sulcus and domain general systems including cognitive control anchored in the VLPFC, with tutoring. Our findings suggest that reconfiguration of brain circuit dynamics in response to math tutoring contributes to efficient integration of numerical and cognitive control processes, and plays a critical role in the development of specialized cognitive skills in children.

## 3-G-49 Pre-delusional Symptom Severity Predicts Accelerated Gray Matter Reduction and Ventricular Enlargement in Prodromal Youth who Develop Psychosis

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A recent prospective longitudinal neuroimaging study of 274 prodromal risk syndrome subjects in North American Prodrome Longitudinal Study (NAPLS) revealed that those who later developed full-blown psychotic symptoms exhibited accelerated gray matter loss and third ventricle expansion around the time of onset of psychosis. However, the relationship between attenuated psychotic symptoms and changes in neuroanatomical structure at the whole-brain level has not been previously examined. In this longitudinal structural MRI study, we investigated whether symptom severity as measured by the Scale of Prodromal Symptoms (SOPS) predicted the accelerated gray matter decline in 274 CHR cases, including 35 who converted to psychosis. Higher levels of unusual thought content (pre-delusional) symptoms at baseline were associated with a steeper rate of gray matter loss in the prefrontal cortex bilaterally and ventricular enlargement among converters. In contrast, there was no association found among non-converters. In addition, ventricular expansion is linked in time to progressive reduction of gray matter, rather than to structural changes in proximal subcortical regions, in a broadly distributed set of cortical regions among CHR youth, including prefrontal cortex, superior temporal gyrus, and parietal cortices. Steeper gray matter loss seems to be unique

to those CHR individuals with higher levels of sub-psychotic pre-delusional symptoms that acutely worsens to full-blown psychosis, and it may reflect pathophysiological processing driving emergence of psychosis.

## 3-G-50 Using Accelerometry to Describe Normative Motor Patterns across Development

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An important outcome of pediatric rehabilitation is meaningful participation in age appropriate life activities. Measures of real-world activity with high inter-rater reliability are missing. The aim of the current study is to describe a normative sample of real-life bilateral upper extremity activity patterns using accelerometry in typically developing children aged 0-17 years. Cross-sectional data were collected from typically developing children (4 girls, 4 boys per 1-year age bin). Participants wore accelerometer bracelets on both wrists for 4 x 25 hours epochs within a one-month period. Caregivers completed a motor capacity screen. Over a period of 18 months, a total of 617 bilateral accelerometry visits were collected from 158 children 0-17 years of age whose parents reported no history or motor or neurological impairment. Fourteen families did not complete the full study protocol. Younger children (0-3 years) accelerometry data reflected equal bilateral activity counts, indicating equal use of both upper extremities over a 25-hours period. Older children favor their dominant hand, with use ratios similar to healthy adults. Accelerometry is a feasible method for identifying normative motor patterns in children of all ages. Accelerometry is a cost-effective, objective method for describing real-world use of bilateral upper extremities. Further research is needed to describe development of activity across childhood.

## 3-G-51 The Role of the Hippocampus in Context Processing and Disruption following Child Trauma

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People react differently to environmental stimuli depending on context. For example, a response to a gunshot would be different at a public park than at a shooting range. But little is known about contextual processing in humans. We examine how context encoding varies across development, identify underlying neural correlates, and examine individual differences related to environmental experiences. Children (n=60; 8-19 years, 24 with violence exposure) completed a context-encoding task. Participants completed a delayed match-to-sample task involving neutral, happy, and angry facial cues embedded in background scenes inside a scanner. Outside the scanner, participants completed a memory test for contextual information. Posterior hippocampus was recruited during context encoding; greater hippocampal volume and activation predicted improved context memory. Context memory and hippocampal correlates did not vary with age. Children exposed to violence had reduced hippocampal volume, poor memory of contexts paired with angry faces, and reduced hippocampal activation and greater functional connectivity between hippocampus and ventrolateral prefrontal cortex on angry trials. Greater connectivity predicted reduced context memory. Posterior hippocampus appears to play a role in context encoding, a process that is intact by middle childhood and stable thereafter. Trauma disrupts context encoding in the presence of threat, which is likely due to greater vlPFC-dependent attentional orienting towards threat cues at the expense of hippocampal-dependent processing of the broader context.

## 3-G-52 Theta relative power distinguishes young children with ADHD from those without ADHD

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Resting electroencephalogram (EEG) in children diagnosed with ADHD (8 years and older) is characterized by elevated theta power compared to peers (Loo 2012). Few studies have examined resting EEG in children with and without ADHD younger than 7. Because early childhood is an important period for the stabilization of symptoms of ADHD (Campbell 2010; Law 2014), learning more about the neural correlates of ADHD in this age range is of primary importance. Participants (N=160) ages 3-7 years old participated in an eyes-open resting EEG. Recordings were acquired using an EGI 128 HydroCel Sensor Net in NetStation (250Hz sampling, 0.1-100.0 Hz bp filter) and the power density spectrum was extracted using EEGLab in Matlab. Participants met criteria for ADHD (N=22 prescribed stimulant medication; N=60 were not) or did not meet criteria for ADHD (N=78). All children participated off medication. Children who met criteria for ADHD and were not prescribed stimulant medication had significantly increased relative power in the theta frequency band [5-8Hz] compared to controls and ADHD participants who had been prescribed medication. Relative theta power was higher across parietal electrodes ($p<0.05$, FDR corrected). Additionally, there was a significant age x diagnosis interaction for relative theta power across parietal and right frontal electrodes ($p<0.05$, FDR corrected). The presence of a main effect of ADHD in addition to an age by diagnosis interaction likely reflects existing deficits in attention as well as extensive developmental change in this population in early childhood.