

when expected values of gambles exceed that of the sure thing—when the gamble is taken once, decision makers will either end up winning something or winning nothing. The qualitative possibility of winning nothing is sufficient to avoid the risk, regardless of the probability of winning something (see Reyna et al., 2003).

The goal of instruction in fuzzy-trace theory, then, is to make gist-based decisions (involving risk-avoidant values) automatic and nondeliberative. Success in training reasoning using fuzzy-trace theory has been achieved with children (Reyna, 1991) and adults (Lloyd & Reyna, 2001), and experimentation is in progress on instruction to reduce adolescent risk taking. To be sure, the implications of fuzzy-trace theory and behavioral decision theory are diametrically opposed, the latter encouraging trading off risks and rewards and the former discouraging such trading off. Because some adolescent decisions appear to be reactive (as in behavioral willingness), rather than rationally deliberative (as in behavioral intentions), a combination of approaches could be more effective than either of them alone (Gerrard, Gibbons, Brody, Murry, Cleveland, & Mills, in press).

GENERAL DISCUSSION: IMPLICATIONS OF DATA AND DEVELOPMENT FOR RISK REDUCTION AND AVOIDANCE

Interventions to reduce risk taking have been developed from explanatory models, and those that combine multiple components have achieved limited success in changing behavior (see, for example, Baron & Brown, 1991; Kirby, 2001; Romer, 2003, for reviews). These components have traditionally included perceptions of risks, benefits, social norms, perceived control, and self-efficacy, as well as practiced skills, such as refusal skills for rejecting sexual activity (for a review of randomized controlled trials for interventions to reduce premature pregnancy and sexually transmitted diseases, see Reyna et al., 2005). Traditional models incorporate these components in a behavioral decision framework that, despite differences in individual models, generally emphasizes conscious behavioral intentions and expectations rather than unconscious emotional and cognitive reactions to environmental triggers. For some adolescents, the traditional models seem to apply; these adolescents take risks because perceived benefits outweigh risks, and long-term consequences are not considered or are undervalued. For other adolescents, the evidence indicates that behavioral willingness and perceptions of the gist or images involved in a decision determine risky behavior. These adolescents do not intend or expect to take risks, and their own rational deliberation might favor behaviors that are different than the actions they have taken impulsively or under the influence of emotion. Still other adolescents, and mature adults, apparently resist taking risks not out of any conscious deliberation or choice but because they intuitively grasp the gists of risky situations, retrieve appropriate risk-avoidant values, and never proceed

down the slippery slope of actually contemplating tradeoffs between risks and benefits.⁸

The policy implication for the first group of adolescents, the risky deliberators, is that traditional behavioral decision making approaches, such as health-belief models or the theory of planned behavior, should be effective in reducing risk taking, provided that adolescents can be convinced that risks outweigh benefits or that competing benefits are more desirable (e.g., playing sports, staying in school). This approach would backfire if, as is likely, adolescents discover that risks are lower than they believed or, for the third group of intuitive gist-based decision makers, that analyzing risks and benefits favors risk taking. The second group of adolescents, the risky reactors, will be unaffected by traditional interventions because risk taking for them is spontaneous and disjoint from rational contemplation of risks and benefits. Gist-based interventions could be more effective for the second and third groups—interventions that stress automatic (nonconscious) encoding of cautionary cues in the environment (getting the gist of risky situations) and repeated practice at retrieving and implementing risk-avoidant values in simulated contexts. Although research supports effectiveness of some pieces of such an intervention, this approach has not been widely extended to reducing risk taking in field-based studies. Clearly, development of psychometric instruments, including behavioral measures, that successfully distinguished the different kinds of risk takers and avoiders would be crucial for matching adolescents with the kinds of programs that are likely to be effective for them (although these mappings may change over time and decision domains, in contrast to those for stable traits such as thrill seeking).

Most traditional interventions, such as the ones we have just discussed, involve verbal instruction (although role playing and skills practice are increasingly used). However, recent laboratory research has shown that decisions reverse when risks are described verbally versus experienced as outcomes in a learning task. That is, risky options are avoided when they are described verbally but are preferred when outcomes are experienced (in both instances, risks are rare, such as for HIV infection, and accompanied by benefits). For this reason, the role of experience is increasingly prominent in theories of risky decision making. For example, intuitions about risky situations are generally not innate (although evolution factors into social perceptions) but, rather, arise mainly from social learning and experience. As dramatically illustrated in Figure 9, the ability to learn from

⁸Although we discuss these typologies of risk takers and avoiders as though they applied to different people (and there are broad developmental and individual differences), the truth is more complicated. A dominant decision-making approach may occasionally give way to a less preferred mode. For different decisions, the same person may be a risky reactor, a risky deliberator, or an intuitive (gist-based) risk avoider. Hence, the mature adult (or adolescent) may have lapses of maturity. The phrase “never proceed down a slippery slope” properly applies to decisions rather than people, and applies to those instances in which the decision maker has avoided the risky route. None of this should be interpreted to mean that there are not reliable differences across age groups and across individuals.

experienced outcomes, good and bad, develops considerably with age, from childhood through young adulthood. The implication for policy is that younger children and adolescents should be sheltered from risky experiences and supervised to thwart negative exploration; they will not be able to benefit from negative experiences. Furthermore, experience with risk-taking behaviors in the absence of negative consequences may increase feelings of invulnerability, which would explain the decrease in risk perceptions from early to late adolescence as exploration and experience accrue. This kind of approach acknowledges that, until adolescents are able to make better decisions, it is important to modify the environments in which they develop, rather than simply focus on improving their decision processes.

Neuropsychological research and research on impulsivity, sensation seeking, and related concepts indicate that some individuals will have greater difficulty learning from negative outcomes, especially outcomes that are mixed (that have some benefits or pleasures associated with them) or are negative over the long run rather than immediately. Valid and reliable measures of some of these individual differences exist today and have predictive validity for certain real-life functioning. The policy questions are whether early identification can be applied fairly across racial and ethnic groups and whether identification will cause more harm than good (Farley, 1996). More importantly, it is not clear how effective interventions to counteract individual differences are or how effective they could be, given appropriate early identification. The latter question, like many we have considered, is an empirical one that can be answered with further research. It is clear, however, that merely informing impulsive, sensation-seeking, or neurologically less-developed adolescents about risks is unlikely to be effective. Other traits or states that make adolescents more vulnerable to risk taking, such as depression, can be effectively treated, and early identification for those conditions is likely to reduce unhealthy behaviors such as risky sexual activities (Romer, 2003). External social factors, such as the presence of peers, continue to be borne out as contributors to adolescent risk taking, and policies that reduce social pressures, such as restricting the number of passengers for beginning drivers, are supported by research.

As this discussion illustrates, the effectiveness of interventions differs depending on the underlying causes of risky behaviors. In a literature dominated by correlational studies, however, there is great need for better causal models of risky behavior and for study designs, such as longitudinal and experimental designs, that permit causal inferences. One of the areas in which this need for causal research is dramatically demonstrated is the heavily researched question of how risk perception is related to risk-taking behavior. Despite the large quantity of research on this question, the answer is far from clear. Contradictory findings have emerged regarding relations between risk perceptions and behavior—i.e., perceiving risks to

be high is either a protective factor associated with lower risk taking, as rational models assume, or, conversely, is recognized by adolescents as part and parcel of their risk-taking behaviors. Conditional assessments and other methodological improvements have clarified some of these relations. However, research that merely catalogs behaviors or correlates variables is simply not adequate for testing sophisticated causal hypotheses that are required for confident applications in the real world. Translational research should explicitly address how basic causal mechanisms transfer, or fail to transfer, from the laboratory to consequential real-world settings.

Although additional research is needed, certain key findings from the extant literature are particularly informative about the causes and remediation of risky behaviors in adolescence. The theories of adolescent risk taking that we have discussed can be evaluated by their ability to accommodate counterintuitive findings such as the following:

- Despite conventional wisdom, adolescents do not perceive themselves to be invulnerable, and perceived vulnerability declines with increasing age
- Although the object of many interventions is to enhance the accuracy of risk perceptions, adolescents typically overestimate important risks such as HIV and lung cancer
- Despite increasing competence in reasoning, some biases in judgment and decision making grow with age, producing more “irrational” violations of coherence among adults than among adolescents and younger children. (This occurs because of a known developmental increase in gist processing with age, which also accounts for developmental increases in risk aversion.)

An implication of these findings is that traditional interventions stressing accurate risk perceptions are apt to be ineffective or backfire because young people already feel vulnerable and overestimate their risk.

This descriptive analysis of actual decision making can be compared to a normative analysis in order to determine where performance falls short of a normative ideal and how much those failures matter.⁹ A normative analysis based on coherence criteria (e.g., is the thinking process behind these decisions logical?) has the important virtue that it defines a minimum criterion for good decision making. Correspondence criteria, such as whether there are positive outcomes that result from behaviors, are also important for evaluating decision performance, despite the difficulty in applying such criteria to single cases and despite the conflict between evolutionarily selected behaviors, such as early procreation, and positive outcomes in a modern society. Although decision-specific performance evaluations are possible and to some extent necessary, there is obviously value to general theories of decision performance—which not only

⁹Note that, in this section, we use the word “descriptive” in its more encompassing meaning in decision-making research, to refer to any empirical research—including theory-driven explanatory and predictive research—about what people actually do, in contrast with normative ideals or prescriptions.

predict performance in multiple settings but also identify the psychological processes producing them. In addition to their inherent theoretical interest, those processes provide indications for improving performance.

The normative analysis that we discussed distinguishes what is rational, good, healthy, or adaptive, coming down on the side of promoting positive long-term physical and mental health outcomes (i.e., correspondence criteria for rationality, but modified to reflect developmental differences between adolescents and adults). We also argue that coherence can promote healthy outcomes under specific circumstances, and that coherence in itself is a separate and valuable indication of a rational decision process. We reject the argument that behaviors are adaptive simply because people engage in them, which is a misunderstanding of evolutionary theory. People who take unhealthy risks often agree that their behavior is irrational, on sober reflection, but they gave in to temptation or were not thinking at the time of the decision and are worse off for having done so. In this review, we have identified two kinds of evidence that favor our definition of rational risk taking: (a) outcomes evidence showing that a significant number of adolescents who are impulsive (i.e., have difficulty delaying gratification), are sensation seeking, are thrill seeking, are motivated by affect, have negative affect and avoidant personalities, or are otherwise reactive to immediate emotions have poorer social, economic, and health outcomes than those who are lower on each of these dimensions; and (b) developmental evidence, both ontogenetic and phylogenetic, showing that these behaviors, and risk-taking preference generally, decline with development and that concomitant negative outcomes also decline. (Although the literature has focused on poor life outcomes, the potential for positive outcomes has received little attention; see above and Farley, 2001.) However, differences in risk-taking propensity may provide sufficient variation in behaviors across individuals to garner the potential benefits for society that come from seeking challenge, creating innovation, and taking healthy risks.

Normatively ideal decision making need not be achievable by any human being; it provides a paragon to which humans should aspire, but the prescribed processes used to approach that goal need not resemble ideal reasoning (e.g., a slightly sloppy process might bring human decision makers closer to the goal than a strictly logical one). Prescriptive approaches bridge the gap between the normative and the descriptive accounts, focusing on those decisions that matter most. Such approaches can be generally divided into persuasive and nonpersuasive. The latter follow most directly from the *laissez faire* perspective of traditional decision theory, which makes no judgments about the desirability of adolescents' goals. Best codified in the procedures of decision analysis, these approaches attempt to help decision makers understand their situations and themselves well enough to reach the best choice of their own accord. Decision analysis reflects both a philosophical commitment to decision-maker autonomy and a practical faith in its possibility.

Persuasive approaches may arise from challenging either assumption. That is, they may reflect the belief that it is one's duty to instruct others about what they should do, or resignation to the practical necessity of doing so in situations in which effective independent action is too risky. Known developmental differences in temporal discounting, impulsivity, and future orientation between adolescents and adults favor persuasive approaches.

This distinction or, rather, continuum between persuasion and nonpersuasion is reflected in the main approaches to risk reduction and avoidance. Some approaches have focused on how adolescents evaluate risks and benefits (e.g., abstinence programs stressing the benefits of avoiding sex outside of marriage). Some have focused on how adolescents estimate the probabilities of these outcomes (e.g., social-norms programs countering the pluralistic ignorance leading adolescents to overestimate the frequency of risk behavior, and hence the chance of being socially approved). Some have focused on changing those probabilities (e.g., social-skills training programs cultivating refusal skills). Some have focused on increasing adolescents' general judgment and decision-making skills. Some have focused on increasing adolescents' reliance on these skills (e.g., by teaching emotional control or directing conflicts to mediation). Some have tried to reshape adolescents' world, so that they have better options from which to choose, so that even poor choices have less drastic consequences.

The limited effectiveness of these programs in the short term and their tendency to wane in effectiveness in the long term (e.g., more than 6 months to a year) suggest not that intervention is futile but that the incorporation of additional explanatory and predictive factors is needed to reduce adolescent risk taking (or, alternatively, to acknowledge the rationality or adaptiveness of risk-taking behaviors in this population in the environments they face). According to fuzzy-trace theory, for example, effective interventions should stress more enduring qualitative (rather than quantitative) gist representations of risk and should facilitate the developmental progression from analytical processing of risks and rewards (e.g., trading off) to intuitive all-or-none categorical avoidance of dangerous risks. (A randomized field trial is currently underway to test this approach.) Alternatively, better ways to inculcate rational trading off may reduce intentional risk taking, consistent with behavioral decision theory.

More generally, most interventions to reduce risk taking aim to enhance the accuracy of risk perceptions, to overcome adolescents' belief that they are invulnerable, and to transform intuitive, biased adolescent decision makers into analytical, unbiased adults. Ironically, according to the data, each of these aims is misguided. To the extent that adolescents base decisions on precise notions of risk, enhancing accuracy is likely to lower some risk perceptions and thereby increase risk taking. Because adolescents already believe they are at greater risk than adults, and objectively higher-risk adolescents often correctly believe

that they are at greater risk than lower-risk adolescents are, devoting energy to combating feelings of invulnerability would seem to be a waste. Adolescents take risks even though they realize that they are vulnerable to undesirable consequences; according to fuzzy-trace theory, they are taking calculated risks that are “worth it” from a compensatory quantitative perspective. However, from a global categorical perspective (e.g., avoid catastrophic risks as a first principle) that is shared by most adults, these risks are not worth it. In the latter view, counting the number of bullets in the chamber of the gun does not make Russian roulette a rational choice.

Finally, data suggest that analytical reasoning is the preferred mode of decision making in childhood and, to some extent, in adolescence, and is a source of developmental differences in preferences for risk. That is, controlled experiments have shown that risk taking declines with increasing age, even without peer influences or motivating social contexts, apparently because analytical processing of risks and rewards gives way to the cruder, qualitative processing that produces phenomena such as risk avoidance, framing effects, and other biases. The implications of recent data are that enhancing the precision and comprehensiveness of information and integrating it more precisely and comprehensively are unlikely to yield anything other than incremental improvements in risk reduction and avoidance. Regardless of the outcome of comparisons of alternative models

and interventions, however, the tripartite division of behavioral decision theory into normative, descriptive, and prescriptive considerations will remain a useful meta-theoretical framework for evaluating policy implications—regarding the gambles to take with adolescents’ welfare, given our current state of knowledge—and research implications—regarding critical normative, descriptive, and prescriptive gaps in our understanding.

In sum, there are some fundamental principles that emerge from our review of theory and data. They can be exploited immediately to fine-tune ongoing interventions to reduce adolescent risk, to design more effective interventions, and to guide research on interventions. For ease of reference, they are set forth in Table 4.

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TABLE 4
Empirically Supported Recommendations for Policy and Practice

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1. Reduce risk by retaining or implementing higher drinking ages, eliminating or lowering the number of peers in automobiles for young drivers, and avoiding exposure to potentially addictive substances (rather than, for example, exposing minors to alcohol to teach them to drink responsibly).
 2. Develop psychometric instruments that reliably distinguish risky deliberators who make decisions on the basis of perceived risks and benefits from those who merely react to environmental triggers.
 3. Develop reasoned arguments and facts-based interventions (including information about social norms) for the risky deliberators, focusing on reducing perceived benefits of risky behaviors (and increasing perceived benefits of alternative behaviors) and spelling out consequences of risk taking. For younger or less mature adolescents, short-term costs and benefits should be highlighted.
 4. Identify factors that move adolescents away from considering the degree of risk and the amount of benefit in risky behaviors toward categorical avoidance of major risks until they are developmentally prepared to handle the consequences.
 5. Monitor and supervise younger adolescents rather than relying on them to make reasoned choices or to learn from the school of hard knocks, especially if assessments indicate that they are willing to take risks that they neither intend nor expect to take. Remove opportunity (e.g., by occupying their time with positive activities).
 6. Practical self-binding strategies (avoiding situations that are likely to elicit temptation or that require behavioral inhibition) should be identified and encouraged.
 7. Encourage the development of positive prototypes (gists) or images of healthy behaviors and negative images of unhealthy behaviors using visual depictions, films, novels, serial dramas and other emotionally evocative media.
 8. Emphasize understanding of risk communications (e.g., why HIV, human papilloma virus, and herpes simplex virus are not treatable with antibiotics), and deriving the gist or bottom line of messages that will endure in memory longer than verbatim facts. Harmful consequences may not be understood because young people lack relevant experience; develop intuitive understanding of risky behaviors and their consequences.
 9. Do not assume that adolescents think that they are immortal. On the contrary, provide concrete actions that they feel capable of taking that will reduce their risk. Teach self-efficacy, help them practice skills, and show them how they can control specific risk factors.
 10. Provide frequent reminders of relevant knowledge and risk-avoidant values; even medical experts fail to retrieve what they know about sexually transmitted diseases without cues. (Repeating the same message over and over is likely to be ineffective, so changes in wording and presentation are required.)
 11. Provide practice at recognizing cues in the environment that signal possible danger before it is too late to act.
 12. Treat comorbid conditions, such as depression.
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