P-1-1 How Therapist Language Influences the Developing Brain: A Look at Adolescent Binge Drinkers

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Understanding how the developing brain responds to therapist behaviors may provide a critical link to improve youth addiction treatment. We enrolled 17 binge drinkers (60% male; M age = 17; range 14-19) and conducted a motivational interviewing (MI) session. From the MI, we extracted 5 client statements in favor of changing drinking behavior (change talk; CT; e.g., "I've been blacking out") and 5 in favor of staying the same (sustain talk; ST; e.g., "I don't want to stop drinking"). We created 2 therapist responses, those proscribed in MI (MI-consistent; e.g., reflections, "You're worried what might happen to you.") and 2 standard responses, discouraged in MI (non-MI consistent; e.g., closed questions; e.g., "Have you tried quitting?"). In the fMRI, we pseudo-randomly presented youth with 4 runs of the following combinations: (1) client CT/therapist reflection, (2) client CT/therapist closed question, (3) client ST/therapist reflection, and (4) client ST/therapist closed question. Contrasting BOLD response during [(1) and (3)] vs. [(2) and (4)], MI-consistent (vs. non-MI consistent) therapist behaviors were significantly associated with activation in brain areas including the IFG ($z = 2.27$; $p < .05$). Using the same contrast, greater BOLD response was significantly associated with better treatment outcomes (fewer binge drinking days 1 month post-treatment; activation in right IFG $z = 3.38$, $d = 1.95$ and insula $z = 2.238$, $d = 1.29$). This is a first step in understanding how certain therapist behaviors may influence the adolescent brain, and response to addictions treatment.

P-2-2 Compliments and insults: Neurobiological and behavioral responses to social prediction error in adolescence

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Adolescents are more sensitive to reward than children or adults (Galvan et al., 2006). They find social feedback rewarding (Jones et al., 2014) and show increased neural sensitivity to unexpected reward, or reward prediction error (PE) (Cohen et al., 2010). Given the adolescent-unique sensitivity to social feedback and prediction error, the goal of this study was to determine the effects of social PE on behavioral and neurobiological responses in adolescents. We developed a social PE task in which participants predicted how a friend would rate characteristics about them. We modified the friend's responses to create trials that were worse than, equal to, and better than what the target expected. We presented expectations and outcomes to the target during an fMRI scan. Social PE was assessed behaviorally by examining response times following presentation of a positive (compliment), negative (insult), or same response compared to what the target expected their friend would report. There was a significant difference in RT, such that adolescents were slowest to react following insults, faster to compliments, and fastest after viewing same PE statements. Preliminary fMRI analyses reveal that adolescents activate regions implicated in: conflict (anterior cingulate cortex) and social cognition

(mPFC) when viewing insults; reward sensitivity (orbitofrontal cortex) when viewing compliments; and emotion regulation (amygdala) when viewing same PE statements. These data suggest that frontolimbic circuitry in the adolescent brain discriminates between social positive and negative PE.

P-2-4 Altered reward processing in adolescent binge drinkers relates to largest number of drinks recently consumed: a longitudinal fMRI study

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Binge drinking may be neurotoxic to the developing brain. In alcoholics, abnormal reward processing could be related to long-term alcohol abuse, since alcohol exerts actions on mesolimbic reward circuitry. Therefore, it is important to understand the effects of binge drinking on reward processing during adolescence, since alcohol may perturb incentive motivational circuitry and increase risk for long-term abuse. At their first study visit, all participants (age 1=15.02±.88) were free of heavy alcohol use. Youth completed a modified version of the Wheel of Fortune (WOF) functional magnetic resonance imaging (fMRI) task, and reported on past 90 day alcohol use every 3 months following their baseline visit. Fourteen youth reported binge drinking on ≥ 3 occasions within a 90 day period (≥ 4 drinks/occasion), and repeated the WOF task during a second visit. Binge-drinking youth were matched to 13 alcohol-naïve youth who were also scanned during a second visit (age 2=16.60±1.21). Groups were matched on demographic characteristics at both time points. Whole-brain analyses showed significant group differences in reward processing (Win vs. NoWin) at time 2 in ventromedial prefrontal cortex (VMPFC), cerebellum, and cuneus, after controlling for baseline brain activity in these regions ($p/\alpha < 0.05$). Largest number of drinks consumed in one setting in the last 90 days was significantly negatively correlated with brain response in the VMPFC, suggesting that initiation of binge drinking during adolescence can alter brain activity in regions implicated in reward processing.

P-1-5 Developmental sex differences in resting state functional connectivity with sub-regions of the amygdala

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Functional connectivity between amygdalar and cortical brain regions undergoes dramatic development across adolescence. In addition, there are sex differences in structural maturation of amygdalar and frontoparietal gray matter, in which girls peak about two years earlier than boys, potentially impacting concomitant functional connectivity of these brain regions. Previous work has found distinct functional connectivity, as measured with resting state functional connectivity magnetic resonance imaging (rs-fcMRI), across amygdalar nuclei; however, sex differences in rs-fc were not studied explicitly. As such, the current study examined the effects of age, sex and their interaction (controlling for motion) on rs-fc of amygdalar nuclei (laterobasal [LB] and superficial [SF]) with cortical brain regions in a large adolescent sample (n=122; ages 12-16 years) using rs-fcMRI partial correlation analyses ($Z>2.25$, $p<.05$). Results

indicated that age was negatively related with rs-fc between left parietooccipital brain regions and bilateral LB and right SF. The effect of sex was such that girls had increased rs-fc, relative to boys, between amygdalar sub-regions (except left SF) and similar regions that were related to age. This sex difference generally diminished across development, which was supported with sex-by-age interaction analyses. These results highlight the importance of considering the effects of sex in developmental samples, especially when measuring neural properties, such as rs-fc, that may be influenced by sexually dimorphic rates of maturation of underlying anatomy.

P-2-6 What has neuroimaging taught us about adolescent social development?

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Traditional psychological measures have established that dramatic changes take place in social behavior across adolescence. Over the past decade a number of functional neuroimaging studies have also addressed this topic. The lessons learned from the neuroimaging approach will be the focus of this presentation. The neuroimaging approach has added several dimensions which complement behavioral and self-report methods. First, neuroimaging studies have highlighted the complexity involved in even relatively simple social interactions. Sub processes like perception, emotional attribution, mentalizing, learning and contextual modulation are all embedded within simple social interchanges. Neuroimaging has helped to parse complex interactions into units more amenable to brain systems analysis. Second, neuroimaging studies are helping to integrate the findings from social interactions into larger literature on more established brain-behavior relations. Social behavior is often interpreted in the context of paradigms like learning, response selection, and emotional modulation of stimulus processing. This approach has helped integrate social based research into a wider developmental neuroscience perspective. Above all the recent wave of neuroimaging studies have demonstrated the immense complexity of social behavior and highlighted the fact that we are in early days of understanding the neural basis of developmental changes.

P-1-7 Child Trauma and Cortical Structure

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The past decade has witnessed a proliferation of research on adverse childhood experiences (ACEs) and developmental outcomes, including neural structure and function. However, this work has suffered from lack of attention to identifying the underlying dimensions of environmental experience that might plausibly influence neural development. We recently proposed a novel conceptual framework for understanding the impact of ACEs on neural development that differentiates between experiences of deprivation and threat and makes distinct predictions about their impact on neural structure and function (Sheridan & McLaughlin, in press). Specifically, our model predicts that exposure to significant threat (i.e., trauma exposure) is associated with reduced thickness of the ventromedial prefrontal cortex

(vmPFC), due to chronic vmPFC under-recruitment resulting from stronger representation of conditioned fear than extinction memories. We tested our predictions regarding threat and cortical structure in a sample of 42 adolescents (aged 13-19 years). Half of the sample had exposure to physical or sexual abuse, and half were age and gender matched controls. Consistent with our hypothesis, maltreated adolescents had significantly reduced thickness and volume of vmPFC and the parahippocampal gyrus, after false discovery rate (FDR) correction. Maltreatment severity was negatively associated with vmPFC and parahippocampal gyrus thickness and volume. Results are discussed with regards to the distinction between deprivation and threat exposure in influencing structural development.

P-2-8 Peer reputation influences brain function during social evaluation in youth at risk for social anxiety

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Shifts in social behavior are normative in adolescence, a critical phase of development during which children with social reticence (SR) are at risk for social anxiety. Childhood SR, expressed as unoccupied, solitary behavior in the presence of peers, reflects a conflict between the desire to engage in social interactions, and the fear of receiving negative social feedback. Childhood SR may have lasting effects on brain function during social interactions. The fMRI-based Virtual School paradigm was developed to assess this relationship by modeling uncertainty during the anticipation and receipt of social feedback during ongoing peer interactions. Maternal report and behavioral observation at 2, 4, 5, and 7yrs of age were used to generate a composite SR score. At 11yrs, high (N=28) and low (N=24) SR subjects underwent fMRI. They visited classrooms populated by purported peers with a reputation for being 'nice,' 'unpredictable,' or 'mean.' A cue indicated a peer was generating a comment (anticipation), prior to comment receipt (feedback). For high-vs-low SR, there was greater activity in: 1) dorsal anterior cingulate, amygdala, and insula when anticipating unpredictable, relative to predictably nice or mean feedback; 2) ventral striatum upon receipt of positive, relative to negative feedback. Thus, SR predicts heighten engagement in conflict and threat-processing circuits for anticipated unpredictable social evaluation, and heightened engagement of learning and reward regions during receipt positive feedback. Data to be discussed in terms of risk for social anxiety.

P-1-9 Different prefrontal-subcortical circuits support chronic and strategic emotion regulation across adolescence

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From birth to old age, emotions are a critical part of our everyday experience. Yet, the way in which we regulate our emotions changes dramatically with age. These changes may occur because of age-related

improvements in effortful self-regulation ("strategic regulation") or because of general and relatively automatic age-related changes in how we respond to emotional stimuli ("chronic regulation"). The present study sought to test these two possibilities by examining behavioral and neural responses to negative images in 99 individuals ranging in age from 6-23 years. To assess strategic regulation ('Far' trials), on one-third of trials participants reappraised images in a more distant and objective way while on the other two-thirds of trials, participants responded in an un-regulated fashion so as to assess baseline emotional responding. Age predicted enhanced strategic regulatory control as indexed by decreased negative affect and reduced dorsal amygdala activity on Far trials. These age-related reductions in the amygdala response were mediated by enhanced recruitment of ventrolateral prefrontal regions implicated in cognitive control. In addition to age effects identified specifically in the regulation condition, age predicted chronically reduced recruitment of the basolateral amygdala - an effect that was mediated by reduced recruitment of ventromedial prefrontal cortex and enhanced recruitment of dorsolateral prefrontal cortex. These data suggest that distinct prefrontal-amygdala circuits support age-related changes in chronic and strategic emotion regulation.

P-2-10 Disrupted functional connectivity of working memory in adolencent-onset phychosis

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Adolescent-onset psychosis (AOP) is associated with more severe cognitive deficits relative to the adult-onset form. Yet little is known about the association between cognitive abilities and abnormal neural activation in AOP. This study seeks to better understand developmental effects on functional networks relevant to working memory (WM) processing in AOP patients relative to controls. Methods: Functional MRI (fMRI) scans were obtained from AOP patients and demographically matched healthy controls (N=17 per group; ages 12-22). Subjects performed an in-scanner spatial capacity task that parametrically varied WM load. fMRI data were analyzed with FSL. Psychophysiological interaction analyses contrasted high and low WM loads within bilateral dorsolateral prefrontal cortex (dlPFC) regions of interest. Results: Relative to controls, AOP patients had decreased overall task performance, increased frontal neural activity at the highest WM demand, and reduced connectivity between the left dlPFC and temporo-parietal regions at higher vs. lower WM loads. At high WM loads, patients also evidenced differentially increased cingulate activation with increasing age. Conclusion: Patterns of aberrant activity among AOP patients parallel findings from adult literature. Findings suggest dysregulation of WM circuitry in AOP patients compared to controls and different patterns of age-associated changes in neural activity. Future studies will utilize measures of structural integrity of WM circuitry to further assess these relationships and possible developmental endophenotypes of psychosis.

P-1-11 Ambiguity aversion is absent in 8-year-old children

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Ambiguity aversion, in which risky gambles with known probabilities are preferred over ambiguous gambles with unknown probabilities, has been well documented in adults. Here, we report a lack of ambiguity aversion in 35 children (8-9y) in two tasks. In Task 1, participants chose between risky versus ambiguous gambles to win 2 or 12 points that were later converted into meaningful rewards. We found that children did not exhibit ambiguity aversion and chose the risky and ambiguous gambles equally often (chose risk 51.2% of the time). A comparison group of 39 adults (19-28y) did exhibit ambiguity aversion: they chose the risky gambles over the ambiguous gambles 59.4% of the time, significantly more often than chance and significantly more often than the children did (Cohen's d = 0.30). In Task 2, participants indicated their maximum willingness to pay (WTP) to play each risky and ambiguous gamble. Children did not exhibit ambiguity aversion and expressed an equal WTP for the risky and ambiguous gambles (difference of 0.03 points). Adults did exhibit ambiguity aversion: they were willing to pay significantly more for the risky gambles than the ambiguous gambles (difference of 0.75 points). Prior work shows that risk aversion emerges over human development, and our study suggests that ambiguity aversion may exhibit a similar developmental pattern. As risk and ambiguity have been shown to have distinct neural representations in adults, future studies should investigate the neural underpinnings of this developmental difference in ambiguity preferences.

P-2-12 Maternal History of Depression Impacts Neural Responses to Emotional Stimuli in School-Age Children

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People with a family history of depression are at a highly increased risk for developing depression themselves compared to people without a family history. Research has suggested that adolescents with at least one parent with a history of lifetime depression show alterations in neural responses to emotional stimuli similar to adults with depression. This type of neural alteration may be a risk factor for developing depression or may serve as an endophenotypic marker of risk. The current study sought to extend previous findings to test effects of maternal depression on neural responses to emotional face stimuli among psychiatrically healthy school age children (7-10 years old). Preliminary data suggests greater amygdala responses to emotional face viewing among children with a maternal history of depression as compared to those with no maternal history of any psychopathology. Follow-up analyses will extend upon these results and previous studies by testing the effects of additional risk factors, including current depression symptoms among mothers, sub-threshold depression symptomology and emotion regulation skills among children, and stressful life events experienced by the children. Overall, these results will help to elucidate the effects of maternal history of depression and other risk factors on limbic responses to emotional stimuli in a diverse sample of psychiatrically healthy children. This may be particularly important to guide understandings of risk for depression among pediatric populations.

P-1-13 Long-term Alterations in Prefrontal Structural and Functional Brain Development in Adolescents Born Moderately Preterm

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Children born very preterm (PT) show alterations in structural brain development that relate to individual differences in executive function (EF). Few studies have investigated neurobehavioral development in children born only moderately PT (32-34 weeks gestation). We characterized the intersection of cognitive, structural, and functional brain development in adolescents born moderately PT (n=17) versus full term controls (n=27). PT children had no history of major perinatal complications, other than being born early. Children completed EF tasks measuring verbal and spatial working memory, an anatomical MRI scan, and a fMRI task assessing cognitive conflict and inhibitory control. Volumetric segmentation of structural scans was performed using Freesurfer. Functional imaging data will be analyzed using FSL. PT adolescents had reduced prefrontal cortex volume in comparison to full term children, driven by reductions in left middle and inferior frontal regions. Adolescents born moderately PT performed more poorly on spatial and verbal working memory measures; within the PT group, working memory scores were predicted by prefrontal volume, suggesting a meaningful relationship between behavioral indices of EF and volumetric development. fMRI analyses are in progress; we expect that adolescents born PT will exhibit differences in functional activity extent and/or magnitude in frontostriatal regions. The current study provides evidence that more subtle variations in early environmental experience, including moderately PT birth, impact multiple aspects of prefrontal development.

P-2-14 Effects of Depression Risk and Current Depressive Symptoms on Striatal Response to Incentives in Healthy Children

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Response to reward within the striatum has been the focus of much recent investigation from typical developmental and psychopathology perspectives. However, few studies have investigated responses to both positive and negative incentive feedback particularly within healthy child populations. The current study aims to investigate whether reduced striatal response to reward and enhanced reactivity to loss, patterns observed in adults/adolescents with/at risk for Major Depressive Disorder (MDD), relates to MDD risk, current depressive symptoms, or both in healthy pre/early-pubertal children. Healthy children (7-10 years) at relatively increased risk for MDD, based upon maternal MDD history (N=12), and at lower risk for MDD (N=17) completed an fMRI card-guessing game using candy pieces delivered post-scan as an incentive (data collection ongoing). A voxel-wise repeated measure ANOVA investigating effects of group (risk, control) and feedback (gain, neutral, loss) was conducted within a striatal mask. Group significantly interacted with feedback type within the ventral striatum. Post-hoc regressions indicated that compared to controls, high-risk children displayed both greater deactivation following loss feedback and reduced activation to gain relative to neutral feedback. Response to neutral feedback did not differ based on group and group differences were unrelated to current depressive symptoms. Results indicate

that reduced striatal response to reward and enhanced loss reactivity may in-fact be a marker of risk evident prior to both puberty and onset of pathology.

P-1-15 Structural brain correlates of executive engagement in children's working memory.

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Although the development of executive functions has been extensively investigated at a neurofunctional level, studies of the structural relationships with brain anatomy are still scarce. Based on our previous published meta-analysis of fMRI studies examining executive functions in children (Houdé, Rossi, et al. 2010), we investigated 6 a priori regions of interest (ROIs): the left anterior insular cortex (AIC), the left and the right supplementary motor areas, the right middle and superior frontal gyri, and the left precentral gyrus. Structural MRI scans were acquired from 22 typically developing children of 10 years of age. Local gray matter (GM) volumes, assessed automatically using a standard VBM approach, were correlated with executive and storage working memory capacities evaluated using backward and forward digit span tasks, respectively. We found an association between smaller GM volume in the left AIC and high backward memory span while GM volumes in the a priori ROIs were not linked with forward memory span. These results were corroborated by a whole-brain a priori free analysis that revealed a significant negative correlation in the frontal and prefrontal regions, including the left AIC, with the backward memory span, and in the right inferior parietal lobe, with the forward memory span. Taken together, these results suggest a distinct and specific association between regional GM volume and the executive component vs. the storage component of working memory in children. Moreover, they support a key role for the AIC in the executive network of children.

P-2-16 Are there sensitive periods for learning in adolescence?

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The human brain goes through a prolonged series of changes throughout adolescence, including significant development of the frontal cortex and the parietal cortex. These areas are involved in high-level cognitive functions such as the manipulation of abstract thoughts, decision making, working memory, planning and numerical skills. Due to protracted development of these brain regions, it has been suggested that adolescence is an ideal time window to acquire and strengthen specific skills such as processing numerical quantities and abstract reasoning. Our study aimed to investigate whether adolescence is a sensitive period for learning. We have developed an online training platform, and have asked participants aged 11-30 to practice a computerised task 5 times a week for 4 weeks. Participants were split into three training groups: (i) relational reasoning; (ii) numerical discrimination; and (iii) face processing. In order to compare the effect of online training we tested participants at three time points: before training, after training and 6 months after training. During testing all groups completed each of

these three training tasks and two transfer tasks; working memory, and face memory. It was hypothesised that learning would be maximal for the participants in the relational reasoning and numerical discrimination training groups in early adolescence compared with other age groups on the tasks on which those participants trained. This study provides a first attempt at measuring sensitive periods in adolescence and the results might have implications for education.

P-1-17 Qualitative but not quantitative structural characteristics of the anterior cingulate cortex predict inhibitory control during childhood: A longitudinal study.

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Difficulties in the ability to control impulses and to inhibit a prepotent response are related to the pathophysiology of several psychiatric conditions. In healthy subjects, inhibitory control (IC) efficiency in childhood is a strong predictor of academic and professional successes later in life. The dorsal anterior cingulate cortex (ACC) is one of the core structures of the brain functional network responsible for IC. Although quantitative structural brain characteristics of the dorsal ACC cortex contribute to IC efficiency, the qualitative structural brain characteristics contributing to the IC development are less-understood. Using anatomical magnetic resonance imaging, we investigated whether the sulcal pattern of the ACC, a stable qualitative characteristic of the brain determined in utero, predicts the development of IC. In this study, the same children performed Stroop tasks at age 5 and 9. We found that the ACC sulcal pattern predicted IC efficiency both at age 5 and 9: ACC sulcal pattern at age 5 explained 27% of the Stroop interference score variability at age 5 and 25% at age 9. The cortical thickness of the ACC was marginally related to IC efficiency at age 5 ($p < .06$) but not at age 9 ($p < .19$). Thus we evidence that the sulcal pattern of the ACC - a qualitative structural characteristic of the brain determined in utero that is not affected by maturation and learning after birth - but not the thickness of the ACC - a quantitative characteristic of the brain - predicts the development of the IC efficiency during childhood.

P-2-18 Interactions between anxiety and cognition in adolescents and adults

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Anxiety interferes with cognitive functioning, and conversely, cognitive control can be applied to prevent disruption from anxiety. This interplay between anxiety and cognition is particularly important to consider during adolescence, when the incidence of anxiety peaks and cognitive demands increase sharply. We showed in healthy adults that cognitive load modulates the effects of induced-anxiety on working memory (WM). We now extend these findings to adolescents, who may be at greater risk for the deleterious effects of anxiety because of the continuing neurodevelopment involving cognitive and emotion processes. 25 healthy adolescents (M=13.9 yo) were compared to 25 healthy adults (28.9 yo) on an n-back WM task using 3 loads (1-, 2- and 3-back). The task was administered in threat (random

presentation of an aversive scream) and safe (no scream) conditions. State-anxiety was assessed via EMG recording of eye-blink startle responses and self-reports. Findings replicated our previous work, showing that high WM load (3-back) reduced the increased startle response to threat, and, in turn, prevented the deleterious effects of induced-anxiety on cognitive performance in both adults and adolescents. Taken together, this study suggests that adolescents already have in place the mechanisms that spare performance on difficult task from the interference of anxiety. These results will be discussed in the context of limited resources theories.

P-1-19 The role of non-numerical stimulus features in the development of the number sense

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Since Piaget there has been great interest and controversy over how children make decisions about number and how non-numerical perceptual features affect their judgments. We use a novel approach to quantitatively address this problem. We tested 4- and 6-year-old children and adults on a non-symbolic numerical comparison task. In the task, element size and spacing were manipulated orthogonally to the numerical ratio between the choice arrays. We fit a generalized linear model to determine the relative weight that participants placed on the number, size, and spacing of array elements. Although perceptual feature bias was present in both six-year-old children and adults, both weighted number more heavily than other stimulus features. Four-year-old children, however, were more biased by size and spacing compared to older children and adults. Our paradigm also allows us to differentiate between the acuity of the number sense and the biasing effects of non-numerical features. In 6-year-old children, number sense acuity was correlated with symbolic math performance, but non-numerical bias was not related to math performance or to other measures of inhibition. This suggests that the link between inhibition and math performance is unlikely to be mediated by visual feature bias. Our data suggest that decreasing the influence of non-numerical features is an important aspect of the development of the number sense. Our next step will be to use fMRI to ask whether there are important neural changes that occur as children move towards the adult-like pattern of numerical decision-making.

P-2-20 Adolescent binge-drinkers show atypical brain activity during risky decision-making

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Due to continued neurodevelopment, adolescence is a period of increased vulnerability to the neurotoxic effects of alcohol. Several developing brain regions play a key role in executive functioning, such as risk-based decision-making. The current study investigated risk-taking behavior and associated brain response using a Wheel of Fortune decision-making task and functional magnetic resonance imaging in binge-drinking (n=9) and alcohol-naïve (n=9) adolescents. All youth had used little to no alcohol at baseline; however, youth included in the binge-drinking sample had reached criterion (≥4 drinks/episode; ≥3 episodes) prior to follow-up. Results indicated that while there were no task-specific

behavioral differences between bingers and controls at baseline or follow-up, controlling for baseline brain activity, at follow-up, bingers showed significantly greater brain response during risky vs. safe decisions than controls in orbitofrontal, medial, and dorsolateral prefrontal cortex, anterior cingulate and occipital cortex, as well as thalamus and striatum. This appeared to be driven by less activation (or even deactivation) in these brain regions during safe decisions in bingeing adolescents at follow-up, an effect similar to that seen in controls and binge drinkers at baseline, but in contrast to the heightened activation of these regions in controls at follow-up. These results indicate that alcohol exposure in binge-drinking adolescents may lead to disruptions in the typical maturation process of the neural control systems utilized in risk-based decision-making.

P-1-21 Sex differences in the development of brain activity during inhibitory control

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Go/Nogo response inhibition becomes more difficult as the number of Go trials increase prior to a Nogo trial ('preceding context effect'). With this parametric manipulation, girls perform better than boys on easy trials at age 10, while both sexes improve on more difficult trials with age; suggesting that inhibitory circuitry may develop differently in boys and girls. Using a Go/Nogo fMRI task, we examined the neural basis of these sex differences in 61 youth (36 girls), ages 10-17. The preceding context effect was created by Nogo trials occurring after 1, 3, or 5 Go trials, with 5 as the difficult response. After standard fMRI processing, age*sex*Nogo type (1,3,5) interactions were seen in inhibition-related BOLD signals (Nogo-Go contrast)($p<.01$, corrected). At age 10, girls (but not boys) recruited parietal, precentral, supplementary motor, cingulate, and right putamen, with the greatest activation seen for more difficult trials. Rather, boys recruited these regions for all Nogo conditions at older ages. Boys also used the lateral occipital, right hippocampus, brainstem, and cerebellum. Boys decreased but girls increased activity in these regions with age. Girls perform better on easy Nogo trials and show greater activation in the cingulate and parietal regions by age 10. As these regions are activated in adults, these results may reflect earlier maturation of inhibitory circuitry in girls compared to boys. Response inhibition development between the sexes may be relevant to understanding sex differences in impulsive behaviors during adolescence.

P-2-22 Limbic hyper-reactivity to threatening social stimuli following early life deprivation

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Early adverse experience has been shown to impact both structural and functional brain development. In particular, emotion processing regions show long-term vulnerability to early maltreatment or deprivation. The current study compared 31 adolescents (12-14 yrs) with a history of early deprivation to 26 adolescent controls. Adolescents in the deprivation group were internationally adopted from orphanage care prior to age 2. Controls were raised in the U.S. by their biological families. Adolescents

viewed angry, fearful, happy, and neutral faces and rated how afraid the face made them feel. Post-institutionalized (PI) adolescents showed greater amygdala activity ($p<.01$) in response to angry faces than controls did. This difference was driven by the later adopted PIs (13-24 mos), who showed greater amygdala activity than both controls and earlier adopted PIs (4-12 mos). PI youth also showed greater activity in other regions associated with emotion processing, including the insula, ACC, and mPFC ($p<.005$). A similar pattern of group differences was observed for neutral faces compared to fixation (PI > Ctrl in amygdala and vmPFC). Later age at adoption also was correlated with greater recruitment of emotion regulation regions in response to neutral faces. Previous work suggests that neutral faces may be interpreted differently by children and adolescents. These results indicate that early institutional deprivation, and longer durations of institutional care, heightens limbic responses to threatening social stimuli.

P-1-23 Numerical performances in schoolchildren is associated with grey-matter differences: A voxel-based morphometry study

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Are individual differences in numerical performance sustained by variations in grey matter volume in schoolchildren? One of the first mathematics learning called the numerical transcoding involves associating a quantity (analog system) with its symbol (oral or written numerical word). The aim of the present study is to provide insights into the relationships between individual differences in numerical transcoding and brain structure in typically achieving schoolchildren (N=22). We used the Voxel-Based Morphometry method to search for possible structural brain differences between two groups of 10-year-old schoolchildren whose performance differed only in numerical transcoding between analog and symbolic systems. Our results indicated that children with low numerical proficiency have less grey matter volume in the parietal areas (particularly in the left intraparietal sulcus and the bilateral angular gyri) and occipito-temporal areas. All the identified regions have previously been shown to be functionally involved in transcoding between analog and symbolic numerical systems. In conclusion, our study, linking numerical transcoding proficiency with brain structure in healthy schoolchildren, contributes to a better understanding of how mathematics learning can modulate brain regions involved in the numerical transcoding.

P-2-24 Sex Differences in Intrinsic Brain Organization in Children with ADHD

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ADHD is the most commonly diagnosed developmental disorder. While it afflicts both sexes, important sexual dimorphisms regarding symptomatology and functional outcome exist. Despite recent theories proposing that dysfunction in functional connectivity distributed across multiple brain networks is an important contributor to ADHD, studies investigating the neural basis of these sex differences have focused mainly on individual brain regions or structural connections. Therefore, we probed sex differences in functional brain organization during rest in children with ADHD and typically developing (TD) children undergoing fMRI. We applied graph theoretical tools to functional connectivity estimates to calculate global measures of network organization across the entire brain in a 2 (diagnosis) x 2 (sex) design, using groups that were matched for age (range: 8-12 y.o.) and average motion during the scan. We focused on local clustering of connections and average length of the paths connecting node pairs. While overall, children with ADHD displayed increased local clustering and longer path lengths (decreased long-range connections) than TD children, we observed significant diagnosis x sex interactions. Specifically, the main effects of diagnosis were stronger in girls than in boys. Further inspection revealed that they were limited to the oldest third of girls. This indicates that the dysfunctional connectivity underlying ADHD may develop around puberty and, like puberty, earlier in girls than in boys. This highlights the importance of understanding sex differences in ADHD.

P-1-25 The association between condom use and the developing adolescent brain

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Adolescence is a unique neurodevelopmental period, during which youth begin to make decisions about whether and when to initiate sexual intercourse, and what preventive health care steps to utilize. Many factors influence this decision-making process, including cognitive, social and emotional factors, such as decision-making in 'hot' contexts. We therefore sought to determine how safer sexual behavior (protected sexual intercourse) would correlate with white matter connectivity between regions implicated in social and emotional functioning (e.g., the amygdala, ventral striatum, orbitofrontal cortex) and cognitive functioning (e.g., the dorsolateral prefrontal cortex, anterior and posterior cingulate, and temporo-parietal cortices). We evaluated these questions through voxel wise fractional anisotropy (FA) using Tract Based Spatial Statistics (TBSS) in 38 high-risk, sexually-active youth (M age=15.47; age range=14-17; 68% male). Specifically, we compared differences in FA across 19 infrequent condom users and a demographically matched set of 19 frequent condom users. We found that within this sample, FA was significantly higher in the "consistent condom use" group in the genu and body of the corpus callosum, the superior corona radiata, and the anterior corona radiata ($p<0.05$, FWE corrected) when compared to the "infrequent condom use" group. Ultimately, these data suggest that FA measures of white matter in key frontal lobe regions is related to more health protective behavior for sexually active youth (e.g., more consistent condom use).

P-2-26 Developmental neuroanatomic endophenotypes of executive function in 22q11.2 Deletion Syndrome

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Executive function (EF) is a broad term that refers to prefrontally-mediated cognitive functions such as attention, impulsivity, and motivation. Important developmental changes occur in these functions in adolescence, which may be relevant to emerging psychopathology in vulnerable individuals. 22q11.2 Deletion Syndrome (22qDS) is a neurogenetic disorder that results from a 1.5-3Mb deletion, and is associated with elevated rates of psychotic symptoms, dopaminergic dysregulation and impaired EF. We hypothesized that EF in 22qDS patients would be related to prefrontal cortical structure, and that this relationship would differ from that in controls. We administered the Behavior Rating Inventory of Executive Function (BRIEF) to assess real-world EF in 22qDS patients and controls (age 10-17). Using FreeSurfer's vertex-by-vertex cortical thickness pipeline, we found a cluster in the right orbitofrontal cortex (rOFC), in which greater thickness was associated with better EF in controls, but worse EF in 22qDS patients ($p<0.001$). At the neurocognitive level we found increased inhibitory dyscontrol, as assessed via the Continuous Performance Task-Independent Pairs, in 22qDS patients, which was significantly related to rOFC thickness. This relationship was not observed in controls. These results demonstrate that the EF deficits in 22qDS related to structure of the rOFC may be mediated by impulsive tendencies. Current analyses are investigating developmental aspects of this phenomenon.

P-1-27 Longitudinal imaging of long range axon dynamics at the synaptic level across development in mice.

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Maturation of the brain across adolescence includes changes in long range connectivity of brain regions and refinement of synaptic connections. However, longitudinal imaging studies of connectivity in humans lack the resolution to observe synapse formation and elimination. We therefore use mice as a model system to study adolescent brain development at the synaptic level. In vivo 2-photon imaging through a cranial window allows us to resolve presynaptic axonal boutons and postsynaptic dendritic spines of genetically labeled cell types in living mice across many days. In the present study, we focused on the maturation of long range axons in association cortex. We imaged axons projecting from the orbitofrontal cortex (OFC) and basolateral amygdala (BLA) to the dorsomedial prefrontal cortex (dmPFC), as well as local axons and dendrites of pyramidal cells in the dmPFC. Juvenile (P24) and adult (P60) mice were imaged at timepoints where we have previously shown that mice differ in flexible decision making and motivation (Johnson&Wilbrecht 2011). We found that long range axons are still actively growing into the dmPFC in juvenile mice. We also found that synaptic connections were less stable in young mice. The relative rates of formation and elimination of synaptic structures depended on both age and cell type. Our results underline the dynamic nature of brain development, and illustrate that specific circuits follow unique trajectories of maturation. These findings provide a normative baseline for future studies of the impact of early life stress on neural circuit development.

P-2-28 Anonymous Peers Increase Engagement of Reward Processing Regions during Adolescent Risk-Taking

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Recent research has demonstrated that risk-taking in the presence of peers during adolescence is a result of heightened reward sensitivity. The current study extends these findings by exploring the effects of peer observation on decision-making when adolescents are explicitly given the information needed to make an informed decision. In an fMRI paradigm, 40 adolescents (ages 15-17) completed a probabilistic gambling task either in the presence of a virtual, anonymous peer or alone. In the task, adolescents were presented with a series of gambles for which the reward and loss probabilities were visually presented and asked to decide whether they would like to play (take a risk) or pass on the gamble. Adolescents who completed the task in the presence of a peer opted to play more often than adolescents who completed the task alone. A whole brain analysis demonstrated that adolescents in the peer condition had higher striatal recruitment during risk-taking than adolescents who completed the task alone. Furthermore, the influence of peers was higher on trials with the greatest probability of loss. In fact, decisions to play on these trials were paired with increased OFC activation in the peer condition. These results suggest that anonymous peers increase risk-taking behavior through heightened engagement of reward processing regions even when the information needed to make an informed decision is provided. This may help explain why programs aimed at reducing risk-taking by providing information regarding the likelihood of negative consequences are only marginally effective.

P-1-29 The unity and diversity framework of executive functions in childhood

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Cognitive development partly depends on the maturation of executive functions (EFs), the control processes that regulate behavior. Among adults, a consistent pattern of three distinct EF components (inhibition, shifting, and updating) emerges in factor analyses. By adulthood, EFs are highly heritable; genetic influences operate broadly on a general executive control dimension and specifically on individual components. The factor structure of executive functions is less clear among school-aged children, with some studies replicating the three-factor solution, and others reporting less differentiated two- and one-factor solutions. Additionally, the degree to which genetic influences operate on developing EFs in childhood is unknown. The current study evaluates the phenotypic, genetic, and environmental structure of EFs in middle childhood. We make use of extensive in-lab measurement of cognitive abilities and EFs in a sample of 8- to 13-year-old twins recruited from the Texas Twin Project. Confirmatory factor analyses indicate strong evidence for a broad executive control dimension, with weaker evidence for separable EF components. This broad executive factor is distinguishable from general intelligence and can be extracted even when general intelligence is partialled from the EF tasks. We report the results of multivariate behavioral genetic decompositions and test whether genetic and environmental influences on EF act through common phenotypic pathways. We discuss hypothesized neurobiological mechanisms underlying this framework and implications for cognitive neuroscience.

P-2-30 Changes in cortical thickness in 6-year-old children open their mind to a global vision of the world

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Even if objectively presented with similar visual stimuli, children younger than 6 years of age exhibit a strong attraction to local visual information (e.g., the trees), whereas children older than 6 years of age, similar to adults, exhibit a visual bias toward global information (e.g., the forest). Here, we studied the cortical thickness changes that underlie this bias shift from local to global visual information. Two groups, matched for age, gender, and handedness, were formed from a total of 30 children who were 6 years old, and both groups performed a traditional global/local visual task. The first group presented a local visual bias, and the other group presented a global visual bias. The results indicated that, compared with the local visual bias group, children with a global visual bias exhibited (1) decreased cortical thickness in the bilateral occipital regions and (2) increased cortical thickness in the left fronto-parietal regions. These findings constitute the first structural study that supports the view that both synaptic pruning (i.e., decreased cortical thickness) and expansion mechanisms (i.e., increased cortical thickness) co-occur to allow healthy children to develop a global perception of the visual world.

P-1-31 Medial temporal lobe structure relates to individual differences in memory and reasoning ability across development

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Recent work has highlighted the protracted developmental trajectory of the medial temporal lobes (MTL), which comprise the hippocampus and immediately adjacent cortex. Yet, the MTL is heterogeneous, with a number of subregions that differ in cellular makeup, anatomical connectivity, and hypothesized function. It has been proposed that neuroanatomical maturation of the MTL may be similarly heterogeneous, underscoring the need for an investigation of the development of MTL subregions and its relationship to behavior. For instance, prior work has shown dissociable changes along the anterior-posterior hippocampal axis, with volume decreases in the hippocampal head and increases in the hippocampal body across development. Parallel volume-performance relationships have also been observed among adults, with smaller hippocampal heads and larger hippocampal bodies relating to superior memory. While the MTL has been widely implicated in the encoding and retrieval of episodic memories, it is also thought to play a role in reasoning tasks requiring consideration of relational information. Here, we turn our investigation to the relationship between MTL structures and individual differences in memory and reasoning ability from ages 6-30. We demonstrate a relationship between MTL subregion volumes and performance on memory and reasoning tasks, with smaller

hippocampal heads being associated with superior reasoning. These findings are consistent with the role of MTL structures in relational coding across development.

P-2-32 Impaired Executive Control and Reward Functioning in Pediatric Obesity

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Obesity, in both adults and children, has been associated with poor impulse control in eating behavior and higher sensitivity to food-related cues. These deficits have been posited to stem from decreased fronto-striatal dopaminergic functioning leading to deficits of executive control and alterations of the mesolimbic dopaminergic system leading to higher reward sensitivity. It is unknown, however, whether executive and reward functioning deficits are present in obese children at baseline, that is, in the absence of the food context. Thus, we examined two core executive control processes, working memory and response inhibition, and reward-related decision making in the absence of food-cues in children who were obese (>95th percentile for height and weight) and not obese (<95th percentile). For the n-back working memory task, accuracy was significantly worse for the higher load (2-back) but did not differ for the lower load (1-back). For response inhibition on the Stop-signal reaction time task, obese children had worse inhibitory control, reflected by a larger stop-signal delay, relative to the not-obese children. Additionally, obese children were more sensitive to monetary reward on the Balloon Analog Risk Taking Task, on which a balloon has to be pumped gaining points which are lost of it pops; obese children had more pops than not-obese children. Together, these results show worse executive control and greater reward sensitivity in the absence of food-cues in pediatric obesity, a potential consequence of altered dopaminergic functioning.

P-1-33 Cortical anatomical correlates of developing language performance in relation to socioeconomic and genetic factors: A cautionary tale

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Developmental studies have begun to investigate correlations between neuroanatomical features and performance on cognitive measures, including language functioning. To date, none have controlled for both socioeconomic and genetic factors suspected of having an impact on these developing brain-behavior relationships. In this study, we used the Pediatric Imaging, Neurocognition, and Genetics (PING) Study Database and Analysis Portal to examine relationships between language performance and cortical anatomy, testing the contributing effects of both socioeconomic status (household income, parental education) and genetically derived ethnic ancestry. In more than 1000 subjects aged 3 to 20

years, cortical surface area, thickness, and volume showed highly significant associations with vocabulary and reading measures from the NIH Toolbox Cognition Battery, controlling for the effects of both sex and age. Overall, surface area explained the most variability, showing robust region-varying effects on statistical maps. However, when SES and ethnic ancestry were used as covariates, all previously significant associations between language performance and cortical anatomy diminished, even when separately controlled. These results provide the first large-scale comparison of the effect magnitudes of socioeconomic and genetic factors on the relationship between the developing cortical anatomy and language functioning. The findings strongly argue for the importance of population stratification controls in interpreting links between cognitive performance and the developing brain morphology.

P-2-34 Testing the dual-processing model of adolescent brain development using resting-state connectivity analyses

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Adolescence has been associated with an imbalance between relatively earlier developing subcortical-affective and later developing cortical-control regions. This has been related to specific adolescent behaviors, such as greater social-emotional reactivity, but also to larger flexibility in goal-directed action. The neural developmental trajectories of affective and control regions have often been studied separately. A functional-network analysis provides a promising method to concurrently test the development of both systems. To this end, resting-state and task-related fMRI were collected of 269 participants (ages 8-25). To combine insights, our resting-state analysis focused on key regions observed in task-related neural activation: The nucleus accumbens (nAcc) derived from a reward-paradigm, and the dorsal lateral prefrontal cortex (dlPFC) derived from a rule-learning paradigm. Seed-based resting-state analysis showed an age-related decrease in connectivity between the nAcc and the orbital frontal cortex. The dlPFC showed an age-related increase in connectivity with the vlPFC and dorsal striatum. We also observed an age-related decrease in connectivity between the dlPFC and (pre)motor cortex. These patterns confirm different development trajectories for components of adolescent brain function, and indicate 1) strengthening of connectivity between regions that support control and learning; 2) more independent functioning of regions that support i) motor and control networks (possibly accounting for a decrease in impulsivity), and ii) motivational and control networks.

P-1-35 Brain Development of Irritability: A fNIRS study of Executive Function in Preschool Children

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Irritability is a dimensional construct that that is normally distributed within the preschool population, but, at the high end, is a risk factor for the development of psychiatric disorders. Little is known about the neural mechanisms which underlie irritability and predict its associated clinical outcomes. The

preschool age is also a period of accelerated growth in executive function, raising the possibility that normative executive function might separate those irritable children who will go on to develop psychiatric disorders from those will maintain irritable temperament, but continue to mature normally. We used functional near infrared spectroscopy (fNIRS) to examine working memory in the prefrontal cortex of 58 typically-developing preschoolers (age 3-5). Children were introduced to a very sneaky monkey who likes to hide his bananas in trees. Using a touch-screen computer, they were asked to remember the location of the hidden bananas after a 2 or 6 second delay. We found significant activity in the lateral and middle PFC during working memory [$t(56)\geq 2.5$, $p<.05$]. Age was a significant covariate in small portions of the lateral PFC [$t(55)\geq 2.0$, $p<.05$], while irritability was a significant covariate in a larger portion of the middle PFC [$t(55)\geq 2.0$, $p<.05$]. This indicates that more irritable children increased PFC activation during working memory, which may underlie their normative behavioral functioning. This study fits into a growing research program mapping the neural circuitry of irritable temperament using multi-modal imaging.

P-2-36 Functional Differences In Stroop Response For Alcohol- And Marijuana-Using High-Risk Youth

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Decision-making is integral to risk for and likelihood of using substances during adolescence. Despite studies showing the relevance of different decision-making abilities, including inhibition and task switching, few have examined these neural processes among high-risk, substance-using youth. Thus, this study explored associations between alcohol and marijuana use and functional differences in Stroop performance among ethnically-diverse, high-risk youth. Consistent with prior work in this area, 81 youth (M age=15.9) were grouped for analysis by level of use [low ALC-low MJ (LOW, n=33); high ALC-low MJ (ALC, n=24); and high ALC-high MJ (ALC MJ, n=24)]. Stroop data were modeled using factors for trial (congruent or incongruent), group, and trialxgroup interaction. Analyses identified group difference (uncorrected $p<.005$) in the right middle frontal gyrus (MFG), right inferior frontal gyrus (IFG), left cuneus, and left precentral gyrus. LOW showed greater activation than ALC in all 4 clusters, and greater activation than ALC MJ in each cluster except MFG. ALC MJ showed greater activation than ALC in MFG. A significant trialxgroup interaction was found in the right posterior cingulate and left cuneus, with ALC and ALC MJ showing less activation than LOW during incongruent but not congruent trials. Overall, limited differences in neural response were observed for marijuana use. However, because the LOW group showed higher performance accuracy ($p=.09$), we suggest that these data may reflect the interference of alcohol use in task-related inhibition processing abilities.

P-1-37 Sex differences in the relation between socioeconomic status and longitudinal trajectories of brain function

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Neural functions supporting inhibitory control, as reflected by neuroimaging metrics of error monitoring, mature during adolescence. Because inhibitory control and neural aberrations related to error-monitoring associate with risk for affective disorders in adolescence, we examined factors that may affect neurodevelopmental trajectories. Socioeconomic status (SES) is a risk factor for affective disorders that may also impact neurodevelopment. As few studies examine how environmental factors influence longitudinal neurodevelopmental trajectories, we examined a broad environmental metric: SES of an individual's childhood neighborhood. Here, 95 healthy youth (8-21yrs; 50 F) completed an oculomotor inhibitory control task annually for up to 6 years. We indexed error-monitoring neural activation in the dorsal anterior cingulate cortex (dACC) during error trials and obtained metrics of neighborhood SES by linking addresses to census tract data. We estimated each individual's growth curve of dACC activation by hierarchical linear models and used metrics of neighborhood SES to predict slopes of individual growth curves. There was no impact of neighborhood SES on slopes of dACC activation across participants (all ps > .124), but trend-level effects suggested interactions between sex and neighborhood education (% with h.s. degree) on dACC slopes (t=-1.778, p = .079). Only in males did neighborhood SES impact dACC trajectories (M: t=-2.163, p = .036; F: t=.201, p = .841). Results may clarify the variable impact of environmental factors on brain development.

P-2-38 Neural mediators of the intergenerational transmission of family conflict behavior

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In a longitudinal study, parents' aggressive family conflict behaviors when adolescents were in mid-adolescence (average age 15.5) predicted youths' aversive conflict behaviors towards parents in late adolescence (average age 17.3). Among a subsample of 21 adolescents who underwent fMRI scanning proximate to the second assessment, this relationship was mediated by neural activation to a task in which adolescents were asked to rate their parents' emotions as seen in brief video clips. Youth from more aggressive family environments showed deactivation (when viewing parents) in areas associated with salience and socioemotional processing, including the insula, amygdala, hippocampus, thalamus, putamen, and precuneus. These patterns of activation were, in turn, associated with youths' aversive conflict behaviors directed towards parents. Regions that statistically mediated the association between parent aggression and subsequent child-to-parent aggression (using a bootstrapping test of mediation) included the insula, right amygdala, thalamus, and putamen. These results suggest that youth exposed to greater parental aggression show dampened limbic system activation when interpreting parents' emotions, which may in turn contribute to youths' aversive behavior towards their parents.

P-1-39 Development of Affective Control: Evidence Based on the Face-word Stroop Task with task relevant emotional stimuli

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Development of conflict monitoring and adaptation across happy, sad, and angry emotions was examined. Two Experiments were conducted based on the Stroop task with faces with emotional expressions as targets and emotion words (Happy/Sad/Anger) as distracters written over the face with ninety participants including children (mean age: 10.4 years) adolescents (mean age: 14.7 years) and adults (mean age: 22.6 years). Experiment-1 with happy and sad faces showed significant yet comparable conflict adaptation effect when the previous trial was incongruent for both emotions. Conflict resolution was faster in the current trial when preceded by sad target faces. Experiment-2 with happy and angry emotional stimuli showed stronger adaptation effect for angry faces among adults. Children showed comparable yet significant adaptation effects for happy, sad and angry emotions. However, adolescents show better conflict adaptation for angry facial expressions as compared to happy and sad facial expressions which could be due to the salience of threat stimuli i e., angry faces in the current study. These results suggest that negative emotions (sad and angry) show greater involvement of proactive control mechanisms. Overall better adaptation effects for negative emotions could be due to narrowing of attention induced by task relevant sad and angry facial expressions. Developmentally, emotion conflict monitoring and adaptation may follow protracted development for positive emotions as compared to the presence of adaptation effect for high arousing negative emotions among adolescents.

P-2-40 The braking and accelerating adolescent brain predicts school performance: a graph theoretical approach to longitudinal cognitive and affective data in young-adolescents

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In most children, the cognitive control system and the socio-emotional system get into balance during adolescence. That is, during development, adolescents make greater use of cognitive control skills to modify attention, emotion and behavior in service of long-term 'adult' goals (cf. Crone & Dahl, 2012). We took a graph theoretical approach to focus on individual differences in this balancing process, in relation to school performance. 392 adolescents performed experimental tasks measuring cognitive control and risk taking propensity. In addition, we indexed school performance, and collected survey data on a.o., pubertal status, need for arousal, need for social support, and resistance to peer influence. Mean age at T1 was 13.5 years (SD=.7); a follow-up study (T2) was done one year later. At T1, the results indicate substantial individual differences between the 'delayed' group (i.e., children who repeated a grade) and the 'on track' group (i.e., children who experienced no delay in their school career). Need for arousal was the most central node in both the on track and delayed group; it was however much more central in the delayed group. Interestingly, the network in the delayed group is much more complex than in the on track group (more connections related to socio-emotional function). The pattern of results at T2 was largely compatible with the results of T1. Together, the results suggest that in the delayed group, the cognitive/socio-emotional balance tips more easily to the socio-emotional side. Results will be discussed vis-à-vis implications for education.

P-1-41 Typical development of basal ganglia, hippocampus, amygdala and cerebellum from age 7 to 24

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Developmental imaging studies show that cortical grey matter decreases in volume during childhood and adolescence. However, considerably less research has adressed the development of subcortical regions (caudate, putamen, pallidum, accumbens, thalamus, amygdala, hippocampus and the cerebellar cortex), in particular not in longitudinal designs. We used the automatic labeling procedure in FreeSurfer to estimate the developmental trajectories of the volume of these subcortical structures in 147 participants (age 7.0-24.3 years old, 94 males; 53 females) of whom 53 participants were scanned twice or more. A total of 223 magnetic resonance imaging (MRI) scans (acquired at 1.5-T) were analyzed. Substantial diversity in the developmental trajectories was observed between the different subcortical gray matter structures: the volume of caudate, putamen and nucleus accumbens decreased with age, whereas volume of hippocampus, amygdala, pallidum and cerebellum showed an inverted U-shaped developmental trajectory. The thalamus showed an initial small increase in volume followed by a slight decrease. All structures had larger volume in males than females over the whole age range, except for the cerebellum that had a sexually dimorphic developmental trajectory. Thus, subcortical structures appear to not yet be fully developed in childhood, similar to the cerebral cortex, and continue to show maturational changes into adolescence. In addition, there is substantial heterogeneity between the developmental trajectories of these structures.

P-2-42 Approach or avoid? The role of emotional information on cognitive control during adolescence

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Adolescence is a period characterised by the increased use of cognitive control to regulate behaviour. However, the degree to which adolescents are exposed to emotionally salient information is thought to influence their ability to recruit these cognitive control processes. Previous work has shown that adolescents' impulse control is reduced when faced with rewarding stimuli such as happy faces. It is unclear if adolescents have similar difficulties regulating their behaviour when faced with negative emotional information. An emotional go/nogo fMRI task was administered to 35 adolescents (M age= 12.95, SD=1.57; 43% male). The task was refined during an initial pilot phase where 126 adolescents rated the valence of 96 (32 per emotion) calm, happy and angry faces, and indicated how realistic they found the expressions. The data were used to select the 10 faces (5 male, 5 female) the participants found most realistic, and that had the highest valence ratings in the happy and angry conditions, and the most neutral ratings in the calm condition. The mean valence ratings in the happy and angry conditions were balanced. Initial analyses of the behavioural data showed that participants made few errors during

go trials, and there was no difference between the emotions in the number of errors made. During no-go trials a difference in error rates was found between emotions, with participants exhibiting more difficulties in inhibiting their response to both happy and angry faces than to calm faces. The fMRI data is currently being analysed and will be presented at the conference.

P-1-43 Shape analysis reveals spatially independent substrates for concurrent and future working memory in the putamen

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Recent works suggested that neuroimaging data contain spatially independent information about future and concurrent working memory (WM) in children (Ullman, J Neurosci, 2014; Darki, Cereb Cortex, 2014). While concurrent WM correlates are mainly located in the fronto-parietal cortex, WM development information are located in the striatum and striato-frontal connections. Here we investigated if local volume in the subcortical nuclei, measured using shape analysis (Patenaude, NeuroImage, 2011), is informative about concurrent and future WM capacity, and if such information is spatially independent. Subcortical nuclei shape analysis was carried out on a longitudinal dataset involving subjects aged 8-20 years. Local volume for each subcortical nucleus at baseline (t1) was entered in a Supporting Vector Regression (SVR), with WM capacity measured two years later (t2) as dependent variable. Local volume in the striatum at t1 significantly predicted WM capacity at t2. Univariate analyses performed using concurrent WM capacity and WM capacity prediction (from SVR) showed that concurrent and future capacity were related to local volume respectively in the dorso-medial and in the ventro-lateral putamen. Probabilistic tractography showed that these regions were mainly connected to dorsolateral and orbitofrontal cortex, respectively. These results suggest that different putaminal subregions are related to concurrent and future WM, supporting the idea that concurrent WM capacity and WM development, i.e. plasticity, may be related to different neural substrates.

P-2-44 Adolescents show unique behavioral and neural responses to unpredictable positive cues

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Prior work has demonstrated that adolescents are especially sensitive to rewards and appetitive emotional cues, and reward-related responses have been shown to interfere with cognitive processes. Though uncertainty potentiates affective responding and is a key feature in models of reinforcement learning, it is not clear whether predictability is a key mediating variable on a) adolescent reward sensitivity, and b) the capacity for affective cues to disrupt cognition. In this study, participants aged 9-22 (n>100) underwent fMRI scanning while completing an emotion-interference task that manipulated predictability and valence. Participants viewed blocks of positive and neutral scenes while completing a concurrent task (determining if indoors or outdoors). For predictable blocks, participants viewed a countdown clock ticking the number of seconds until an image would appear, and for unpredictable

blocks, participants viewed a clock ticking randomly. Overall, response times were slower for the unpredictably relative to the predictably timed images, and for positive images relative to neutral images. Early adolescents were slower to respond to unpredictable events, suggesting a developmental pattern of behavioral sensitivity to uncertainty. FMRI results revealed that late adolescents showed heightened responses for unpredictable positive cues in the striatum and insula, regions commonly implicated in reward processing and salience detection. Overall, these findings suggest that uncertainty is a critical mediating factor of adolescent sensitivity to affectively positive cues.

P-1-45 Temporal uncertainty differentially impacts concurrent task performance across development

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Prior research has demonstrated that emotionally salient information is particularly effective in capturing attention, thereby reducing performance on a concurrent task. This decrement is termed emotional interference. Preliminary data are mounting to suggest adolescents are selectively more influenced by emotional cues while trying to engage in a cognitive regulation task relative to children and adults. Previously, our group has shown that healthy adults show exaggerated emotional interference in the face of unpredictable emotional cues. In the current study, we aimed to elucidate how temporal uncertainty moderates emotional interference across development. A large sample (N>100) of participants (9-22 years) completed an fMRI scan during an emotional interference task. Negative and neutral pictures from the International Affective Picture System were presented following either chronological (predictable) or random (unpredictable) countdown to the picture cue. While viewing the pictures, participants were instructed to complete a concurrent judgment task - deciding whether the scene displayed takes place indoors or outdoors. Overall, reaction time was slowed during negative pictures compared to neutral pictures. Responses were also slowed in unpredictable contexts compared to predictable contexts. An interaction between predictability and age indicated that children and late adolescents demonstrated exaggerated slowing in unpredictable contexts. Current analyses target identification of neural substrates that drive this interaction between temporal uncertainty and age.

P-2-46 Classification of children with Tourette syndrome using resting state functional connectivity MRI

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Tourette syndrome (TS) is a neurodevelopmental disorder characterized by motor and vocal tics. While tics constitute the major diagnostic symptom, TS is quite heterogeneous, involves other psychiatric and cognitive symptoms, and has varied symptom progression. Current understanding of the brain mechanisms underlying TS is based on research that, in general, treats individuals with TS as essentially

homogenous. Thus, the field is in need of approaches that can capture the underlying features of an individual's particular presentation. In the present study, we aimed to take a first step toward this goal and make diagnostic predictions about individuals using resting state functional connectivity (RSFC) MRI. We applied support vector machine (SVM) classification to test whether patterns in whole-brain RSFC can predict diagnostic group membership. RSFC data from 42 children with TS (8-15 yrs) and 42 tic-free controls (age, IQ, in-scanner movement matched) underwent strict volume censoring and preprocessing procedures to minimize motion-related effects. While univariate tests revealed no significant group differences, SVM (multivariate) was able to classify group membership with 74% accuracy ($p < .001$). Interrogation of the RSFC features driving the classification revealed an aggregation of functional connections that were both within and between brain networks. These results support the contention that multivariate methods may be necessary to capture the complexity of some brain disorders, and hold promise for predicting prognosis and treatment outcome for individuals with TS.

P-1-47 The neural systems predicting long-term outcomes in arithmetic development varies as a function of parental socioeconomic status

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Socioeconomic status (SES) is a strong predictor of individual differences in children's arithmetic skill. Although not much is known about the neurocognitive representations that underlie SES-related effects in math achievement, recent research suggests that SES effects on neural basis of arithmetic might vary as a function of skill. In subtraction, with increasing skill higher SES children might rely on brain regions that subserve verbal representations, whereas higher skill low SES children might rely on spatial representations. Here we examined the longitudinal effects of the SES differences in the neural bases of single-digit subtraction in school-aged children (N=33). SES was measured by a composite measure of parental education in years and occupation. We identified brain regions supporting verbal and spatial representations via independent localizer scans. Children's math skill was measured using Woodcock-Johnson Math Fluency measure at 9-12 years of age, and again 2.5 years later. The brain regions that predicted growth over the 2.5 years varied as a function of SES. Growth for higher SES children was associated with greater recruitment of brain regions that subserve verbal representations, i.e. left IFG, whereas growth for lower SES children was associated with greater recruitment of brain regions that subserve spatial representations, i.e. right precuneus/IPS. Enriched environmental experiences might aid children's mappings of verbal representations to mathematical representations. Lack of such input might lead to greater reliance on spatial representations.

P-2-48 The association of cortical structure and cognition with classroom-based stress

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Brain maturation is thought to be the output of biological, genetic and environmental variables, and involves a series of progressive and regressive cellular events that are thought to be the hallmarks of neural plasticity. Research suggests that early life experiences, such as those in the home, may have effects on the developmental trajectory of brain structures important for healthy development. Further, evidence indicates that various stress factors, such as those experienced in the school environment, may interact with various cognitive measures and therefore, healthy cortical development. One thousand and ninety typically developing, socioeconomically diverse children were recruited, ranging in age from 3 to 20 years (Mean= 12.13, SD=4.93). We analyzed associations between measures of vocabulary, reading, and working memory and cortical area, cortical volume and cortical thickness without anatomical constraints while controlling for age, gender, scanner device, and genetic ancestry. In a subset of the participants we tested the relationship between self-reported stress in the classroom environment and the same cortical measures while controlling for gender, scanner device, and genetic ancestry. Performance on all cognitive measures was positively and significantly related to greater cortical area and volume, and there was a positive relationship between working memory and cortical thickness. Stress in the classroom did not mediate these relationships. Future studies that investigate the associations with environmental stressors are needed.

P-1-49 Anxious children exhibit an altered pattern of cortical maturation

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High trait anxiety is a heritable risk factor for many adverse neuropsychiatric and socioeconomic outcomes. Anxiety has been linked to differences in both structure and function of the ventromedial prefrontal cortex (VMPFC). However, the nature of this relationship remains poorly understood, particularly in children and adolescents. Advances in structural imaging methods have made it possible to probe correlates of anxiety in cortical surface area and cortical thickness separately. Distinguishing between these two broad cortical phenotypes may be important because they are both heritable, but the genes that influence these processes appear to be different. The present study examined relationships between cortical surface area and thickness of the VMPFC and a self-report measure of anxiety (SCARED-R) in 287 youths aged 7 to 20. Age-related changes in these relationships were also examined. The VMPFC was defined using a genetically-informed, data-driven parcellation of the cortex. High anxiety was associated with decreased relative expansion of the VMPFC and global cortical thinning, but these associations diminished with age. The two cortical phenotypes contributed additively to the prediction of anxiety. Exploratory maps show a similar areal reduction in the precuneus associated with anxiety in older subjects, as well as age-unrelated areal expansion in the inferior parietal cortex. These findings suggest that a high anxiety phenotype in children is characterized by both delayed expansion of the VMPFC and an altered trajectory of global cortical thinning.

P-2-50 The direct section of the arcuate fasciculus is specifically predictive of longitudinal reading outcomes

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Crossmodal integration is critical for reading. We previously demonstrated that fractional anisotropy (FA) in the arcuate fasciculus is specifically related to crossmodal reading performance and brain activity. However, the arcuate may be subdivisible into a direct segment arcing from the temporal to the inferior frontal lobe, and an anterior fronto-parietal part. Here, we examine longitudinal data from 20 typical children to determine whether initial coherence in the direct or anterior subsections of the arcuate is predictive of reading three years later. The arcuate was divided using probabilistic tractography with several waypoint and exclusion masks; mean FA across each subtract was extracted for each participant. Time 2 reading (identification, fluency average) was predicted by both initial reading score and direct arcuate FA; FA remained significant even after partialing for variance accounted for by all reading measures and age. Participants with lower direct arcuate FAs demonstrated lower Time 2 reading scores (r=.328). Further, Time 1-2 change in reading was only significantly predicted by direct arcuate FA (r=.513). Participants with lower direct arcuate FA demonstrated decreasing reading standard scores, potentially reflecting lessened improvements due to continued inefficient crossmodal processing. As such, we demonstrate that the relationship between reading and the arcuate is specific to the direct section and that it predicts unique variance in reading outcomes. The arcuate may thus support crossmodal reading processing both initially and longitudinally.

P-1-51 Familial risk factors predict neural architectural differences in typically developing children and adolescents

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Familial history of substance abuse and other psychiatric illnesses is known to increase risk for these problems as well as other adverse outcomes in children and adolescents. However, the mechanisms by which these risks are conferred are poorly understood. One way in which risk may be conferred is through genetically- or experientially-mediated alterations in neural architecture. The present study examined this hypothesis using data from over 1000 subjects aged 3 to 20 years from the multi-site Pediatric Imaging, Neurocognition, and Genetics (PING) study. Generalized additive models were used to examine the effects of reported history of parental drug and/or alcohol problems, as well as bipolar disorder, on variability in cortical thickness and fractional anisotropy (FA) in the cingulum. Analyses indicated that subjects with reported history of drug or alcohol problems in one or both parents had globally thinner cortex. An interaction between gender and history of parental drug or alcohol problems was observed in cingulum FA and hemispheric asymmetry of cingulum FA. A similar interaction between gender and parental history of bipolar disorder was observed for hemispheric asymmetry of cingulum

FA. In male subjects only, these risk factors were associated with higher cingulum FA and relatively higher right than left cingulum FA. All results were significant independent of age, genetic ancestry, and socioeconomic status. These results suggest that familial risk factors may influence neural architectural development even in typically developing children and adolescents.

P-2-52 Early life food insecurity decreases flexibility in multiple choice reversal learning in adulthood

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In humans, early poverty-related adversity is associated with abnormal or delayed cognitive development. Food insecurity, a prevalent dimension of poverty, has been found to affect children's academic performance, but its effects on specific cognitive processes remain unknown. The purpose of this study is to examine the effects of early life food insecurity on cognitive flexibility in adulthood. P21, post-weaned mice, were assigned to a control, constant food restriction or food insecurity group for 20 days. Following this period, all mice had ad lib access to chow for 20 days. At P60-70, we tested all mice on discrimination and reversal of a 4-choice odor-based foraging task known to depend on the integrity of the rodent orbital and dorsomedial prefrontal cortex. In males, the three groups showed no differences in initial discrimination learning, but in the reversal phase of the task, males who had previously experienced food insecurity were significantly more perseverative than males who had experienced ad lib or constant food restriction schedules. No group differences were found in female mice. These data suggest that experience of food insecurity during the juvenile period can impact cognitive flexibility in adulthood, thus leading to potential deficits in exploratory and exploitative behavior throughout the life course.

P-1-53 Increased Attention to Social Stimuli in Preadolescent Macaques

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Face processing is a crucial component of primate social success. Recent human studies investigating face processing abilities in older children and adolescents showed a decrement in recognition of emotional expressions and identity during adolescence. These social cognitive changes are thought to be directly related to pubertal (hormonal) changes influencing the neural substrate mediating face processing. However, the contribution of hormonal changes to this late-developing neural circuitry has yet to be investigated. To this end, we thought to create a nonhuman primate model of adolescent social development that could be manipulated in more controlled and mechanistic studies. We began by following the development of attention towards social stimuli in 3 juvenile (14 months) and 1 adult (7 years) male rhesus macaques. Animals viewed video-clips of monkey faces displaying neutral, fearful, or threatening displays. Percent of fixations made on the face and body of the stimulus monkey and background were measured using a Tobii Eye Tracking system. Juvenile monkeys tended to fixate more on the stimulus monkey as compared to the adult ($p < .09$) for all face stimuli. Also, all monkeys fixated

more on fearful and aversive faces as compared to neutral faces ($p < 0.01$). These data indicate that juvenile monkeys demonstrate heightened interest in social stimuli, consistent with the increase in social awareness typically present during this period of nonhuman primate social development, yet have an adult-like preference for emotional stimuli. (Supported by MH 086947).

P-2-54 The importance of naps for generalization of verbs in habitual nappers and non-nappers

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Recent research demonstrates the importance of sleep for generalization of learning in infants after a 24-hr delay (Hupbach et al., 2009). By the preschool years children begin transitioning out of naps raising questions about the necessity of naps for learning during this transition. Prior research suggests that children in this transition can wait until nighttime sleep to consolidate rote memories (Kurdziel et al., 2013). How this transition impacts generalization of learning to new instances, is unknown. We investigated whether naps would differentially impact generalization of new verbs in 3-year-olds who are still napping habitually and those who are not. Children watched videos of girls performing two unfamiliar actions labeled as either blicking or rooping (e.g., Look, she's blicking!). Testing occurred after a 24 hour delay. Children either napped or stayed awake within 5 hours following training. At test, children were presented two videos side-by-side (one with a new girl performing blicking and one with a new girl performing rooping). Children were asked to point to the correct action when prompted with one of the words, with generalization reflected in mean accuracy across test trials. Children benefited from naps soon after learning whether they were habitual nappers (M=66%) or not (M=92%); however performance was at chance levels 24-hrs later in both of the wake conditions (Habitual-nappers: M=50%; habitual-nonnappers: M=44%). Naps appear to be critical for generalization of learning for at least a period after children have transitioned out of napping.

P-1-55 Deprivation and Threat: The impact of socioeconomic status and community violence on working memory

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Previous research has demonstrated that dorsolateral prefrontal cortex recruitment increases with load and presence of distractors during working memory encoding. It has been amply demonstrated that this effect of load on prefrontal activation increases across age from childhood through adulthood (Thomason, et al., 2008), however, the development of working memory filtering remains relatively unexplored. We recruited 64 individuals in late adolescence and early adulthood (mean age 18, sd=4.39) to participate in an fMRI study of visual-spatial working memory (McKnab & Klingberg, 2008). Participants were asked to remember the location of 2 or 4 stimuli. When 2 stimuli were presented they were sometimes presented with two distractors which participants were told to ignore. Images were

acquired at Harvard University on a 3T Siemens Tim Trio MRI scanner and analyzed using Freesurfer and FSL through Nipype. Age was unrelated to task performance, however, it influenced recruitment of the basal ganglia on filter trials. In addition, age predicted the link between basal ganglia activation and intraparietal sulcus recruitment on filter trials. Finally, filter trial recruitment, specifically, was affected by history of exposure to community violence linked to parental socioeconomic status. These results demonstrate the continued development of working memory into early adulthood and the importance of experience in shaping that development. They are discussed in light of emerging theories distinguishing between exposure to deprivation and threat (Sheridan & McLaughlin, under review).

P-2-56 Funding priorities for developmental translational research at NIMH

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This presentation will give a brief overview of current funding priorities for developmental cognitive research at NIMH with a special emphasis on developmental translational research. The Division of Developmental Translational Research (DDTR) supports an integrated program of research across basic behavioral/psychological processes, environmental processes, brain development, genetics, and developmental psychopathology. Of particular interest to participants of the FLUX conference, DDTR places special emphasis on the following: delineating neurobehavioral mechanisms responsible for the development of psychopathology, including critical and sensitive periods in brain development and the effects of sex, behavior, and experience on the brain; using behavioral phenotypes reflecting dimensional processes to maximize discovery of underlying neural systems and genes, and refining behavioral assessment tools so that they are comparable across age, species, and social experience; testing integrative models incorporating biological, behavioral, and experiential factors in the development of psychopathology, and using longitudinal research to track trajectories of risk and protection based on the combined and interactive influences among these factors.

P-1-57 Creativity in the Children's brain

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The ability to generate new ideas and creative solutions to problems is crucial for adapting to a changing and open-ended environment. Although considerable efforts in the field of cognitive neuroscience have been recently leveled at identifying the processes involved in creative ideas generation, little is known about neural basis of creativity in children. In order to reveal the cortical structures involved in creative thinking in children, we investigate the relationship between the ability to generate creative ideas and the thickness of the cortex in 10 years old children. Children performed the "egg task", in which they had

to propose as many creative solutions as possible to prevent a hen's egg to break when dropped from a height of 10 meters. We assessed the creativity of the solutions with two classical criteria: fluidity (i.e., the capacity to generate alternative ideas as measured by the number of solutions) and flexibility (i.e., the number of categories of solutions). Using FreeSurfer, we obtained an estimate for each child of the cortical thickness in the ROIs linked to creativity in adults. Critically, we found a positive correlation (a) between fluidity and the thickness of the posterior cingulate gyrus and (b) between flexibility and the cortical thickness of the supramarginal gyrus, the superior temporal gyrus, and the right inferior frontal gyrus. Taken together, these results suggest that the generation of creative ideas in children involves not only the activation and the retrieval of semantic information but also the executive control brain network.

P-2-58 Using mouse models to investigate the effects of accelerated puberty onset on development of the prefrontal cortex

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Adolescence and puberty are associated with remarkable changes in behavior as well as structural and functional reorganization of the prefrontal cortex (PFC). However it is difficult to differentiate which aspects of PFC maturation are dependent on puberty. This is critical because puberty onset has accelerated in girls in western society and perturbed pubertal timing is implicated in the etiology of a number of behavioral and psychological dysfunctions. To better understand the impact of early puberty onset on PFC development we are mapping out the timing of pubertal milestones, peripubertal changes to behavior, and PFC neural circuits in transgenic mouse models using in vivo 2-photon imaging and slice electrophysiology in the dorsomedial (dm)PFC. We find significant changes in behavioral flexibility in a reversal task, decreases in dmPFC dendritic spine density and turnover (an in vivo measure of plasticity), and changes in dmPFC inhibitory synaptic currents over the peripubertal period in mice. We hypothesize these changes may be accelerated or interrupted by earlier onset of puberty. To test this we accelerate puberty onset with hormone injections, which allows us to assay maturation of the prefrontal cortex in age-matched mice that vary in pubertal status. These data will shed light on the relationship between adolescent neural and behavioral changes and pubertal onset while informing us of the possible public health consequences associated with earlier puberty.

P-1-59 Do we need inhibition to be creative? Evidence from a dual-task paradigm

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Creativity is a fundamental process in many areas of everyday life such as education or scientific reasoning. Developmental cognitive neuroscience studies converge in showing that prefrontal brain regions - known to be involved in executive control - are activated during the generation of creative

ideas. Nevertheless, previous behavioral studies did not systematically find support for a positive relation between creativity and executive control. Thus, in the present study, we investigate whether inhibitory control is a critical process to generate multiple creative ideas. We used a dual-task paradigm to reduce participants' inhibitory control resources while performing a creative task. More specifically, young adults were asked to generate creative alternative uses of conventional everyday objects while performing either the interference or the control conditions of a computerized version of the Color-Word Stroop task. We found that reducing inhibitory control resources hindered participants' performance in the creative ideas generation task: participants proposed fewer categories of solutions when they performed the interference condition than the control condition of the Color-Word Stroop task. These findings are in line with previous developmental neuroscience studies and strongly support the notion that creative reasoning involves inhibitory control.

P-2-60 Developmental Integration Patterns of Functional Brain Networks

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Resting state networks have been found to continue to specialize throughout adolescence as cognitive abilities continually improve. The effects of development on network community organization and integration is not well understood. We collected 5 minutes of resting state data from 192 subjects, ranging in age from 10-26 years old controlling for head motion artifact. Timeseries were correlated from 264 regions of interest (ROI) selected from Power and colleagues (2011). Age was treated as a continuous variable, as well as in stages representing children, early teens, late teens, and adults. A modularity algorithm partitioned the full network into communities for each group and normalized mutual information (NMI) was calculated. We next calculated participation coefficient (PC) for each ROI to determine the changing architecture of highly integrative regions. We used permutation testing to statistically test age-related differences of observed values for NMI and PC. Results indicated no age-related changes in community organization, indicating that it is stable by late childhood. However, there was significant reorganization of highly integrative regions from childhood to adulthood represented by significant increases in PC primarily in regions comprising control networks, including association cortex, insula, and cerebellum. These results suggest that the global organization of functional networks is established early in development with shifting integration patterns throughout adolescence, possibly supporting known developmental improvements in cognitive control.

P-1-61 How peer's choices influence risk-taking in adolescence?

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In order to apprehend the specificity of risk taking in adolescence, neurodevelopmental models posit an imbalance between the relative maturity of the adolescents' brain systems that are in charge of socio-emotional and incentive-based behaviors and the immaturity of the cognitive control system. Although previous studies converged in showing that adolescents are hypersensitive to rewards - particularly in salient socio-emotional contexts such as in the presence of peers - less is known about the direct influence of peers choices on adolescents' decision making. The aim of the present study is therefor to examine whether peers' behavior increases or decreases adolescents' risk-taking. Sixty-nine adolescents aged from 13 to 15 completed a new adaptation of the Balloon Analogue Risk Task. Participants were required to cumulate as much points as possible by inflating balloons associated with variable break points. They could save the cumulated points at any moment but if the balloon exploded first, all the cumulated points were lost. In this new adaptation, participants also received information about the decision made by three classmates for each balloon. Critically classmates' choices were a design manipulation promoting either risky or cautious behavior. Results showed that cautious peers reduced adolescents' risk-taking leading them to collect more points whereas risky peers had the opposite effect. The present findings expand our understanding of the positive and the negative influence of the socio-emotional context on risk-taking behavior in adolescence.

P-2-62 Cortical thickness and executive function relationships in adolescents with prenatal exposure to cocaine, alcohol and tobacco

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Inconsistent effects of prenatal cocaine exposure (CE) on brain structure have been reported. The negative effects of prenatal alcohol (AE) and tobacco exposure (TE) on brain structure and cognition are also known. We expected co-exposures to AE and TE on CE could be related to greater abnormalities in cortical thickness (CT) and executive function (EF), than CE alone. 42 subjects (CE=27; 14-16 years) received a structural MR scan and EF tests. CT was measured through FreeSurfer. Main effects and interactions between drug exposures and cognitive variables on CT were tested. Analyses (multiple comparisons corrected with 1000 permutations, $p<0.01$) were first conducted in the whole sample, and verified in the CE sub-sample. CE had higher cocaine, tobacco, and alcohol exposure, but were matched with controls on cognitive performance, age, mother's education, socioeconomic status, and gestational age. As expected, AE and TE, but not CE was significantly related to CT. There were also significant interactions between co-exposures to alcohol and tobacco on CT, where higher CE and TE were related to greater cortical thickness, while higher AE was related to lower cortical thickness. Finally, interactions were significant for drug exposures and EF: lower CT was associated with better performance in CE children. Results indicate that despite normal cognition, CE youth have abnormalities in cortical thickness and in brain-behavior relationships in relation to poly-drug exposures. Follow-up studies are needed to identify persistent poly-drug effects on young adults with prenatal CE.

P-1-63 Mother-Child functional brain differences in response to appetizing food images

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Introduction: Rates of pediatric obesity have tripled since 1980. Obese adults and children demonstrate neurofunctional differences in response to food stimuli. The present study examined the association between maternal and child brain activation when completing a standardized, validated food motivation paradigm during a functional magnetic resonance imaging (fMRI) scan. Methods: Three obese mother-child dyads were recruited from local pediatric obesity interventions. Children (mage=10.5 years; BMI%ile=98.9) and mothers (mage=37.3 years; BMI= 37.9) underwent a visual block design food motivation task to assess neural activation in response to food stimuli. fMRI data were analyzed using Brain Voyager QX with random effects. Voxel values were considered significant if the activation survived a statistical threshold of p<.01 corrected for multiple comparisons using a Monte Carlo simulation [7 voxels]. Results: Mothers demonstrated significantly greater activation than their children [food > animal images] in right putamen (14 contiguous voxels; max voxel 23, 7, 9). Children demonstrated greater activation than their mothers [food > animal images] in bilateral inferior parietal lobe (14 contiguous voxels; max voxel 47, -38, 39; max voxel -31, -53, 39). Discussion: Compared to their children, mothers demonstrated greater activation in part of the striatum, an area associated with reward processing areas when viewing food stimuli. Children, however, demonstrated greater activation than their mothers in a region associated with attentional resources.

P-2-64 Computerized Training of Inhibitory Control in Children with ADHD

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Attention-deficit hyperactivity disorder (ADHD) is one of the most commonly diagnosed mental disorders in children. Previous studies exploring the effects of computerized training programs for children with ADHD have mainly targeted working memory and attention. However, many lines of research point to inhibitory control (IC) having a central role in ADHD pathophysiology (Barkley, 1997; Huang-Pollock & Nigg, 2003; Nigg, 2000). In the present randomized, single blind study, we used a training program that targets IC using a modified stop-signal task designed by NeuroScouting, LLC. Forty children with ADHD, aged 8 to 11 years, were randomly assigned to either adaptive treatment or non-adaptive control (identical stimuli and task goals). Children were required to train at home for at least 5 days a week for a 4-week period. Main outcome measures were resting EEG, visuospatial working memory task, modified Go/NoGo task, and parent and teacher behavior ratings. Results showed that compared to controls, the treatment group had a significantly greater average improvement on parent ratings of inattention. Preliminary findings from resting EEG data suggest that theta band relative power over parietal electrodes decreased after training, consistent with the finding that children with ADHD have elevated power in theta compared to controls. Lastly, the treatment group was marginally better able to use attention cues to enhance their performance on an untrained Go/NoGo task. Overall, the inhibitory control training appeared to be beneficial for children with ADHD in middle childhood.

P-1-65 Neural Systems Supporting Cognitive Control for Matched Hot and Cold Tasks in Mid-Adolescence

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Whether neural systems supporting "hot" versus "cold" cognitive control are distinct or overlap during adolescence remains unclear. We compared brain activation for 2 well-matched Stroop-like tasks, one with emotional distractors (i.e. "hot" task) and one with non-emotional distractors (i.e., "cold" task), in 26 adolescents (14 female, 12 male) (mean age =16.1, s.d. = .9). In the hot task, individuals classified a word, superimposed on either a distracting happy face or sad face, as either positive or negative in valence. In the cold task, individuals classified a word, superimposed on either a distracting neutral-expression face or a house, as referencing the concept above or below. In both tasks, half the trials were congruent (C) (e.g. "joy" on a happy face) and half were incongruent (I) (e.g., "up" located on the chin of a face). Both tasks yielded a significant behavioral interference effect (i.e., longer RT on I than C trials), which were equivalent in size. Patterns of brain activation indicated that cognitive control regions were significantly engaged both for congruent and incongruent trials and to an equal degree in the hot task, and likewise for neutral-expression faces in the cold task. Moreover, cognitive control regions were engaged to a greater degree when faces rather than houses were the distracting stimuli in the cold task. These findings suggest that facial stimuli are especially salient during mid-adolescence and that the neural systems that exert control over such salient emotional stimuli are similar regardless of task demands ("hot", "cold").

P-2-66 Brain Myelin Water Imaging in Children and Adolescents with Prenatal Alcohol Exposure

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Introduction: Prenatal alcohol exposure (PAE) is linked with alterations of cerebral white matter, including volume and non-specific indices of micro-structure. Animal models of PAE demonstrate reduced myelination but this has not been evaluated in humans. PAE can cause substantial cognitive deficits, particularly in executive functioning, and may be linked with altered brain myelination. Multi-echo T2 MRI was used here to evaluate brain myelin water fraction (MWF) in children with PAE. Methods: PAE (n = 10, 6 females, mean age 13.9 years, range 7-18 years) and controls (n = 14, 11 females, mean age 13.2 years, range 9-16 years) underwent MRI including 32-echo T2 for MWF maps and T1 for region-of-interest placement on a 3T Philips. MWF was measured in 5 white matter and 2 deep grey matter regions. Executive functioning was assessed with NEPSY-2. Results: MWF was highest for white matter such as internal capsule and genu/splenium of corpus callosum (10-15%) while the caudate and putamen had MWF less than 5%. Age was significantly positively correlated with MWF only in the genu of the corpus callosum and minor forceps, notably frontal tracts, for the two combined groups. Mean MWF was similar between PAE and controls for all regions suggesting that white matter alterations shown in other imaging studies may reflect other micro-structural anomalies (e.g. axon caliber/packing). Several negative correlations between MWF and executive functioning were found (e.g. bilateral minor forceps), albeit in the opposite direction one might expect.

P-1-67 Human Chromosomal Modification Associated With Early-life Stress Induced Depression

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Exposure to early-life stress (ELS) has consistently been associated with a range of negative health outcomes that include increased risk for psychopathology, in particular disorders of emotion regulation such as depression. Emerging evidence suggests telomere erosion, a marker of biological aging, may provide insight into the mechanisms that underlie how negative early-life experiences alter psychobiological processes at a genetic level. The current study examined the effects of ELS in previously institutionalized children and adolescents and healthy comparison youth across a wide age range (ages 3-17 years old). Consistent with previous research, the findings suggest that depression is greater in youth with a history of ELS than healthy comparison youth. Additionally, findings demonstrate that children with a history of ELS have significantly shorter telomere length than the comparison group. Lastly, a negative correlation between depression and telomere length was observed. The results from the current study have important implications for understanding the associations between ELS exposure, depression, and genetic changes occurring early in development that may advance the study of deleterious psychological outcomes in this population.

P-2-68 Eye Blink Rate as a Proxy for Measuring Dopamine in Adolescent Risky Decision Making

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Adolescence is characterized by increased sensitivity to rewards, which is reflected in heightened responsiveness in the ventral striatum (a region associated with the neurotransmitter dopamine) in response to anticipated and experienced reward and to changes in the value of stimuli. Dopamine can be non-invasively measured by recording a particpant's eye blink rate (EBR). EBR at rest was measured for 25 adolescent participants, who also completed a risky choice task with three potential strategies: maximizing the probability of winning, maximizing potential gain, or minimizing potential loss. Greater EBR in adolescents was associated with fewer probability-maximizing choices (a value-insensitive strategy because it does not change the maximum and minimum monetary values of the task), suggesting a positive relationship between dopamine and value sensitivity during risky choice. Furthermore, decreasing potential loss amounts led to significant increases in use of the gain-maximizing strategy, and this relationship was stronger for participants with higher EBR. This suggests a possible influence of dopamine on adolescent sensitivity to changes in value during decision-making under risk.

P-1-69 Development of the central executive and default mode networks in early adolescence: Longitudinal changes and relation to full-scale IQ

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The human brain is organized into a series of neural networks, defined by regions that exhibit correlated activation during tasks and at rest. While previous research has examined differences in these functional networks between children and adults, little is known about the development of these networks at the onset of adolescence, a period defined by significant brain maturation as well as changes in social and cognitive domains. Using fMRI, we examined the Central Executive Network (CEN) and Default Mode Network (DMN) in late childhood and early adolescence in a longitudinal sample of 45 participants. We observed significant changes in both networks from age 10-13. In the DMN, participants showed increased integration (i.e., stronger within-network connectivity) between the posterior cingulate cortex (PCC) and the medial prefrontal cortex. Participants also showed increased segregation (i.e., weaker between-network correlation) between the PCC and regions of the CEN. Similarly, from age 10-13, participants showed increased connectivity between the dorsolateral prefrontal cortex and other CEN nodes, as well as increasing segregation from the DMN. Participants also differed in network connectivity as a function of IQ: at age 10, participants with higher IQ demonstrated greater within-network integration in the CEN and greater segregation between networks. These findings highlight preadolescence as a period of significant maturation in the brain's functional architecture and suggest that cognitive ability predicts the extent to which this maturation has occurred by age 10.

P-2-70 Cognitive Reappraisal and History of Family Aggression

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We use a novel approach to explore cognitive reappraisal during adolescence. Reappraisal is a strategy for regulating emotions where an initial emotional reaction is reevaluated and changed. Our novel task expands on existing literature by dissociating two important components of the reappraisal process, targeting the ability to disengage from an emotion that one is currently experiencing, without requiring participants to generate a novel appraisal. Subjects were 22 youth, ages 15-18. The task involved two conditions: negative congruent and negative incongruent. Each condition included 15 images taken from the IAPS. Subjects saw an image for a 4-second period. They then rated "how the scene made them feel" on a scale from "very negative" to "very positive." Next, they saw the image again with a caption that gave additional information about the scene. In congruent trials, the caption maintained the image's emotional valence. In the incongruent trials, the caption was designed to change the image's emotional valence. Participants then rated the image a second time. MRI data were collected concurrently. Behavioral results indicate the task was effective at changing participants' emotional reactions. Neural data showed that incongruent trials were associated with increased signal in medial PFC. Decreased activation was found in the bilateral precuneous and occipital cortex. Family aggression history was associated with activation in the bilateral IFG. These findings contribute to our understanding of reappraisal and highlight the potential impact of family aggression.

P-1-71 The effect of emotional cues on uncertainty-driven exploration in adolescents and young adults

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Adolescence is characterized by elevated emotional reactivity and risk-taking behaviors that partly reflect strategic exploration (SE) of rewards to reduce uncertainty about their value. In two studies, we sought to characterize the influence of emotional cues on reward learning in adolescents and young adults. For the first study, participants were 36 normally developing individuals (ages 14-31) who completed a behavioral decision-making task. For each trial, participants received a probabilistic reward by stopping a ball that revolved around a happy, fearful, or scrambled face image. We fit a reinforcement-learning model to response times to estimate influences of SE and prediction errors (PEs). We found that SE declined with age ($r = -0.35$, $p = .04$) and that fearful faces were associated with weaker SE, whereas SE was higher for happy faces. The influence of positive PEs in youth, but not adults, was associated with poorer self-regulation (age x PPE $t = 2.75$, $p = .001$). In the second study, 15 adolescents (ages 14-16) and 15 adults (ages 26-28) completed 8 blocks of the same task during an fMRI scan. Preliminary analyses suggested greater recruitment of rostrolateral prefrontal cortex for SE in teens than adults, whereas PE signals in the dorsal ACC were weaker in adolescence. Complete analyses and interpretation of the fMRI data will be discussed. Altogether, our findings suggest that sensitivity to better-than-expected outcomes is associated with self-regulation problems in adolescence, but that adolescents also excel at using relative uncertainty to guide behavior.

P-2-72 Maternal interleukin-6 concentrations during pregnancy and newborn functional brain connectivity

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Maternal gestational psychosocial and immune stress increases offspring risk for psychiatric disorders. Inflammatory cytokines represent a likely mediator for effects of maternal prenatal stress and inflammation on the developing fetal brain with implications for subsequent mental health. Maternal interleukin-6 (IL-6) is of particular interest due to evidence for increased concentrations in response to psychosocial stress and infection, and its capacity to both cross the placenta and stimulate placental cytokine production. However, effects of maternal IL-6 during pregnancy on the fetal brain have not been reported in humans. We examined maternal IL-6, measured in each trimester of pregnancy, as a predictor of functional brain network strength in neonates (N=58, M=26.3 days, SD=13.2 days). We focused on the default mode network (DMN) as it appears to be influenced by events prior to term gestational age (e.g. preterm birth), and is associated with mental health status in children and adults. Higher average gestational maternal IL-6 was associated with weaker DMN connectivity involving the posterior cingulate cortex (PCC), dorsal and subgenual medial prefrontal cortex (MPFC), and bilateral lateral parietal cortex. Especially during the first trimester of pregnancy, higher maternal IL-6 was

associated with weaker newborn PCC to MPFC connectivity. This research provides support for the role of maternal gestational immune activation in offspring risk for psychiatric disease via effects on functional brain organization particularly during the first trimester of pregnancy.

P-1-73 The developmental emergence of goal-directed action

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Psychological theories distinguish "goal-directed" actions, performed to obtain desired outcomes, from "habits", actions rendered stimulus-bound and automatic through previous reinforcement. Goal-directed action is proposed to rely upon "model-based" learning, which recruits a cognitive model of the consequences of potential actions, enabling flexible adaptation to a dynamic environment. In contrast, habits are thought to recruit a more efficient "model-free" learning process that attaches an action value to a stimulus, allowing well-honed behavioral routines to be executed without forethought or attention. Model-based learning is proposed to recruit prefrontal-subcortical circuitry, which undergoes substantial structural and functional changes during maturation from childhood into adulthood. While this suggests that individual reliance upon goal-directed versus habitual action might change markedly with age, the developmental trajectory of action selection strategies has not yet been examined. In this study, children, adolescents, and adults performed a two-stage reinforcement-learning task in which we can estimate model-based and model-free contributions to choice behavior in each age group. Our data suggest that while the behavioral signature of model-free habitual learning is present from childhood onwards, model-based goal-directed choice is not evident until adolescence, and continues to mature into adulthood. This protracted maturation of goal-directed action may contribute to the shortsighted decision-making that is commonly observed during adolescence.

P-2-74 Brain Structure of Children at Risk for Huntington's Disease

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Huntington's disease (HD) is an autosomal dominant disorder caused by an expansion of the CAG repeats on the gene encoding for the huntingtin protein (HTT). Although the primary neuropathology is that of neurodegeneration of the striatum, mutant huntingtin (mHTT), which is present throughout the life span, may also affect normal brain development. In the current study, the effect of mHTT on neural development was examined by evaluating the brain morphology of children (6-18 years of age) at risk for HD (no juvenile HD included). Brain volumetric measurements of children tested as gene-expanded (n=41, CAG repeats ≥ 39) or gene non-expanded (n=41, CAG repeats ≤ 36) as a result of presymptomatic gene assessment (for research purposes only) were compared to those of a large number of healthy children matched for age and sex. The gene-expanded children, but not the gene non-expanded children, showed significantly lower intracranial volume (ICV), caudate and putamen volume measures when compared to healthy peers. We also observed an enlarged thalamic volume coupled with the

smaller striatal volume which resulted in a significantly lower corpus striatum-to-thalamus ratio in the gene-expanded children compared to healthy controls. The brain structural alterations in children who are estimated to be decades ahead of HD diagnosis, indicate mHTT related aberrant brain development which could contribute to the pathogenesis of HD. Further, the enlarged thalamus in the presence of lower striatal volume found in the gene-expanded children may reflect a potential compensatory mechanism.

P-1-75 Bilateral amygdala connectivity during emotion reappraisal in MDD correlated with rumination

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Major depressive disorder (MDD) is characterized by an inability to effectively regulate responses to negative content. MDD is also frequently characterized by rumination about negative thoughts and experiences, which may be related to poor emotional regulation. Studies of emotion regulation have implicated abnormal amygdala connectivity in poor emotion regulation. The current study investigated whether amygdala functional connectivity (FC) during an emotion regulation task was related to rumination in children with and without MDD. Twenty MDD and 23 healthy (TD) children (8-14 years old) completed the Cognitive Emotion Regulation Questionnaire (CERQ), then performed an fMRI slow-event-related emotion regulation task with neutral and sad pictures. For reappraisal trials, a sad image was followed by a prompt to "Make Positive." fMRI data were motion scrubbed by removing volumes with framewise displacement greater than .9mm, slice-time and motion corrected, normalized, and smoothed with a 6mm FWHM Gaussian kernel. Contrasts for regulate vs baseline were used to create psychophysiological interaction (PPI) FC analyses using left and right amygdala seeds. Individual PPI results were entered into a multiple regression analysis to assess Group x CERQ rumination score interactions on amygdala FC. Interactions were seen bilaterally, with rumination in MDD more strongly correlated with medial and lateral prefrontal FC than in TD. This abnormal amygdala FC during directed emotion regulation suggests inefficient amygdala regulation, which may contribute to rumination in MDD children.

P-2-76 The Influence of Incentives on Cognitive Control During Adolescence

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Characterizing the normative interaction of reward processing and inhibitory control through adolescence promises to yield critical insight on basic mechanisms underlying risky decision-making. In this presentation, we will provide an extensive update of our on-going work examining the effects of incentives on aspects of cognitive control. This will include examination of developmental changes in reward and cognitive control-related brain circuitry as a function of incentive context during both correct and incorrect antisaccade trials, as well as examination of incentive effects on other aspects of

cognitive control (e.g., a rewarded visual spatial working memory paradigm). Additionally, we will present complementary data characterizing the functional connectivity of reward and inhibitory control related circuitry in our sample. In aggregate, our data demonstrate that adolescents show specific, persistent differences in the integration of incentives and cognitive control. Implications for how these differences may contribute to differential adolescent decision-making and risk taking will be discussed, with an emphasis on smoking during late adolescence.

P-1-77 Retention of statistical learning in 6.5-month-old infants

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Infants show robust statistical learning on immediate test (Saffran et al. 1996). Little is known of the neural structures supporting such learning in infants. No research has assessed retention of statistical learning in infants over a delay. Here we explore how sleep/wake delays contribute to retention of statistical learning in 6.5mo and the potential neural mechanisms implicated. Structures in the trisynaptic circuit of the hippocampus support adult statistical learning (Schapiro et al., 2012) and neural replay implicated in sleep-dependent consolidation also originates in the trisynaptic circuit (Diekelmann & Born, 2010). These structures are not fully connected at 6.5mo (Nadel & Hupbach, 2008), suggesting that infants may use alternate mechanisms. As such, statistical learning may be supported by cortical structures that retain memories equally over sleep and wake (Inostroza et al., 2013; vanderHelm et al, 2011). 28 6.5mo were familiarized with 4 bisyllabic words strung together in random order such that transitional probabilities between syllables within words were 1.0 and between words were .5 (Thiessan & Saffran, 2003). After a delay (sleep/wake), infants were tested for discrimination of words and part-words. If cortical structures are implicated, then we expected infants to show no differences after wake versus sleep. We found that infants in both groups listened significantly longer to part-words than words. Critically, there were no significant differences after a delay of wake versus sleep, consistent with a cortical encoding account of statistical learning.

P-2-78 Incentive Effects on Visual Spatial Working Memory

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Incentives improve performance on inhibitory control tasks (e.g., antisaccade), but little is known about their influence on other aspects of cognitive control like working memory. This lack of understanding is of concern as working memory processes have been hypothesized to contribute to reward-based decision-making and potentially risk taking, like smoking, during adolescence. To begin to address this issue, we tested 56 late adolescent (18-20 years) and adult (21-65 years) smoker and non-smoker participants on a novel incentivized visual spatial working memory (VSWM) task. Preceding each VSWM trial, participants viewed a cue indicating whether performance on that trial would be rewarded or not (i.e., a neutral trial). Participants completed the task at two separate sessions; smoking participants

completed the task during a smoke as usual session and after 12 hours of abstinence (counterbalanced order) in order to assess how acute nicotine exposure and abstinence affect these systems. Non-smokers were also tested twice as a control. In this presentation, we highlight our preliminary data demonstrating incentive effects on VSMW task performance, focusing on velocity and latencies of initial saccades, and accuracy in smokers vs. nonsmokers and in late adolescents vs. adults. We discuss implications for adolescent risk-taking and smoking cessation.

P-1-79 Age-related Differences in Dynamic Whole-brain Connectivity Patterns

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Developmental studies of functional connectivity (FC) often assume FC architecture is static across context and time. Thus, FC is often estimated from resting-state data and computed from full time courses (e.g., Fair et al., 2007). However, whole-brain FC dynamically transitions between discrete connectivity states that are substantially different from average FC patterns (Allen et al., 2012; Hutchison et al., 2013; Liu & Duyn, 2013) and possibly linked to cognition. Development then could bring changes both in the repertoire of FC states and transitional dynamics between these states. The present investigation represents an initial step toward characterizing FC states, their transitional dynamics, and their association with context across development. 51 participants (9-32 y) were scanned at rest and task. The task consisted of a blocked stimulus-response compatibility task in which the frequency of incompatible trials within blocks varied. As expected, response times and SR-compatibility effects both increased as the frequency of incompatible trials increased. A sliding-window whole-brain FC analysis of adult (n = 19) and child (n = 32) data revealed 17 distinct connectivity states. States were linked to changes in task context, insofar as some states increased in frequency with parametric increases in cognitive challenge while others decreased. Two states showed an Age X Condition interaction, pointing to age-related differences in the linking of FC-states and cognition. Results provide the first evidence for changes in the dynamics of whole-brain FC across development.

P-2-80 The Importance of Knowing What You Don't Know: Exploring the Neural Basis of Individual Differences in Monitoring of Episodic Memory

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The ability to flexibly monitor the uncertainty of one's own memory has important implications for learning and goal-directed behavior. While some ability to introspect on uncertainty is already present in the preschool years, children's tendency to strategically withhold responses continues to develop during middle and late childhood. The goal of the present study was to examine the neural underpinnings of uncertainty monitoring during episodic retrieval and its contribution to memory performance. Children (N=145, 7-11 years) and adults (N=39) encoded object-scene pairs followed by a source memory task while undergoing fMRI scanning. During this retrieval task, participants could select an 'I don't know'

(DK) answer if they were uncertain about which scene had been originally studied in association with the target object. In all age groups there was pronounced heterogeneity in DK response use. Source accuracy was lower in 8-year-olds compared to older children and adults. Higher DK response rates were associated with higher source memory performance (r=.43, p<.001) across all participants, controlling for age. Preliminary whole-brain analyses in a subsample of participants providing sufficient number of trials (N=50, 8-21 years) revealed that DK responses were associated with increased activation in bilateral insula, ACC, anterior PFC, lateral temporal gyrus and right inferior parietal lobe. These results suggest that the salience network may play an important role in uncertainty monitoring during episodic retrieval with implications for memory performance.

P-1-81 Electrophysiological Oscillations and Slowed Cognitive Processing Speed as Biomarkers of Psychosis Risk in Adolescence

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Mapping the transition from high risk state to diagnosable psychotic disorder (e.g., schizophrenia) requires biomarkers sensitive to adolescent neurodevelopment and to emerging pathology. Several lines of evidence suggest that behavioral performance on tasks measuring cognitive processing speed and EEG signal power in the theta frequency band (4-8 Hz) may meet these criteria, a possibility we tested in the present study. Typically developing adolescents (TDA; N=20), adolescents at clinical high risk for psychosis (CHR; N=20), and individuals with adolescent-onset psychosis (AOP; N=20) performed a computerized digit-symbol substitution task while EEG was recorded. TDA show a strong, direct association between age and processing speed; however, AOP do not. AOP appear to fail to make age-normative gains in processing speed. CHR show an intermediate age-speed association. EEG findings demonstrate that TDA show a distinct pattern of theta band modulation during the 1 s preceding behavioral response: a drop in power from 1 to 0.5 s prior to response, followed by an increase in power during 0.5 s before response. AOP show no such modulation, and during the 0.5 s preceding response, lower theta power overall. CHR appear to show an intermediate level of modulation. The brain-behavior relationship between EEG theta activity and cognitive processing speed shows promise as a biomarker reflecting aberrant neurodevelopment. Further investigation of the neural underpinnings of theta modulation may provide insight into the pathophysiology of early psychosis.

P-2-82 SIMPHONY: Studying the impact music practice has on neurodevelopment in youth

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The SIMPHONY study is a five-year longitudinal project to study the impact of music training on children within a neurocognitive framework designed to understand how the environment and brain interact during child development. It is designed to contribute to ongoing nature vs. nurture debates regarding

the origin of brain changes observed in adult musicians. Each year children (age 5-10 at start) complete an extensive battery of cognitive and developmental tests, and the imaging of brain structure and connectivity. The project addresses the question of specificity by comparing children undergoing intensive instrumental music training (in the San Diego Youth Simphony's El Sistema inspired Community Opus Project) to two control groups: children not receiving music training, and actively engaged in martial arts training. With longitudinal data, we will test the hypothesis that music training accelerates cognitive and neural developmental trajectories, and attempt to draw brain/behavioral links by examining how any observed behavioral changes are mirrored by changes in brain structure. To date, fourteen music-learners, five martial arts learners, and thirty-eight control children have completed the first year baseline measurements. We will present an initial cross-sectional analyses of performance on cognitive tests of beat perception and production describing how beat perception and production scores vary with age, and how they may relate to measures of other aspects of cognitive performance and brain structure.

P-1-83 Age-associated abnormalities in white matter microstructure in 22q11.2 deletion syndrome

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Background: 22q11.2 deletion syndrome (22qDS) is a neurogenetic syndrome associated with elevated rates of developmental neuropsychiatric disorders and intellectual impairment. It is unclear how the development of white matter (WM) microstructure may be impacted during adolescence in 22qDS. Here we explored whether there are altered age-related trajectories of WM pathways in 22qDS. Methods: We acquired 64-direction diffusion weighted-imaging (DWI) scans from 22qDS participants (10-25 years old, N=36) and age-matched typically developing controls (N=29). DWI data were analyzed using FSL's Tract-Based Spatial Statistics. Using regions of interest from the John Hopkins University probabilistic tractography atlas, we computed measures of fractional anisotropy (FA), axial (AD) and radial diffusivity (RD). These measures are believed to reflect white matter integrity, axonal coherence, and myelination, respectively. Results: Relative to controls, 22qDS participants showed reduced AD in multiple WM tracts. There was one significant age*group interaction detected, for RD in the right inferior longitudinal fasciculus (p=.02). For controls, RD significantly decreased with increasing age (r=-.50, p=.006); however, these age-related changes were not seen in 22qDS (r=-.05, p=.76). Conclusion: Our findings suggest that 22qDS participants fail to show age-appropriate changes in white matter microstructure in the inferior longitudinal fasciculus, a major occipital-temporal connection. These findings may be indicative of disrupted myelination during adolescence and young adulthood in 22qDS.

P-2-84 Integrating smoking beliefs into a neurobiological model of smoking-related decision-making

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Smoking initiation most often occurs before age 20, highlighting adolescence as a critical period for prevention. Smoking is a multi-determined behavior, a fuller understanding of which necessitates an integrated perspective. We present a model of smoking-related decision-making that begins this task of integration across levels of analysis. Focusing on the interplay between incentive processing and cognitive control, we suggest that the motivation to approach desirable but unhealthy rewards (e.g., cigarettes) may be overcome by enhancing cognitive control through the use of non-drug incentives. This enhanced capacity allows the inhibition of impulsive behavior. Once an impulse has been inhibited, deliberative decision-making is undertaken. We suggest that adolescents may decide to smoke, even after inhibition of the impulse to smoke, especially if information about the detrimental effects of smoking is not salient. Alongside this model, we present data from an incentivized oculomotor task demonstrating the ability of monetary incentives to bolster inhibitory control. We also present a novel measure through which salient beliefs about the causes and effects of smoking can be examined and demonstrate that late-adolescent smokers hold more optimistic beliefs about the effects of smoking than non-smokers. Finally, we discuss changes to this decision-making process with the onset of nicotine dependence by demonstrating, using an incentivized Go/No-Go task in smokers across levels of satiety, that smoking abstinence may lessen the ability of incentives to enhance inhibition.

P-1-85 Are teens jetlagged? Variations in salivary cortisol as a function of week to weekend sleep in adolescents.

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Adolescents are often described as being "chronically jet lagged" resulting from the mismatch between their biological clock and early school obligations. Some teenagers use weekends to "catch up" for lost sleep by delaying rise time, which may further desynchronize hormones driving the sleep-wake cycle. In adults, jet lag is associated with higher circulating cortisol, a hormone that responds to alertness and stress and affects emotion and cognitive functioning. If teens are jet lagged, then this subsequent increase in cortisol could have profound implications for emotion and cognition during a critical developmental period; however, no research to date has investigated sleep-related cortisol changes in this population. We tracked 17 subjects (8 female) aged 14-16 years across 8 days during the school year. We measured consistency of sleep, defined as the difference in average rise time from week to weekend, using actigraphy and self-report. Salivary cortisol measures were collected 4 times daily surrounding bed and wake times. A multilevel model treating time as a predictor showed that inconsistent sleep elevates cortisol levels by 0.13 nmol/L ($p = .03$). Furthermore, the waking cortisol response of consistent sleepers tends to decrease by 0.05 nmol/L across the school week ($p = 0.01$), perhaps indicating faster adaptation of the rhythm to the early rise time. These findings provide evidence that teens' inconsistent sleep habits can trigger a biological response that mirrors jet lag in adults, with possible consequences for daytime functioning.

P-2-86 Multiple learning systems in adolescence

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Adolescence is a brief window of development that involves dramatic changes to behavior and the brain. Studies of cognitive development have focused on the risky decisions that adolescents make and the developing brain circuitry underlying these potentially maladaptive choices, in particular the striatum and the prefrontal cortex. A largely separate area of research in reinforcement learning implicates these same regions in action-outcome learning which is essential for adaptive behavior. Taking advantage of the foundation of this previous work, we investigated feedback-learning in healthy adolescents under simple reinforcements from correct vs. incorrect feedback while undergoing fMRI. We found that adolescents show better learning ($p=0.01$) and heightened prediction error related striatal activity relative to adults ($p\text{-FEW}<0.05$). In light of this heightened striatal activity, we investigated consequences for other learning systems. We found greater prediction error activity related to feedback in the hippocampus in adolescents ($p\text{-FEW}<0.05$). Finally, we tested memory for trial unique, incidentally encoded items that had been presented at the time of feedback. We found that adolescents remembered more items than adults ($p=0.03$). Taken together, our findings suggest that heightened sensitivity to feedback in adolescents confers a benefit for striatal dependent learning, and that heightened activity in the striatum may have downstream behavioral consequences for other types of learning and memory.

P-1-87 Community Detection & Network Topology During the First Year of Life - A Resting-State Functional Connectivity Study

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Research concerning functional brain development over the first two-years of life continues to evolve as methods describing the topology of large-scale systems are applied to neuroimaging. The current study attempts to extend previous work during this surgent maturational period using community detection and graph theory. Here we explore the developmental trajectory of community structure and network topology based on voxelwise cortical maps, and a set of 264 functionally defined regions after motion correction in neonates and one-year olds. Community detection was performed over a range of tie-density thresholds to identify functionally related modules. This approach is potentially a more reliable method to decipher and categorize spatially adjacent, overlapping systems likely to dominate the infant brain. Overall, results demonstrate a functionally localized architecture in neonates with key components of specific networks defined in adults evident, but isolated in fragmented clusters. Notably, large-scale systems such as the fronto-parietal, dorsal-attention, cingulo-opercular and default-mode networks begin to emerge into coherent, though immature partitions in one-year olds. By categorizing communities at the voxel-level we can explore functional subsystems in greater detail, including the spatiotemporal dynamics between representative nodes of a community over the course of

development. Results of the present study may help establish key fluctuations within and between subsystems informing future research regarding the changing landscape that is the infant connectome.

P-2-88 Early Brain and Cognitive Development in Children at Risk for Schizophrenia

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Schizophrenia is a debilitating disease with neurodevelopmental origins that impact the structure, connectivity and function of the brain. In early childhood, prior to illness onset, both cognitive and motoric deficits are reported. High-risk infants and matched comparisons were examined in this follow-up study at 1 and 2 years of age. Methods- Structural (3T) magnetic resonance images (MRI) were prospectively obtained in the offspring of mothers with schizophrenia or schizoaffective disorder (1yr N=32; 2yr N=28) and matched comparison mothers without psychiatric illness (1yr N=64; 2yr N=56). Cognitive assessments were also performed with high-risk children (1yr N=41; 2yr N=31) and matched comparisons (1yr N=82; 2yr N=62). Analyses of brain structure included: intracranial, CSF, GM, WM, lateral ventricle volumes and in 90 regions of interest. Cognitive measures included: subscales and composite scores from the Mullen Scales of Early Learning. Results- High-risk children had significantly lower cognitive scores in each domain of the Mullen Assessment; differences were magnified at 2 years. Relative to the matched comparison subjects, the high-risk children had nonsignificantly larger intracranial, CSF and lateral ventricle volumes. While regional analysis revealed that at 1yr high-risk infants had significantly smaller hippocampi and right insula volumes, but larger precentral left GM. These finding remained at 2yrs, with the exception of the hippocampal volumes. Conclusions- differences in structural volumes and cognition were apparent in HR children at 1 & 2yrs of age.

P-1-89 Brain Structure and Function in Children with Non-Verbal Learning Disability

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Nonverbal learning disability (NLD) refers to a constellation of neuropsychological deficits specific to nonverbal cognitive processes, including tactile and visual perception, complex psychomotor activity, processing of novel stimuli, sustained attention, executive function, mathematical reasoning, and socioemotional cognition. It has been hypothesized that NLD constitutes a right-hemisphere neurodevelopmental disorder, with problems in white matter development and right hemisphere connectivity. The purpose of this pilot study was to examine brain structure and connectivity in children with NLD using structural MRI, diffusion tensor imaging (DTI), and resting-state functional connectivity MRI (rs-fMRI). 11 children with NLD (9 M, 2 F; age = 7-12) were compared to 33 age and sex-matched healthy controls. Intracranial volume was decreased in children with NLD. In addition, the right hippocampus was decreased in volume in NLD. Decreased right hippocampal volumes directly correlated with a number of nonverbal cognitive measures. DTI revealed a decrease in fractional

anisotropy (FA) in several white matter tracts in both hemispheres in NLD. Resting-state fMRI data indicated a decrease in connectivity within right hemisphere regions, accompanied by an increase in connectivity to left hemisphere regions in NLD. The results provide support for a neurodevelopmental component to NLD. Rs-fMRI data indicate decreases in right hemisphere connectivity, with a compensatory increase in left hemisphere connectivity, possibly explaining the intact verbal abilities in these children.

P-2-90 On the development of brain systems for non-symbolic numerosity and the relationship to formal math academic achievement

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A central question in cognitive and educational neuroscience is whether brain operations supporting non-linguistic intuitive number sense (numerosity) predict individual academic achievement for symbolic or "formal" math knowledge. This work describes a developmental functional MRI study of non-symbolic numerosity task performance in 44 participants including 14 school age children (7-12 years-old), 14 adolescents (13-17 years-old), and 16 adults and compared an FMRI measure of numerosity precision to scores from the Woodcock-Johnson III Broad Math index of math academic achievement. Accuracy and reaction time from the numerosity task did not reliably predict formal math achievement. We found a significant positive developmental trend for improved numerosity precision in the parietal cortex and intraparietal sulcus (IPS) specifically. Controlling for age and overall cognitive ability, we found a reliable positive relationship between individual math achievement scores and parietal lobe activity only in children. Surprisingly, we found a reversing relationship in the hippocampus with greater numerosity precision associated with greater math achievement in children, but lower math achievement in adults. Thus, high-level visuospatial processing may play a positive role in formal math knowledge attainment in childhood, whereas dependence on this process in adults may be a marker of poorer math achievement in adults. These results suggest that two different brain systems may contribute to observed math achievement and non-symbolic numerosity task performance in children.

P-1-91 Using task-evoked pupillometry to predict children's short-term memory recall on a trial-by-trial basis

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Pupil dilation is a reliable measure of processing load and attentiveness during performance of cognitive tasks (Beatty, 1982). Previous studies have examined the relationship between working memory capacity and pupil dilation in adults (e.g., Karatekin, Marcus, and Couperus, 2004), and our laboratory has begun to explore the use of task-evoked pupillometry as an index of cognitive processing in children (Johnson et al., 2014). Here, we sought to investigate whether task-evoked pupillary responses within a

trial were related to subsequent recall performance. To this end, we administered a computerized digit span task to 37 5th-grade students at two time points (4-month interval) with eye tracking. On four separate trials, participants listened to a series of nine digits presented in approximately 1-sec intervals, after which they were prompted to recall the digit series in the same order. We measured mean pupil dilation and recall accuracy for each of four trials. Across both time points, mean pupil dilation during a trial and the point at which peak dilation was observed during encoding of the series of digits (e.g., during encoding of the 6th digit) predicted recall performance for that trial ($r=.24$, $p<.01$; $r=.23$, $p<.01$, respectively, controlling for timepoint). These correlations retained significance even after controlling for WISC digit span. These findings suggest that task performance can be predicted via pupillary responses in children.

P-2-92 Functional segmentation of the striatum in children and adults using resting state fMRI

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The human striatum, a subcortical region that serves multiple cognitive, affective, and motor behaviors. Multiple parallel functional loops linking various subregions of the striatum are thought to underlie its functions. Prior studies using resting state functional connectivity in adults have parcellated the striatum based on its functional organization and connectivity profiles. However, very few studies to date have explored how the striatum is organized in childhood, and how that may differ from adulthood. Characterizing the development of the striatum is important for understanding the nature of developmental change in key cognitive, and affective behaviors as well as identifying the etiology and progression of many developmental disorders. We collected resting state data on a 3-Tesla GE scanner on children (7-12 years) and adults (19-22 years). Using a consensus clustering based on evidence accumulation frame-work, we clustered the striatum into subregions based on the similarity of the time series of all the voxels in the region. Both groups showed three distinct clusters comprising of the caudate nucleus, putamen, and ventral striatum, consistent with previous studies. However, the boundaries and volumes of clusters differed between children and adults. Lastly, we report age-related cortico-striatal connectivity differences using functionally parcellated striatal regions as seeds. Findings will lend insight onto developmental changes in the organization and connectivity of the striatum between childhood and adulthood.

P-1-93 Right insula response is decreased in boys carrying the MAOA-risk allele

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Impulsive aggression is discussed to be modulated by different MAOA polymorphisms. One aspect of impulsive aggression is a deficient inhibitory control, which has been investigated in male adults in the framework of MAOA using functional magnetic resonance imaging so far. Here, we investigated blood oxygenation level-dependent responses in boys (aged 7 to 12 years) carrying (N = 21) and not-carrying

(N = 21) the MAOA-risk allele who perform a cognitive GoNogo taks. Both groups were comparable concerning age, socio-economic status and IQ. Across all subjects, typical activation patterns were found in a neural network associated with inhibitory control, in particular in superior and inferior frontal gyri, anterior cingulate cortex, insula, superior parietal lobe and basal ganglia. Between-group comparisons revealed significant differences in the right insula with decreased responses for the careers of the MAOA-risk allele. Results are discussed in the framework of child development.

P-2-94 Hemispheric Asymmetry in White Matter Microstructure in Adolescents with Fetal Alcohol Spectrum Disorder (FASD).

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Prenatal alcohol exposure (PAE) underlies deficits in cognition, self-regulation, and adaptive functioning, known as fetal alcohol spectrum disorders (FASD). PAE alterations in rodents include asymmetry in neurochemical levels and motor function. In youth with FASD, alterations in symmetry of gray matter have been shown, but asymmetry in white matter remains unknown. Here, we examined hemispheric asymmetry of white matter microstructure in youth with FASD. Diffusion tensor imaging (DTI; 30 dir) was used to estimate fractional anisotropy (FA) in 7 major bilateral tracts. Youth were part of the Collaborative Initiative on FASD from Los Angeles, USA and Cape Town, South Africa (n=140, 13yr, 46û Control (C) or alcohol-exposed (AE)). Paired correlations were conducted within each subgroup (C-boys; C-girls; AE-boys; AE-girls). Pearson r-values were z transformed before group RM-ANOVA analyses. Preliminary results in male participants revealed a significant group by tract interaction [$F(6, 712)=8.61$, $p<0.001$)]. Tukey's HSD revealed reduced symmetry in FA between the hemispheres in AE compared to C for the cingulum (CGC; $p<0.001$) and the corticospinal tract (CST; $p=0.038$). Findings suggest that AE may enhance asymmetries in white matter microstructure of the limbic (CGC) and motor (CST) systems in boys. Current research is under way to determine sex differences in these patterns. Understanding asymmetries in microstructure of these tracts may elucidate common deficits in emotional regulation and motor control that are common to individuals with a FASD.

P-1-95 Prefrontal structural correlates of cognitive control during adolescent development: a 4-year longitudinal study

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Development of cognitive control has been attributed to the protracted structural maturation of the prefrontal cortex during adolescence. This study examined the relationship between development of two forms of cognitive control (proactive and reactive control) and structural maturation of the anterior cingulate cortex (ACC), dorsolateral prefrontal cortex (dlPFC) and ventrolateral prefrontal cortex (vlPFC)

between early and mid-adolescence. Adolescents (N = 95, 48% male) from Australian primary schools were examined longitudinally at 12 and 16 years of age. A modified Stroop task was used to examine proactive and reactive control. Structural MRI scans were obtained and cortical thickness was measured using FreeSurfer. Linear mixed models were employed to analyze the relationship between brain development and cognitive control development, including sex effects. Results revealed that males exhibited significant longitudinal improvements in reactive control. The magnitude of improvement in proactive control was associated with reduced thinning of the right vlPFC across both sexes, while the magnitude of improvement in reactive control was associated with reduced thinning of the left ACC in males alone. Findings indicate that individual differences in maturation of the ACC and vlPFC underlie the development of reactive and proactive control, but they challenge the notion that greater thinning is more adaptive across all periods of adolescent development. They also highlight the importance of examining sex differences in cognitive and neurobiological maturation.

P-2-96 Protracted development of brain systems underlying working memory into early adulthood: a longitudinal fMRI study.

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Working Memory (WM), the ability to retain and manipulate information on-line to guide goal directed behavior, shows protracted development through adolescence and into young adulthood [Luna et al., 2004]. Cross-sectional studies using functional magnetic resonance imaging (fMRI) have found age related increases and decreases in the magnitude of activity regions supporting WM including dorsolateral prefrontal cortex (DLPFC), posterior parietal cortex (PPC). These discrepancies could be due in part to cohort effects inherent in cross-sectional designs or to different stages of working memory processing. In this longitudinal study, 143 neurotypical individuals ages 8-30 performed a memory-guided saccade (MGS) task during fMRI. Participants were scanned annually for up to 8 years for a total of 378 scans. The MGS task was designed to infer brain activation during WM stages of encoding, delay, and response. Results showed decreases in MGS latency ($p=9.8 \times 10-14$) and improved accuracy ($p=0.01$) with age. In the brain, regional development varied by task stage (all $p<0.05$): 1) encoding - activity decreased in late adolescence/early adulthood in the striatum and hippocampus, 2) maintenance - activity decreased in early adolescence and early adulthood in frontoparietal regions, and 3) retrieval - activity decreased in early adulthood in striatum. These results suggest decreased engagement of WM circuitry in the context of improved WM performance that are specific to different stages of WM processing.

P-1-97 The development of cortico-ventral striatal resting-state functional connectivity over adolescence

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The relative maturation of striatum and cortex is of great interest for understanding the neural basis of increased sensation seeking in adolescence. However, the development of striatal connectivity to cortical regions is not yet well understood. Graph theoretical analyses have suggested development of global network architecture, but these studies have lacked specific descriptions of fine-scaled changes in patterns of corticostriatal connectivity per se and have often been confounded by motion. Here we examine the development fine-scaled voxel-wise patterns of cortico-ventral striatal (VS) resting-state connectivity in 187 subjects aged 10-26. We accounted for motion artifacts using custom preprocessing procedures that include wavelet de-spiking and simultaneous band-pass filtering and nuisance regression. Results showed that the functional organization of cortico-ventrostriatal connectivity was established by childhood with greatest connectivity between VS and anterior cingulate, vmPFC, mediodorsal thalamus, and anterior insula. However, VS connectivity strength decreased to widespread areas of cortex. The greatest age-related decreases in connectivity strength were observed between VS and dorsal and rostral anterior cingulate. These results suggest that striatal predominance may attenuate with development, contributing to decreases in sensation seeking behavior with age. This work provides a step forward in forming a comprehensive understanding of VS maturation in the adolescent human.

P-2-98 Assessing eye movements to investigate reading in children with and without dyslexia

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Naming speed (NS) deficits, impaired timing mechanisms that affect reading fluency, are characteristic of reading difficulty from the early stages of reading into adulthood. NS tasks measure how quickly and accurately subjects can name a set of highly familiar stimuli (e.g., letters) randomly presented in a visual array. We used a letter NS task and three variants that were either phonologically and/or visually similar while participants' eye movements and articulations were recorded. We examined how these manipulations influenced performance and whether there were differences with increased reading acquisition from ages 6-10 and between dyslexic and average readers. Participants were in three groups (n=15/group): dyslexics (age 9-10), chronological-age (CA) controls (age 9-10), and reading-level (RL) controls (age 6-7). For all groups NS manipulations were associated with specific patterns of behavior and saccade performance which were influenced by visual rather than phonological similarity. When the task was both visually and phonologically similar all groups made longer naming times and fixation durations, more naming errors, more frequent and shorter saccades, and had shorter eye-voice spans. Compared to CA controls, dyslexics performed more like RL controls and were less efficient, had longer articulation times, pause times, and fixation durations, shorter eye-voice spans, and made more errors, saccades, and regressions. Overall there were developmental changes in performance in normally achieving children from ages 6-10 that appear to occur more slowly for dyslexics.