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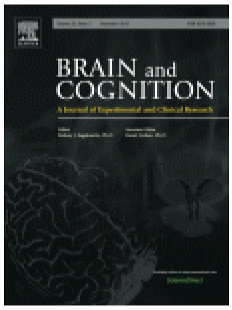

Examining the link between adolescent brain development and risk taking from a social–developmental perspective

Author links open overlay panelTeena Willoughby [a], Marie Good [b], Paul J.C. Adachi [a 1], Chloe Hamza [a 1], Royette Tavernier [a 1]

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Abstract

The adolescent age period is often characterized as a health paradox because it is a time of extensive increases in physical and mental capabilities, yet overall mortality/morbidity rates increase significantly from childhood to adolescence, often due to preventable causes such as risk taking. Asynchrony in developmental time courses between the affective/approach and cognitive control brain systems, as well as the ongoing maturation of neural connectivity are thought to lead to increased vulnerability for risk taking in adolescence. A critical analysis of the frequency of risk taking behaviors, as well as mortality and morbidity rates across the lifespan, however, challenges the hypothesis that the peak of risk taking occurs in middle adolescence when the asynchrony between the different developmental time courses of the affective/approach and cognitive control systems is the largest. In fact, the highest levels of risk taking behaviors, such as alcohol and drug use, often occur among emerging adults (e.g., university/college students), and highlight the role of the social context in predicting risk taking behavior. Moreover, risk taking is not always unregulated or impulsive. Future research should broaden the scope of risk taking to include risks that are relevant to older adults, such as risky financial investing, gambling, and marital infidelity. In addition, a lifespan perspective, with a focus on how associations between neural systems and behavior are moderated by context and trait-level characteristics, and which includes diverse samples (e.g., divorced individuals), will help to address some important limitations in the adolescent brain development and risk taking literature.

Introduction

The adolescent age period is often characterized as a health paradox because it is a time of extensive increases in physical and mental capabilities, yet overall mortality/morbidity rates increase significantly from childhood to adolescence (Casey and Caudle, 2013, Dahl, 2004). Moreover, the primary causes of death and disability among adolescents are not related to disease, but rather to preventable forms of injuries (e.g., unintentional injuries, suicide, and homicide), and are linked to involvement in health-risk behaviors such as substance use and delinquency (Dahl, 2004). While extensive research has been conducted examining how the social context (e.g., peer and family influence) and individual differences in personality factors (e.g., sensation-seeking, impulsivity) are linked to adolescent risk taking behaviors (e.g., Donohew et al., 2000, Romer et al., 2011), more recently researchers have started to focus on how adolescent brain development might be implicated in these behaviors (e.g., Steinberg, 2008, Telzer et al., 2013).

Models of adolescent brain development such as the Dual Systems Model (see Steinberg, 2008) suggest that adolescents may experience a temporal gap between a relatively early maturing affective/approach system and a slower maturing cognitive control system (e.g., Ernst et al., 2006, Geier and Luna, 2009). The early maturing affective/approach system is hypothesized to be a result of increases in dopaminergic activity and subcortical brain structures such as the ventral striatum, perhaps linked to puberty, leading to increases in reward seeking and need for novelty (see also the Triadic model for a further distinction between the approach/reward and avoidance/emotion systems; Ernst et al., 2006). In contrast, the slower maturing cognitive control network is hypothesized to be led by the prefrontal cortex, responsible for planning, judgment, and inhibition, and is thought to not be fully mature until the mid-20s (Ernst et al., 2006, Galvan et al., 2006). Neural connections among brain regions also continue to strengthen across adolescence into young adulthood (Dosenbach et al., 2013, Eluvathingal et al., 2007, Paus, 2009). This asynchrony in developmental time courses between the affective/approach and cognitive control systems, and the ongoing maturation of neural connectivity are thought to lead to increased vulnerability for risk taking (Casey et al., 2008, Ernst, this issue, Giedd, 2004, Steinberg, 2008; but see Pfeifer & Allen, 2012, for a critique of this hypothesis), particularly during the middle adolescent period (Steinberg, 2008). Adolescents are thought to be at risk particularly in situations in which they feel high arousal (e.g., when they are with their peers, and/or in emotionally salient situations (Casey et al., 2011, Ernst et al., 2009, Geier and Luna, 2009, Hare et al., 2008, Steinberg, 2008). These new insights into adolescent brain development have played a critical role in increasing our understanding of adolescent engagement in risk taking behaviors.

The focus of the present article is to highlight relevant social developmental research on risk taking across the lifespan in order to add to the current discussion regarding the link between adolescent brain development and risk taking, as well as to offer a few suggestions for how future research in this area might be harnessed to increase our understanding of risk taking behaviors. We focus specifically on the following questions: (a) Are the increases in mortality and risk taking behaviors from childhood to adolescence as dire as often implied? (b) Does the peak age of involvement in real-world risk taking correspond to predictions based on the Dual Systems Model of adolescent brain development? (c) Is risk taking necessarily unregulated? and (d) What differs between adolescent and adult risk taking?

Section snippets

National statistics on mortality

Significant increases in mortality and morbidity from childhood to adolescence have been documented in Western culture (e.g., National Vital Statistics Reports, 2012), a fact that has been repeated often by researchers studying risk taking in adolescence (e.g., Casey and Caudle, 2013, Dahl, 2004, Geier et al., 2010). Rarely mentioned, however, is that although mortality increases from childhood to adolescence in these cultures, very few children or adolescents die. As presented in Fig. 1, the

Question 2: Does the peak age of involvement in real-world risk taking correspond to predictions based on the Dual Systems Model of brain development?

Similar to unintentional injuries, there is a widely held perception by researchers, media, and policy makers that high rates of risk taking, such as substance use, reckless driving, and sexual risk taking, are more common during adolescence than at any other age period (e.g., Dahl, 2004; Galvan, 2013, Somerville et al., 2010, Steinberg, 2005). Indeed, according to the Dual Systems Model of adolescent brain development, the peak age of potential for risky behavior should be in *middle adolescence*

Question 3: Is risk taking necessarily unregulated?

One of the assumptions of adolescent brain development models (e.g., Dual Systems Model; Triadic Systems Model) is that risk taking in adolescence is often impulsive, in that it results from a lack of self-control (i.e., adolescents have difficulty regulating their impulses to engage in risky behavior due to an immature cognitive control system, particularly under conditions of high arousal; Steinberg, 2008). We contend, however, that risk taking is not necessarily unregulated or impulsive, and

Question 4: What differs between adolescent and adult risk taking?

While the previous section explored how risk taking behavior in adolescence may not always be the result of *unregulated* decisions, here we draw attention to the fact that unregulated (i.e., emotional, impulsive) risk taking resulting in harmful consequences is not limited to adolescence. Although adolescent brain development models suggest that adolescence might be the age at which individuals may be most vulnerable to risk taking behaviors, particularly in the presence of strong emotions or

Conclusions

Adolescent brain development models, such as the Dual Systems Model (see also the Triadic Systems Model), increasingly have been used to account for the incidence of risk taking in adolescence (Ernst, this issue, Steinberg, 2005). A critical analysis of the frequency of risk taking, as well as mortality and morbidity rates across the lifespan, however, challenge the hypothesis that the peak of risk taking should occur in middle adolescence when the asynchrony between the relatively early

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References (95)

- E.H. Telzer *et al.*

  Ventral striatum activation to prosocial rewards predicts longitudinal declines in adolescent risk taking
  Developmental Cognitive Neuroscience
  (2013)
- L. Steinberg

  A social neuroscience perspective on adolescent risk-taking
  Developmental Review
  (2008)
- L. Steinberg

  Cognitive and affective development in adolescence
  Trends in Cognitive Sciences
  (2005)
- M.S. Stanford *et al.*

  Impulsiveness and risk taking behaviors: Comparison of high-school and college students using the Barratt Impulsiveness Scale
  Personality and Individual Differences
  (1996)
- L.H. Somerville *et al.*

  A time of change: Behavioral and neural correlates of adolescent sensitivity to appetitive and aversive environmental cues
  Brain and Cognition
  (2010)
- P. Slovic *et al.*

  Rational actors or rational fools: Implications of the affect heuristic for behavioral economics
  Journal of Socio-Economics
  (2002)
- K.L. Rush *et al.*

  A photovoice study of older adults' conceptualizations of risk
  Journal of Aging Studies
  (2012)

- J.H. Pfeifer *et al.*

  Arrested development? Reconsidering dual-systems models of brain function in adolescence and disorders
  Trends in Cognitive Sciences
  (2012)
- R. Leshem *et al.*

  The construct of impulsivity revisited
  Personality and Individual Differences
  (2007)
- S. Hooshmand *et al.*

  Does the direction of effects in the association between depressive symptoms and health-risk behaviors differ by behavior? A longitudinal study across the high school years
  Journal of Adolescent Health
  (2012)

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