Leah Somerville - selected references

1 Jones, R. M., Somerville, L. H., Li, J., Ruberry, E. J., Powers, A., Mehta, N. et al. (2014). Adolescent-specific patterns of behavior and neural activity during social reinforcement learning. *Cogn Affect.Behav.Neurosci., 14,* 683-697.
Notes: Humans are sophisticated social beings. Social cues from others are exceptionally salient, particularly during adolescence. Understanding how adolescents interpret and learn from variable social signals can provide insight into the observed shift in social sensitivity during this period. The present study tested 120 participants between the ages of 8 and 25 years on a social reinforcement learning task where the probability of receiving positive social feedback was parametrically manipulated. Seventy-eight of these participants completed the task during fMRI scanning. Modeling trial-by-trial learning, children and adults showed higher positive learning rates than did adolescents, suggesting that adolescents demonstrated less differentiation in their reaction times for peers who provided more positive feedback. Forming expectations about receiving positive social reinforcement correlated with neural activity within the medial prefrontal cortex and ventral striatum across age. Adolescents, unlike children and adults, showed greater insular activity during positive prediction error learning and increased activity in the supplementary motor cortex and the putamen when receiving positive social feedback regardless of the expected outcome, suggesting that peer approval may motivate adolescents toward action. While different amounts of positive social reinforcement enhanced learning in children and adults, all positive social reinforcement equally motivated adolescents. Together, these findings indicate that sensitivity to peer approval during adolescence goes beyond simple reinforcement theory accounts and suggest possible explanations for how peers may motivate adolescent behavior

2 Somerville, L. H. (2013). Special issue on the teenage brain: Sensitivity to social evaluation. *Curr.Dir.Psychol.Sci., 22,* 121-127.
Notes: Relative to childhood, peer relationships take on a heightened importance during adolescence. Might adolescents be highly attuned to information that concerns when and how they are being evaluated, and what their peers think of them? This review evaluates how continuing brain development - which influences brain function - partially explains or reflects adolescents' attunement to social evaluation. Though preliminary, evidence is mounting to suggest that while processing information relevant to social evaluation and the internal states of other people, adolescents respond with greater emotional intensity and corresponding nonlinear recruitment of socioaffective brain circuitry. This review highlights research findings that relate trajectories of brain development and social behavior, and discusses promising avenues of future research that will inform how brain development might lead adolescents sensitized to social evaluation

3 Somerville, L. H., Jones, R. M., Ruberry, E. J., Dyke, J. P., Glover, G., & Casey, B. J. (2013). The medial prefrontal cortex and the emergence of self-conscious emotion in adolescence. *Psychological Science, 24,* 1554-1562.
Notes: In the present study, we examined the relationship between developmental modulation of socioaffective brain systems and adolescents' preoccupation with social evaluation. Child, adolescent, and adult participants viewed cues indicating that a camera was alternately off, warming up, or projecting their image to a peer during the acquisition of behavioral-, autonomic-, and neural-response (functional MRI) data. Believing that a peer was actively watching them was sufficient to induce self-conscious emotion that rose in magnitude from childhood to adolescence and partially subsided into adulthood. Autonomic arousal was uniquely heightened in adolescents. These behavioral patterns were paralleled by emergent engagement of the medial prefrontal cortex (MPFC) and striatum-MPFC connectivity during adolescence, which are thought to promote motivated social behavior in adolescence. These findings demonstrate that adolescents' self-consciousness is related to age-dependent sensitivity of brain systems critical to socioaffective processes. Further, unique interactions between the MPFC and striatum may provide a mechanism by which social-evaluation contexts influence adolescent behavior

4 Somerville, L. H., Hare, T., & Casey, B. J. (2011). Frontostriatal maturation predicts cognitive control failure to appetitive cues in adolescents. *J.Cogn Neurosci., 23,* 2123-2134.
Notes: Adolescent risk-taking is a public health issue that increases the odds of poor lifetime outcomes. One factor thought to influence adolescents' propensity for risk-taking is an enhanced sensitivity to appetitive cues, relative to an immature capacity to exert sufficient cognitive control. We tested this hypothesis by characterizing interactions among ventral striatal, dorsal striatal, and prefrontal cortical regions with varying appetitive load using fMRI scanning. Child, teen, and adult participants performed a go/no-go task with appetitive (happy faces) and neutral cues (calm faces). Impulse control to neutral cues showed linear improvement with age, whereas teens showed a nonlinear reduction in impulse control to appetitive cues. This performance decrement in teens was paralleled by enhanced activity in the ventral striatum. Prefrontal cortical recruitment correlated with overall accuracy and showed a linear response with age for no-go versus go trials. Connectivity analyses identified a ventral frontostriatal circuit including the inferior frontal gyrus and dorsal striatum during no-go versus go trials. Examining recruitment developmentally showed that teens had greater between-subject ventral-dorsal striatal coactivation relative to children and adults for happy no-go versus go trials. These findings implicate exaggerated ventral striatal representation of appetitive cues in adolescents relative to an intermediary cognitive control response. Connectivity and coactivity data suggest these systems communicate at the level of the dorsal striatum differentially across development. Biased responding in this system is one possible mechanism underlying heightened risk-taking during adolescence

5 Somerville, L. H., Jones, R. M., & Casey, B. J. (2010). A time of change: behavioral and neural correlates of adolescent sensitivity to appetitive and aversive environmental cues. *Brain and Cognition, 72,* 124-133.
Notes: Adolescence is a developmental period that entails substantial changes in affective and incentive-seeking behavior relative to both childhood and adulthood, including a heightened propensity to engage in risky behaviors and experience persistent negative and labile mood states. This review discusses the emotional and incentive-driven behavioral changes in adolescents and their associated neural mechanisms, focusing on the dynamic interactions between the amygdala, ventral striatum, and prefrontal cortex. Common behavioral changes during adolescence may be associated with a heightened responsiveness to incentives and emotional cues while the capacity to effectively engage in cognitive and emotion regulation is still relatively immature. We highlight empirical work in humans and animals that addresses the interactions between these neural systems in adolescents relative to children and adults, and propose a neurobiological model that may account for the nonlinear changes in adolescent behavior. Finally, we discuss other influences that may contribute to exaggerated reward and emotion processing associated with adolescence, including hormonal fluctuations and the role of the social environment