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

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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.

1. 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 & 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, Betancourt, Brodsky, Giannetta, & Yang, 2011), more recently researchers have started to focus on how adolescent brain development might be implicated in these behaviors (e.g., Steinberg, 2008; Telzer, Fuligni, Lieberman, & Galván, 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, Pine, & Hardin, 2006; Geier & 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, Petersen, & Schlaggar, 2013; Eluvathingal, Hasan, Kramer, Fletcher, & Ewing-Cobbs, 2007; Paus, 2009). This asynchrony in developmental time courses between the affective/approach and cognitive control

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systems, and the ongoing maturation of neural connectivity are thought to lead to increased vulnerability for risk taking (Casey, Getz, & Galvan, 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, Jones, & Somerville, 2011; Ernst, Romeo, & Andersen, 2009; Geier & 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?

2. Question 1: Are the increases in mortality and risk taking from childhood to adolescence as dire as often implied?

2.1. 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 & Caudle, 2013; Dahl, 2004; Geier, Terwilliger, Teslovich, Velanova, & Luna, 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 crude rate of deaths in 2005 for 10–14 year old Canadian children, for example, was 4.9 per 100,000 population, or 0.0049%. Similarly, in the US the crude rate of deaths in 2009 for 10–14 year olds was 6.8 per 100,000 population, or 0.0068% – see Fig. 2. In adolescence

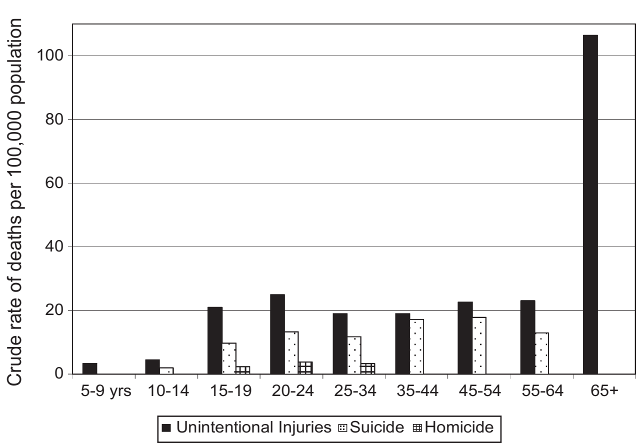

Fig. 1. Death rates per 100,000 population in Canada, 2005. Suicide rates unavailable for people aged 65 years and above, and homicide rates unavailable for people aged 35 years and above. Adapted from Public Health Agency of Canada. Retrieved from http://www.phac-aspc.gc.ca/publicat/lcd-pcd97/table1-eng.php.

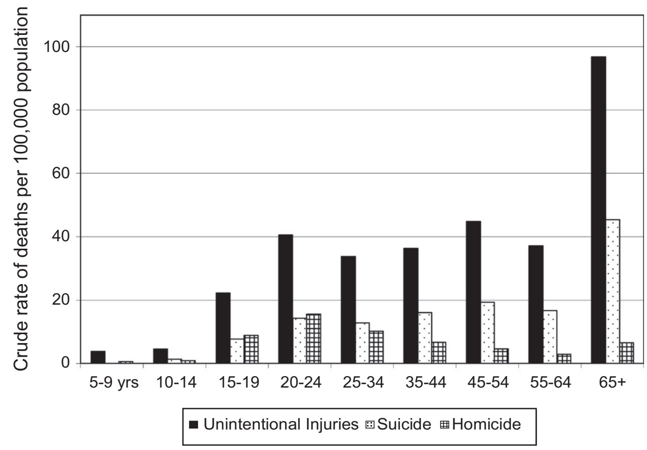

Fig. 2. Death rates per 100,000 population in United States, 2009. Adapted from National Vital Statistics Reports, Vol. 60, No. 3, and Vol. 61, No. 7, October 26, 2012.

(i.e., from 15 to 19 years of age), these rates climbed to 33.1 per 100,000, or 0.0331%, in Canada, and 38.9 per 100,000, or 0.0389% in the US. While these increases are significant, and of course every death in that age group is tragic, the mortality rate for adolescents in these countries is still less than 1/20 of one percent. In other words, the survival rate of high school students in North America is an impressive 99.96%. Note also that the death rate continues to rise in emerging adulthood, and therefore, is not particularly characteristic of adolescence.

2.2. National statistics on morbidity

Moreover, traditional morbidity measures indicate that relatively few children and adolescents experience disease, such as cancer and heart disease. There are significant increases, however, in unintentional injuries from childhood to adolescence. For example, in the US, 14,490 youth (per 100,000 population, or 14.49%) aged 15–19 were treated for unintentional injuries in hospital emergency departments in 2005, in contrast to 11,228 youth aged 10–14 (per 100,000 population, or 11.23%) – see Fig. 3. In addition, specifically in terms of inpatient hospitalizations, in 2005 the rate for unintentional injuries was 464 per 100,000 population for 15–

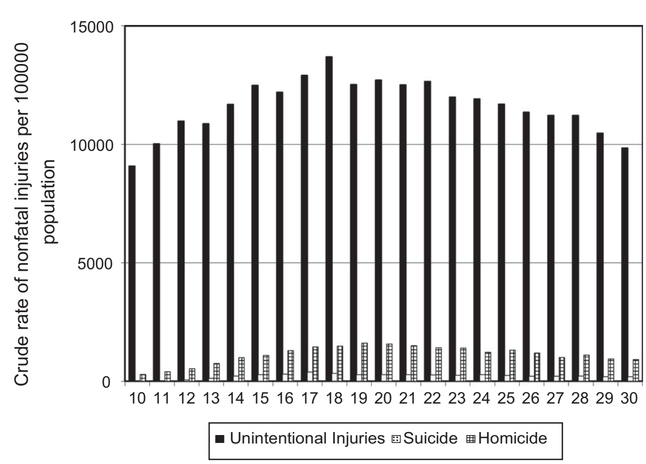

Fig. 3. National estimates of injuries per 100,000 population treated in U.S. hospital emergency departments for 2005. Adapted from National Center for Injury Prevention and Control. *Data source*: NEISS All Injury Program operated by the Consumer Product Safety Commission for numbers of injuries. Bureau of Census for population estimates.