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Editorial

Current theories of risk and rational decision making

There are few topics that are more important than risk and rational decision making, as the contributions to this special issue attest. If we contemplate the risks and consequences of smoking, substance use, reckless driving, violent crime, and unprotected sex, we cannot help but conjure up an image of the stereotypical, irrational risk taker: the adolescent. Statistics confirm that adolescents and young adults are disproportionately responsible for carnage on the highway, new cases of HIV/AIDS, initiation of poor lifestyle choices such as smoking and unhealthy eating, and a host of other risk-taking behaviors that pose challenges for the law, public health, clinical psychology, and public policy (Reyna & Farley, 2006). Therefore, it is not surprising that the articles contained in this issue on risk and rational decision making focus on adolescence, which had been neglected until the recent flurry of work on this time of life.

Although the focus is on adolescence, and on the developmental differences between adolescents and other age groups, the implications of this body of work are far-reaching. Each contributor has articulated a theoretical framework that is guiding the science of risky behavior in new directions, albeit from varied perspectives (e.g., emphasizing cognitive, social, emotional, public health, or behavioral neuroscience approaches). The discussant, a distinguished legal scholar, has ably integrated the papers and identified key theoretical and policy implications. Theories of adult behavior must take account of these perspectives or leave themselves open to the obvious criticisms that they are (a) incomplete because they ignore the origins of behavior and (b) irrelevant because they ignore major causes of death and human suffering. Thus, this special issue provides an authoritative review of developmental research on risk and rational decision making, with fundamental implications for theories of reasoning, judgment, and decision making, especially neurobiological and dual-process theories.

Adolescent risk-taking and the science of judgment and decision making

Before moving on to the specific contributions to this issue, we want to say a word or two about how research on adolescent risk-taking fits into the larger enterprise of judgment-and-decision-making research. The study of judgment and decision-making has emerged as a field at the intersection of important problems in law, medicine, economics,

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and business. Major thinkers in this field have been awarded Nobel prizes for their work, including Maurice Allais, Herbert Simon, and Daniel Kahneman. As these lists suggest, research has focused most particularly on risk and uncertainty.

Two basic research strategies or approaches to doing science have been applied to the study of risk and uncertainty: The first, which characterizes work appearing in prominent adult journals (e.g., *Psychological Science*, *Journal of Experimental Psychology: Learning, Memory, and Cognition*, and *Psychonomic Bulletin & Review*), mainly concerns the psychology of the college sophomore. That is, it consists of experiments conducted with young adults that are aimed at understanding the processes that control their behavior in laboratory analogies of everyday risk-taking, such as the well-known framing problem as well as other games and gambling tasks. The other approach is aimed at understanding the processes that control the behavior of various subject populations for whom risk is part of their "job description" (i.e., who are engaged in risk-taking as a matter of course): insurers, stock traders, emergency-room physicians, attorneys working on contingency fees, military and political leaders, intelligence and special forces officers, race car drivers, mountain climbers, and others. Although studying these populations tells us about risk-taking, the problem is that these categories of people might be peculiar in some way. Being in these roles is the result of a self-selection (and other-selection) process; only peculiar people might get into these roles in the first place.

Adolescents, however, provide a normative sample of people for whom risk-taking is a preoccupation of daily life. Moreover, as the articles in this special issue demonstrate, it is possible to conduct high-quality research that takes both approaches to doing science: Laboratory studies can be, and have been, conducted with adolescent samples, but studies have also been conducted that follow the adolescent into the real world of drinking, driving, drug-taking, and sexually transmitted disease. Thus, the work in this issue is an example of an approach that combines the best of both worlds: basic science, including basic theories that apply to adult decision making, and applied science, including real-world risk-taking. It is also an example of a special approach that eliminates a potential problem. By selecting a time of life at which risk-taking is normal (and is at a high-water mark), we avoid many of the problems of selection bias. Just as memory problems are a hallmark of aging (and so it is natural to study memory processes in aging), problems with risk-taking are characteristic of adolescence, and thus it is natural to study these problems in adolescence. One might say that adolescents are the "*Drosophila*" of risk-taking research because they are such a natural preparation for understanding this fundamentally human phenomenon.

Behavioral decision-making framework

As an inheritor of the dominant expectancy-value approach in judgment and decision-making, and a pioneer in research on adolescent risky decision making, it is fitting to begin with the work of Baruch Fischhoff. In this issue, Fischhoff (2008) makes a compelling case for the behavioral decision-making framework, emphasizing assessment of decision-making competence and providing a clear-eyed analysis of the components of this competence. Readers will find this article very useful; it is a succinct yet comprehensive description of an approach that has produced empirical breakthroughs concerning both adult and adolescent risky decision making. Among these findings is the noteworthy and now replicated finding that adolescents do not consider themselves to be invulnerable, exploding a myth

that was once "received wisdom" and that continues to be believed by many practitioners and policy makers despite the evidence against it (e.g., Quadrel, Fischhoff, & Davis, 1993; see also Millstein & Halpern-Felsher, 2002). Table 1 in Fischhhoff's article provides additional evidence against the invulnerability hypothesis, showing that adolescents overestimate a myriad of risks to themselves, including their own mortality (data are derived from Bruine de Bruin, Parker, & Fischhoff, 2007). Although overestimation of risks is not an invariant finding, nevertheless, these findings join a growing number of findings showing that adolescents do not believe that they are immortal, but, on the contrary, they envision an unduly premature death (see also Jamieson & Romer, 2008; Reyna & Farley, 2006; Fig. 12). Fischhoff ascribes the latter findings more to measurement error and adolescents' inability to skillfully use numerical response scales rather than to their real beliefs ("mortality judgments are anomalous"). It is a measure of how far the debate has shifted, however, that we are discussing the degree to which adolescents' overestimation, as opposed to underestimation, of risk is real.

A great variety of decisions can be described using the components of the behavioral decision-making framework, as Fischhoff (2008) well illustrates. Furthermore, guidance is provided on proper assessment of these components, namely, how to assess subjective probabilities (what adolescents believe) and values (what adolescents want or prefer). Fischhoff explains how values can be extracted through decision analysis if preferences are well-articulated or through methods that encourage reflection if they are not (e.g., the value elicitation approach). Although subjective probabilities and values constitute the basic building blocks of the behavioral decision-making framework, Fischhoff shows how social and affective factors can have influences on behavior via these constructs. Thus, this approach is powerful but relatively unconstrained. It can accommodate a variety of "theories" and possible results. For example, Fischhoff discusses how the framework accommodates multiple factors—and more factors could be added—that possibly influence how adolescents discount future outcomes (analogous to Frederick, Loewenstein, & O'Donoghue's, 2002, seven proposed factors; Table 2, Fischhoff). As Fischhoff concludes, "From a behavioral decision research perspective, there can be no simple answer."

Prototype–willingness model

Like the behavioral decision-making framework, the prototype–willingness model of Gerrard, Gibbons and associates (2008) is descended from expectancy-value approaches, in particular, the theories of reasoned action and of planned behavior. In addition to beliefs and values, the latter theories include perceptions of control, social norms, and self-efficacy in determining behavioral intentions, which are then used to predict behavior. Although much research on adolescent risk-taking has been guided by such "deliberative" theories, newer approaches such as the prototype–willingness model emphasize the "less deliberative modes of decision making." The concept of "willingness" captures, in part, what is meant by less deliberative modes of decision making. Willingness appears to be a more sensitive measure than either intention or expectation. Adolescents will divulge that they are willing to engage in socially less acceptable behaviors even when they deny that they intend or expect to engage in those behaviors, and willingness is associated with a greater tendency to take risks.

Although earlier deliberative models had multiple components, they assumed a single mode of analytical processing. Analytical processing could be engaged in well or poorly,

and it was assumed to be subject to a "garbage in-garbage out" constraint on reasoning, namely, that if beliefs were faulty, decisions would be faulty. Lack of information, or combining information incorrectly, could also lead to poor decisions, as in the behavioral decision-making framework. But a single kind of thinking was assumed. In contrast, the prototype–willingness model is a dual-process model, a feature shared by Casey, Getz, and Galvan's (2008) developmental cognitive neuroscience approach, by Steinberg's (2008) social neuroscience approach, and by Rivers, Reyna, and Mills', 2008 fuzzy-trace theory. According to the prototype–willingness model, there is a reasoned path to adolescent risk-taking (incorporating assumptions from the theories of reasoned action and planned behavior) and "a social reaction path that is image-based and involves more heuristic processing." Although intention is the product of the reasoned path, willingness is the product of the reactive path. Prototypes are the images of typical members of social categories (e.g., smokers or non-smokers). Similar to the concept of gist in fuzzy-trace theory (derived from earlier cognitive constructs such as prototypes and schemas), images also have positive or negative valences. The more favorable an image (e.g., of smokers), the more willing adolescents seem to be to accept the social costs associated with engaging in risky behaviors (e.g., smoking).

Gerrard et al. (2008) offer an encyclopedic overview of evidence gathered to-date in the tradition of theories of reasoned action and related models, such as the prototype–willingness model, especially with respect to developmental issues. Their model is more encompassing than internal factors, such as willingness and prototypes. They also incorporate external factors, such as media exposure to alcohol and violence (which affects prototype favorability) and accessibility to alcohol and drugs in neighborhoods (which affects risk opportunity). Not surprisingly, willingness is more strongly tied to risk-taking in environments in which substances and other temptations are accessible. As Gerrard et al. so pithily put it, "When few substances were available, adolescent willingness did not result in much use." This result reinforces the importance of the context in which risky activities occur, as Steinberg (2008) argues. However, as we shall discuss, behavioral decision-making and dual-process theories differ from neurobiological approaches in their emphasis on interventions, on changing the individual as well as changing the environment.

Developmental cognitive neuroscience framework

Casey et al. (2008) also propose a dual-process model, but one that is derived from recent human imaging and animal studies. Three kinds of neuroimaging evidence are reviewed: structural MRI, which is used to measure the size and shape of brain structures; functional MRI which is used to measure patterns of brain activity; and diffusion tensor imaging (DTI) which is used to trace connectivity of white-matter fiber tracts. Despite the inherent challenges, Casey et al. make this material accessible to a broad audience. Behavioral researchers looking for a readable and integrative overview of research on risk-taking and the adolescent brain, written by experts in the field, will find that this article fills the bill. Moreover, it is apparent from this overview that research in behavioral neuroscience is in the mainstream of work on adolescent risk-taking, essential for understanding social, emotional, and cognitive mechanisms of development—and for understanding the challenges that human biology poses for public health interventions.

As Casey et al. (2008) discuss, there is broad consensus among developmental researchers that cognitive control (inhibition) increases with age across childhood and adolescence, and that this increase is associated with maturation of the prefrontal cortex. The importance of cognitive control is distilled by Casey et al. into a statement that is redolent with implications for social, emotional, cognitive, and biological development: "A cornerstone of cognitive development is the ability to suppress inappropriate thoughts and actions in favor of goal-directed ones, especially in the presence of compelling incentives." As suggested by this statement, there are few major applied problems in education, mental health, or law enforcement that are not directly tied to this ability.

Casey et al. (2008) rely on emerging neurobiological evidence concerning developmental differences, knitting disparate sources of evidence together. Dual processes are substantiated, in part, by findings showing differential development across brain regions: Although the prefrontal cortex, crucial to cognitive control, matures relatively slowly from childhood through adolescence, subcortical regions mature relatively quickly. Neuroimaging studies of reward-related processing have homed in on a subcortical region called the nucleus accumbens, a portion of the basal ganglia involved in the anticipation of rewards. Recent research has shown that adolescents have enhanced accumbens activity in response to rewards, compared to either children or adults. Thus, in Casey et al.'s model, adolescent risk-taking is the result of an unequal competition between immature, top-down control from the prefrontal cortex and heightened activation in subcortical reward areas (reflecting heightened responsiveness to rewards; see Fig. 1 in Casey et al.). Top-down control in adolescence is further undermined by delayed functional connectivity between these prefrontal cortical and limbic subcortical regions.

Further, Galvan, Hare, Voss, Glover, and Casey (2007) showed that, across age, individual differences in risk-taking were associated with greater activation in the nucleus accumbens. The flip side of cognitive control is impulsivity (i.e., difficulty with inhibition), which was also found to differ across age. Impulsivity, however, was not associated with accumbens activation. This pattern of findings is consistent with recent work showing that impulsivity (or delay of gratification) is empirically distinguishable from preferences for risk-taking (Green & Myerson, 2004; Myerson, Green, Hanson, Holt, & Estle, 2003; see also Reyna & Farley, 2006). Therefore, although words such as "impulsive" and "risk-seeking" have been used almost interchangeably to describe adolescent behavior, Casey et al. review evidence supporting the conclusion that "these constructs rely on different cognitive and neural processes."

Developmental social neuroscience framework

Steinberg (2008) summarizes, organizes, and interprets a wealth of data, ranging from effects of gonadal hormones at puberty (on the proliferation of receptors for oxytocin, implicated in social bonding) to neuroimaging of anger (that individuals who are susceptible to peer influence may be unusually aroused by anger in others but less able to inhibit their responses). He ties this variegated evidence together using a dual-process model pitting cognitive control against socio-emotional systems. (Risk-taking decreases because of the former and it increases because of the latter.) Like Casey et al. (2008), Steinberg premises his dual-process approach on the observation that risk-taking appears to increase between childhood and adolescence, and to later decrease in adulthood. Linear or mono-

tonic trends in cognitive control are not sufficient to explain such trends because, by themselves, they predict that children ought to be more risk-seeking than adolescents (assuming that all other factors are equal, such as risk opportunity).

Steinberg (2008) argues that logical reasoning and basic information-processing abilities of adolescents are comparable to those of adults, and thus "the factors that lead adolescents to engage in risky activity are social and emotional, not cognitive." Although the decrease in risk-taking from adolescence to adults is attributable to maturation in the cognitive control system, according to Steinberg, the earlier maturing "socio-emotional system" leads to increased reward seeking (and, hence, risk-taking) in adolescence. Relatively little research has been conducted on reasoning and information processing in adolescents, but the research that has been done suggests that the underlying competence to reason logically or probabilistically is present as early as elementary school, but is not necessarily tapped in decision making even by adults (Reyna & Brainerd, 1994). Steinberg, then, focuses on the key question: What factors interfere with the ability to express that competence, especially in adolescence? Like Gerrard et al. (2008) and Casey et al. (2008), Steinberg points to a "socio-emotional system that leads to increased reward seeking, especially in the presence of peers."

A particularly dramatic example of peer effects on risk-taking is provided by results of a study on simulated driving conducted with adolescents (mean age 14), youths (mean age 20), and adults (mean age 34). Subjects performed the driving task alone or in the presence of friends (Gardner & Steinberg, 2005). In the task, a yellow traffic light signals that a wall will appear and the car will crash. The longer that subjects drive, the more points they get, but they also run the risk of crashing into the wall. The mere presence of friends "doubled risk-taking among the adolescents, increased it by 50% among the youths, but had no effect on the adults." As Steinberg (2008) discusses, recent research with adolescents shows that social stimuli, such as peer acceptance (relative to rejection), activate brain areas known to be sensitive to reward. A large study of respondents ranging from 10 to 30 years old ($N = 935$) confirmed that measures reflecting sensation-seeking and reward sensitivity increased from mid-childhood (age 10) until mid-adolescence (age 13–16). Tantalizing pilot data suggest that the presence of peers in the simulated driving task also activates reward circuitry. Such results are interpreted as showing that peers may make risk-taking more rewarding. As Steinberg concludes, "In adolescence, then, more might not only be merrier—more may also be riskier."

The mechanisms underlying social rewards in the brain are not entirely understood but Steinberg (2008) provides a cogent description of the working of the dopaminergic system. As Steinberg states, "dopamine plays a critical role in the brain's reward circuitry." Therefore, remodeling of the dopaminergic system at puberty, and subtle changes in the number or relative density of dopamine receptors in cortical and subcortical areas of the brain, are plausibly implicated in changes in responsiveness to rewards during adolescence. Steinberg also provides an extremely thoughtful discussion of diverging views as to whether adolescents pursue rewards because they experience stimuli as less rewarding (the "reward deficiency syndrome") or as more rewarding, relative to children and adults. Steinberg points out that adolescents do not consistently show more limbic activity when exposed to emotional stimuli than adults. Instead, it is the coordination (through improved connectivity) between cortical and subcortical limbic regions—the dance between affect and thinking—that may develop (Finucane, Peters, & Slovic, 2003; see also Rivers et al., 2008 below).

Fuzzy-trace theory

Many dual-process approaches assume that adolescents take risks not because they decide to do so, but, instead, because they react rather than decide. As we have seen, this view is variously enshrined in theory as the social reactivity path (Gerrard et al., 2008), the socio-emotional system (Steinberg, 2008), and the subcortical limbic system (which includes connected brain areas; Casey et al., 2008). Fuzzy-trace theory similarly assumes that reactivity decreases from childhood through adulthood, and that inhibition correspondingly increases (Reyna & Mills, 2007; Rivers et al., 2008). However, according to this theory, the "other" dual-process that opposes reactivity (or inhibition) is not solely analytical. (Fuzzy-trace theory remains a dual-process theory of reasoning because there are two qualitatively different reasoning modes; inhibition is not a reasoning mode but operates to withhold thoughts and actions.) In addition to a "verbatim-based" (focusing on precise literal details of information or experience) analytical mode of risky decision making, a gist-based intuitive mode is assumed. This gist-based intuitive mode operates on simple, bottom-line representations of the meaning of information or experience (see Reyna & Brainerd, 1995; Rivers et al., 2008). In this article, Rivers et al., 2008 describe how emotion interacts with different modes of thinking to produce risk-taking in adolescence, reviewing research on emotion conceived as valence (positive–negative), arousal (excited–calm), feeling states (moods), and discrete emotions (e.g., anger vs. sadness).

Rivers et al. (2008) review the tenets of fuzzy-trace theory, which have been supported by empirical tests, including tests of mathematical models used to separately estimate gist-based, verbatim-based, and inhibitory processes. Fuzzy-trace theory is consistent with findings from a recent review of the existing literature on real-life risk-taking in adolescence (Reyna & Farley, 2006; see also Romer, 2003), but it has also led to new predictions and findings concerning adolescent risk-taking that are discussed. A key finding is that risk-taking in the laboratory and in real-life has been found to often be analytical and intentional, that it involves an analytical process of weighing magnitudes of risks and benefits, and trading them off against one another. Thus, adolescents' conscious, reflective ratings of personal perceptions of risks and benefits often predict their behavior (see Reyna & Farley, 2006). Although risk takers might regret negative outcomes, they do not necessarily recant their perceptions of risks and benefits, which provide the calculus for their decisions. According to traditional economic theories, these decisions could be viewed as "rational" inasmuch as adolescents are pursuing their goals in accordance with their beliefs and values. However, according to fuzzy-trace theory, this kind of intentional, calculated risk-taking is supplanted in mature adults by a simpler meaning-based approach that involves getting the core "gist" of important decisions, which allows adults to avoid unhealthy risks. Experiments on risky decision making have demonstrated that adults' behavior can be explained by specific gist-based processing and that younger adolescents' behavior can be explained by specific verbatim-based processing (e.g., Mills, Reyna, & Estrada, in press; Reyna, 1996; Reyna & Ellis, 1994).

As Rivers et al. (2008) discuss, strong emotions permeate adolescent risk-taking. A central conclusion to emerge from this review is that gist representations frequently incorporate emotion (or affect), coloring the perception of risks and benefits and, hence, determining risk-taking. Research has long shown that valence is encoded automatically and persists over time in memory, hallmarks of gist representations (Osgood, Suci, & Tannenbaum, 1957; Zajonc, 1980). Valence, derived from experience, supplies intuitions that

protect adults from harm (e.g., Bechara, Damasio, Tranel, & Damasio, 2005). For example, as a result of social and cultural exposure, many adolescents derive the "valenced knowledge" that unsupervised parties are "fun" and are likely to encode them positively when faced with a decision (similar to images in prototype–willingness theory; see Fig. 1 in Rivers et al.). Young children lack the experience to know much about what an unsupervised party entails, engendering a neutral reaction. Adults, however, "perceive readily the unsupervised party to be risky as negatively valenced knowledge is conjured up automatically, quickly likening the behavior to other obvious risks (such as driving drunk or having unprotected sex)." There is an abundant literature on valence (or affect) the details of which support interpretation in terms of gist representations (see also Reyna & Brainerd, 2008).

Rivers et al. (2008) also review research on mood congruency and other affect-as-information results, memory and emotion, reliance on gist-based stereotypes and heuristics, and the relation between arousal and inhibition. This research indicates that emotions conceived as valence, arousal, feeling states, or discrete emotions infiltrate the decision process in different ways. Emotions interfere with adolescents' ability to recognize the gist that danger is present; to reliably retrieve their values and principles that would protect them against unhealthy risk-taking; and to reason "above the fray" of strong emotions using fragile, newly acquired gist representations rather than competing low-level, verbatim surface details (e.g., the irrelevant detail that the teens at an unsupervised party have never gotten in trouble before). Different emotions also warrant gist interpretations of decision situations and pre-load responses to risk (e.g., anger encouraging risk-taking and fear discouraging it) regardless of the verbatim facts of such situations (Lerner & Keltner, 2001). Different emotions bias information processing to focus either on those gist interpretations or on the verbatim facts. In short, "a full account of risk-taking must encompass the role of emotion, in particular, the mechanisms through which it affects decision making." According to fuzzy-trace theory, analysis or cold cognition is not the only alternative to reactive, impulsive processing: Gist-based intuition has been used to explain and predict risk-taking in children, adolescents, and adults—and to design interventions to reduce unhealthy behaviors (Reyna, in press; Rivers et al.). Emotion is an important factor that defines, guides, and, at times, disrupts that gist-based intuition.

Conclusions: Settled issues and open questions

The authors of the articles in this special issue on Current Theories of Risk and Rational Decision Making agree on a number of fundamental issues. First, they agree that adolescent risk-taking is a crucially important health and public policy issue, and they each provide disturbing statistics to support this view. Sunstein (2008), a leading scholar of public policy, reinforces that point (and suggests "tools that policymakers might use if they seek to move adolescents in better directions"). Despite the seriousness and pervasiveness of this problem, it has only recently begun to attract a concerted intellectual effort. To be sure, there are longstanding efforts to describe the extent of the problem, as exemplified by the Youth Risk Behavior Survey (part of the Youth Risk Behavior Surveillance System of the Centers for Disease Control and Prevention) and other similar instruments. Recently, the MacArthur Foundation Research Network on Adolescent Development and Juvenile Justice launched an admirable effort to build a foundation of knowledge relevant to juvenile justice—but the problems of adolescent risk-taking far outstrip the confines of

the legal system. Medicine, education, transportation, and mental health are among the areas in which adolescent risk-taking exacts an enormous toll in economic costs and human lives. However, research that focuses on causal mechanisms of adolescent risk-taking, and that integrates such research with neurobiology or with rigorous theories of adult judgment and decision-making, has been rare. Such research is essential, in our view, to make the scientific advances that will break the causal chain that produces adolescent mortality and morbidity.

The articles in this issue are an excellent first wave in what we hope will be a flood of theoretically motivated research on adolescent risk-taking. This work is more than a proof-of-concept that deep theoretical work can be done on this important practical problem; the research programs represented in these articles are models of the kind of research that is needed. We have also argued that their scientific significance goes beyond adolescence. The influence of theories of adolescent risk-taking and theories of adult judgment and decision-making ought to be reciprocal in order to avoid serious gaps in scholarship and, ultimately, irrelevance regarding a large domain of real-life risk-taking.

These articles also illustrate the kind of integrative approaches that are rapidly becoming standard science. Perhaps that is no where better illustrated than the resonant concept of "social meaning" discussed by Sunstein (2008), described as the "social signals that are sent by their [adolescents'] behavior," which "varies across persons, groups, and time." Social meaning captures bits of each of the approaches in this issue, from the socio-emotional system to the brain's responsiveness to rewards (which can sometimes be socially determined). Sunstein reminds us that social meaning is malleable, that even primary reinforcers, such as sex and food, are shaped by social context and interpretation, and images and gist all the more so.

Sunstein (2008) also draws our attention to some diversity of opinion concerning the effectiveness of behavioral interventions: As Sunstein notes, "Steinberg is not surprised that educational programs often have so little effect in reducing adolescent risk-taking." In Steinberg's (2008) view, adolescent risk-taking "is likely to be normative, biologically driven, and, to some extent, inevitable." Casey et al. (2008) do not explicitly declare such a pessimistic view, but they, too, emphasize biological maturation. Very different perspectives are held by Fischhoff (2008), Gerrard et al. (2008), and Rivers et al. (2008), each of whom is actively engaged in behavioral interventions. It goes without saying that there are many open questions that pertain to effective interventions, including the possibility that behavioral interventions might affect biological maturation and that biological factors might affect receptivity to behavioral interventions.

Finally, these approaches also differ with respect to their emphasis on prescription, and on whether characterizing rationality falls in the purview of the theory. Fischhoff's (2008) behavioral decision-making framework takes an explicit approach to rationality, applying the triumvirate of descriptive, prescriptive, and normative considerations and harkening back to the axioms of subjective expected utility theory as the ultimate arbiter of rationality. Rivers et al. (2008) take a somewhat more empirically oriented view of rationality, appealing to evidence about developmental precedence: what develops earlier vs. what develops later, after considerable practice at a task (although both coherence, logical consistency, and correspondence, good outcomes, of decisions figure in the larger theory). The behavioral decision-making framework and fuzzy-trace theory seem to take differing positions on whether "rationally" weighing costs and benefits (and trading them off quantitatively) is better or worse, overall, for adolescent risk-taking (e.g., compared to processing

the core gist of a decision). Although Gerrard et al. (2008) operate within the expectancy-value framework, similar to Fischhoff, they focus on the reduction of very real harms, such as those due to smoking. Both Steinberg (2008) and Casey et al. (2008) invoke evolutionary arguments about how aspects of biological maturation might have adaptive value. Despite its notorious subtlety, the issue of which decisions are good or bad, and how to tell, is one that we must continue to grapple with if research on adolescent rationality is to be relevant to public policy.

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