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Adolescent pleasure and novelty seeking is associated with greater neural response in reward and control circuitry during evaluation of risk and reward

Amanda Del Giacco, Angelica M. Morales, Scott A. Jones, Dakota R. KIAMOVICH, Bonnie J. Nagel

OHSU

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Abstract

Adolescence is a period of neurodevelopment during which risky behaviors often increase. This may be explained by the mismatch in brain maturation between bottom-up reward processing networks (which develop early in adolescence), and top-down regulatory control networks (which develop later). However, there are significant individual differences in adolescent risk taking which could be attributable to a variety of factors, such as differences in temperament. This study investigated the neurobiological underpinnings of risk and reward evaluation as they relate to self-reported pleasure derived from novel or intense experiences on the Early Adolescent Temperament Questionnaire. Participants included 265 healthy 12-17 year-old adolescents (~50% female). Participants underwent functional magnetic resonance imaging during a modified Wheel of Fortune task, where they evaluated a series of choices between lower probability/higher reward options (10% probability of winning \$7 vs. 90% probability of winning \$1) and higher probability/lower reward options (30% probability of winning \$2 vs. 70% probability of winning \$1). Whole brain and a priori ventral striatal region-of-interest regression analyses revealed that greater novelty seeking was associated with greater activation in the ventral striatum, posterior cingulate cortex, and left middle frontal gyrus when evaluating higher potential for risk and reward, regardless of the decision made. Novelty seeking was not associated with the proportion of high risk/reward selections. Together, these findings suggest that while adolescents who enjoy novel and intense experiences have greater reward-related brain response in situations with greater potential for risk and reward, they also show greater activation in regulatory control regions, potentially counterbalancing the bottom-up driven reward response. Although there was no association between novelty seeking and risk taking behavior on this task, more research is needed to determine whether individual differences in brain activation related to novelty seeking are related to decision making in more ecologically valid settings (e.g. under peer influence).