Title of Symposium: ACQUIRING KNOWLEDGE: A MULTIMETHOD AND MULTISPECIES SYMPOSIUM ON LEARNING

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Details of Research Subjects: Other

Keywords: learning, attention, memory, neurodevelopment

Ethical Agreement: I agree

Symposium Proposal Text (type or paste from Word doc):

The single most important job that developing organisms have is to master their environments. Learning is the driving mechanism that supports this process of mastery. In this symposium, we will explore biobehavioral mechanisms underlying such learning across development. Beginning in early infancy, Dr. Natalie Brito will present her work exploring links between language exposure, resting EEG and learning outcomes. Next, Dr. Dima Amso will demonstrate how the fundamental precursor for learning, attention, is differentially deployed by children in 2D vs. naturalistic environments. Then, moving through childhood and adolescent stages of development, Dr. Bridget Callaghan will examine the maturation of hippocampal encoding networks during an associative learning task, and Dr. Jennifer Silvers will discuss how the brain encodes safety and fear cues during observational learning of parents and strangers. Using a translational bridge, Dr. Heidi Meyer will then discuss how learning safety gates the expression of fear in adolescence. The innovative work presented in this symposium cuts across several domains (affective, cognitive, virtual, naturalistic), and uses a variety of assessment tools (behavior, EEG, MRI), to bring forth insights on the science of learning. Such insights are highly valued by funding agencies as we strive to better the educational and life prospects of children. Considering that learning is a core instigator of development, this symposium will be of wide interest to the members of ISDP. Top notch female researchers based at 5 different institutions across the United States, and who hail from around the globe, strengthen the international relevance of the symposium.

LEARNING TO ATTEND: 2D AND NATURALISTIC ENVIRONMENTS REQUIRE DIFFERENT LEARNING SYSTEMS.

Dima Amso, Brown University, Providence, RI, United States **(Primary Presenter)**
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Human adults have demonstrated sensitivity to visual context cues, exploiting implicitly learned memories of the structure of the visual environment to facilitate both spatial navigation and visual search. Studies of contextual cueing in childhood have produced mixed

results. These discrepancies may derive from issues with construct validity, the use of screen-based tasks to study an inherently embodied process that depend not only on simple memory and attention, but complex interactions of these systems with bodily frames of reference. The allocentric frame involves information about objects in the environment relative to *each other* (2D), while the egocentric frame includes information about the viewer's location relative to objects in the environment. In naturalistic environments, these frames of reference are coupled in the service of spatial abilities. Here we examined developmental change in naturalistic and 2D contextual cueing in the same *N*=39 4-9 year-old children in two parallel tasks, one in our naturalistic SmartPlayroom space and the other using snapshots of the space in a 2D computerized task. The computational power of the SmartPlayroom allowed us to examine behaviors associated with co-occurrence learning, incidental encoding, relational encoding, and estimation of similarity in path and eye movement trajectories. Our data showed generally successful visual search and spatial attention in both 2D and naturalistic environments, but that incidentally fixating objects in the SmartPlayroom, but not the 2D task, resulted in implicit encoding of object location into memory in a way that resulted in more efficient search when that object later became the target.

ASSOCIATIONS AMONG SOCIOECONOMIC STATUS, HOME LANGUAGE ENVIRONMENT, AND RESTING EEG DURING INFANCY

Natalie Hiromi Brito, New York University, New York, NY, United States **(Primary Presenter),** natalie.brito @ nyu.edu
W.P. Fifer, J. Islerand K.G. Noble

Extensive research has demonstrated socioeconomic disparities in brain structure and function (Brito & Noble, 2014; Hackman & Farah, 2009). However, few studies have examined links among socioeconomic status (SES), experience, brain development and cognitive performance. Socioeconomically disadvantaged children tend to experience less linguistic and cognitive stimulation from their home environments than children from higher-SES homes (Hart and Risley, 1995; Bradley and Corwyn, 2002). The present study examines associations between SES, the home language environment, concurrent EEG power, and language skills for infants 6- to 12-months (current N = 50). We find no correlations between SES and language skills; however, significant positive associations were found between socioeconomic factors (family income, maternal education) and EEG (13-36 Hz) in the left parietal (β:0.21-0.42, $p < 0.05$) left temporal (β:0.30-0.39, $p< 0.05$), and right temporal (β:0.31-0.37, $p< 0.04$) regions. Education, but not income, was associated with the number of adult words heard by the infant in the home (AWC:β=.27, p= .04) and AWC was also correlated with resting EEG (13-36 Hz), in the left parietal (β:0.56-0.88, $p< 0.007$) and right temporal (β:0.38-0.42, $p< 0.04$) regions. When controlling for AWC, parental education (b = -0.03, p= 0.36) was not significantly associated with EEG (R^2= .37, Bootstrap: b = .04, SE = .02, 95% CI = .004 to .09), supporting a mediational hypothesis. Examining environmental mechanisms by which SES disparities operate is imperative in understanding risk and resilience during childhood.

MEMORY MATURATION: UNDERSTANDING THE ROLE OF THE HIPPOCAMPUS IN LONG-TERM MEMORY FORMATION ACROSS DEVELOPMENT

Bridget Callaghan, Columbia University, New York, NY, United States **(Primary Presenter)** blc2139 @ columbia.edu
Nim Tottenham, Columbia University, New York, NY, United States

Episodic memories underlie our sense of self, acting as the cornerstone of human experience. Healthy episodic memories are critical for emotional health as dysregulated memory systems characterize many mental illnesses. While children can learn and remember events for long periods of time, episodic memories undergo rapid change in childhood and through adolescence. However, the neural mechanisms underlying such developmental trajectories are not well explicated. In this study we use functional magnetic resonance imaging (fMRI) to examine the role of the hippocampus in episodic memory encoding during childhood and adolescence (ages 5-17 years). We then assess youth's memory performance outside of the scanner and a week later at their home. We test the prediction that encoding patterns in the hippocampus will strengthen with age, and will predict long term memory performance. The findings from this study are essential for our understanding of typical hippocampal maturation and the neurobiology of learning and memory in childhood.

OBSERVATIONAL LEARNING AS A MECHANISM FOR TRANSGENERATIONAL TRANSMISSION OF FEAR

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We humans do a great deal of learning by observing others, including what to fear and what to trust in our environment. Observational fear learning may be especially important early in life when children turn to their parents to gather information about their world. Yet, the vast majority of empirical research on fear learning in children has thus far focused on firsthand classical conditioning, which may fail to capture one of the primary means by which children acquire fears. To address this gap in the literature, the present study examined observational fear learning in children and adolescents (n=33; age range: 6-17 years) as they watched videos of their parent and an unfamiliar adult undergo fear conditioning. Subsequent to this acquisition learning phase, participants viewed the CS+ and CS- they previously observed in the videos (test phase). Participants demonstrated robust observational fear learning, as indicated by changes in their self-reported liking of the CS+ (a geometric shape that was paired with an aversive noise 80% of the observed trials) and CS- (a geometric shape that was never paired with an aversive noise on the observed trials). Observational learning was enhanced for one's own parent, and this effect was particularly pronounced among children of high-anxiety parents. Parent anxiety also predicted differential prefrontal-amygdala connectivity in their children during observational learning, and this connectivity mediated the relationship between parent anxiety and learning. These results suggest that youth preferentially learn fears via observation of their parents and that learning is influenced by parental emotional traits

AGE DIFFERENCES IN THE IMPACT OF SAFETY SIGNALS ON FEAR EXPRESSION AND REGULATION

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Evidence from both humans and animals has indicated that adolescents are sensitive to threat, and that fear is easily generalized and retained during this developmental stage.

Moreover, although the emergence of anxiety disorders is highly prevalent in developing populations, conventional behavioral treatments are ineffective for a notable percentage of adolescents. An understanding of the development of fear acquisition and regulation is therefore necessary to optimize alternate behavioral treatments better suited for this period. Previously, mitigating elevations in fear responding during adolescence has only been possible through increased exposure to extinction protocols, or pharmacological intervention. However, safety learning may provide a unique avenue to address this issue. Safety signals are stimuli that predict the explicit absence of an aversive outcome and can modulate fear responding through a process known as conditioned inhibition. Our lab has recently carried out a series of studies in mice considering the ontogeny of safety learning and the extent to which safety signals are capable of modulating, or inhibiting, fear during adolescence. Notably, our lab has recently obtained evidence that exposure to safety signals can augment the rate of extinction learning in adolescents, inducing marked improvements in fear regulation relative to conventional extinction training. In addition, our data suggest age differences in how the 'safe' properties of a safety signal are formed and maintained. By utilizing techniques that assess brain circuit-specific activity in tandem with behavioral assays, we have also begun to investigate the mechanism by which safety signals gate the expression of fear behaviors.