their actions. Both of these perspectives on emotion differ from traditional decision-analysis approaches in emphasizing the importance of emotion—whether it is germane to resisting immediate pleasure or to anticipating future pain. The behavioral decision-making perspective has been expanded to encompass social and emotional evaluations of risk taking as legitimate precursors of rational choices. There is a growing consensus that the inability to connect consequent emotions to antecedent choices can produce debilitating social problems (such as those observed in Bechara et al.'s patients, substance abusers, and other groups), including self-destructive risk taking.

Explanatory models of individual differences in risk-taking propensity have long emphasized the importance of physiological (e.g., arousal) and genetic underpinnings, especially in such personality traits as sensation, thrill, or novelty seeking (e.g., Cloninger, Svrakic, & Przybeck, 1993; Eysenck, 1967; Farley, 2001; Zuckerman, 1979). The pace of research on physiological and genetic approaches has quickened, however, because of the development of new techniques and methodologies. The integration of behavioral genetics, neurophysiology, neuroimaging, and animal models is an exciting frontier in the effort to improve explanatory models of risk-taking propensity in adolescence (e.g., Cardinal & Howes, 2005; Moffitt, 2005; Steinberg & Morris, 2001; for an overview, see Dahl & Spear, 2004).

Because these areas are so new, particularly as applied to adolescence, empirical generalizations must be qualified and are subject to flux. For example, challenges to the association between dopamine receptor D4 (DRD4) gene polymorphism and novelty seeking were quickly followed by a study producing evidence for this association but showing that it was moderated by sociodemographic characteristics (Lahti et al., 2006). Although the debate about DRD4 is not over, the theme of gene–environment interaction has been echoed in other research on relations between genetics and temperament in risk taking (e.g., see Moffitt, 2005; Steinberg et al., 2004). These subtle, interactive effects underscore the importance of adapting environments (e.g., schools; Farley, 2001) to accommodate different temperaments. Although we have stressed the unhealthy side of risk taking in adolescence, there is, for sensation, thrill, or novelty seekers, a potential upside to risk—provided that environmental factors are conducive. A fortuitous combination of person and environment can yield creative artists, scientists, or entrepreneurs who eschew conventional approaches and relish risky challenges with large positive potential for society as well as for themselves (Farley, 2001). As we have discussed, a person–environment mismatch, however, can result in substance use, unsafe sex, reckless driving, and other attempts to increase stimulation.

Despite overall developmental trends toward lowered risk taking after adolescence, a minority of individuals continue to take unhealthy risks in adulthood, as in life-course-persistent (as opposed to adolescence-limited) antisocial behavior (Moffitt, 1993, 2003). Antisocial behavior that appears initially in adolescence has been linked to effects of the environment, whereas life-course-persistent criminality shows a moderate genetic influence (Zuckerman, 2002). These extreme and persistent risk takers contribute disproportionately to the societal burden of unhealthy risk taking. Comprehensive prevention and intervention programs that encompass the most extreme risk takers await novel integration of the explanatory approaches we have discussed. For extreme thrill seekers, the usual behavioral equation is confounded because the risks *are* the benefits (i.e., the thrill of taking risks is a reward in itself).

## KEY FINDINGS: DESCRIPTION

Explanatory models predict that the perception of risks (e.g., vulnerability in the health-beliefs model), benefits (e.g., affective motivators in reactive models), or both (e.g., beliefs about the probabilities of outcomes and their subjective utilities or values in the behavioral decision-making framework) should determine adolescent risk-taking behaviors. It has generally been assumed—and we present pertinent data later—that adolescents' risk perceptions are distorted. If adolescents perceive risks to be sufficiently high, then, according to rational models, they should not take those risks. Thus, one remedy for risk taking is to assess risk perception and, if subjective risk is too low, provide information that brings perceptions into line with objective reality.

Distortions in risk perceptions can be examined in at least three ways: (a) Adolescents' perceptions of their own risks can be compared to their perceptions of peers' risks, (b) adolescents' perceptions of their own risks can be compared to adults' perceptions, and (c) adolescents' perceptions of risks can be compared to published estimates of objective risks. Specifically, with respect to the first type of comparison, adolescents can be asked to estimate their own risk relative to the risk of peers, acquaintances, or other adolescents. Across studies of this sort, the risk being estimated has ranged from the possibility of unspecified harm to the probability of dying from lung cancer if one smokes for 30 to 40 years. A common method in evaluating risk perceptions is to use a rating scale (e.g., −3 to +3) for which the midpoint (0) is labeled as "average" risk, negative numbers (e.g., −3) represent less risk than average, and positive numbers (e.g., +3) represent more risk than average. Adolescents who view themselves, on average, as at less risk than average exhibit a Lake Wobegon effect (i.e., "where all the children are above average") or, more technically, an *optimistic bias*. This phenomenon of optimistic bias was originally found with adults, and has since been replicated across many health domains (e.g., Rothman, Klein, & Weinstein, 1996; Weinstein, 1980, 1982, 1989).

Although optimistic bias is not invariably found for adolescents, many studies have documented a tendency for them to see their own vulnerability as lower than that of comparable others

(e.g., Arnett, 2000; Chapin, 2000, 2001a; Greening & Stoppelbein, 2000; Romer & Jamieson, 2001). However, other studies have shown no evidence of bias or have obtained mixed results (Benthin, Slovic, Severson, 1993; Ellen, Boyer, Tschann, & Shafer, 1996; Johnson, McCaul, & Klein, 2002; Whaley, 2000). To illustrate, Chapin (2001a) reported that, on a −3 to +3 scale, African American adolescents with sexual experience rated their risk of negative outcomes associated with sexual behavior as −1.64, significantly lower than average, whereas adolescents without experience rated their risk as −.52. However, Ellen et al. (1996) found almost perfect calibration for adolescents' perception of risk for sexually transmitted diseases: 33% rated their risk as below average, 36% rated their risk as average, and 32% rated their risk as above average. Finally, Johnson et al. (2002) found that adolescents who were daily smokers and those engaged in unprotected sex estimated their risk of getting lung cancer or a sexually transmitted disease, respectively, as significantly higher than did adolescents not engaging in those behaviors (see also Chapin, 2001b; and Gerrard et al., 1996). Regarding the studies that found no difference, the failure to detect an optimistic bias among adolescents—a null effect—is not evidence that there is no bias, as methodological problems might have interfered with detecting an effect that was really there; nothing definitive can be inferred from null effects.

Thus, based on the literature as a whole, we can conclude that there is an overall tendency (we discuss exceptions presently) to view oneself as more invulnerable to risk than unspecified others are, whether this perception is due to illusions of control, motivated belief or self-enhancement, or nonmotivational information-processing constraints (Chambers & Windschitl, 2004). Weinstein and Lachendro (1982) evaluated an egocentric hypothesis that, when making comparative judgments, people consider their own risk-increasing or risk-decreasing behaviors but fail to fully consider such information as it applies to others. Contrary to a motivational account, Windschitl, Kruger, and Simms (2003) showed that people's estimates of the likelihood of winning a trivia game were influenced more by their own level of knowledge than by their estimates of their competitors' knowledge, even when attention was drawn to the latter by explicitly asking about it. If people rely, for nonmotivational reasons, on self-relevant information more than on other-relevant information, they should sometimes also make unfavorable comparison judgments when self-relevant information is unfavorable; this has been found to be the case (Chambers & Windschitl, 2004). Although nonmotivational information-processing factors (e.g., egocentric focus) seem to be sufficient to produce optimistic bias, motivational factors may also produce such a bias. Crucially, interventions to improve risk perceptions must be designed to address the source of the distortions—for example, denial of risk to rationalize behavior versus lack of awareness that others' risk-reduction strategies are similar to one's own (and do not sufficiently lower risk).

A slightly different question about perceived vulnerability is asked by dividing adolescents into lower- and higher-risk groups, such as nonsmokers and smokers or sexually abstinent and sexually active adolescents, and comparing their risk perceptions. That is, both groups of adolescents could exhibit an optimistic bias, although higher-risk groups might exhibit less of a bias than lower-risk groups might. In this case, although both groups' estimates would be biased, their relationship to one another would accurately reflect relative risk. Several studies have shown such a relationship—namely, that objectively higher-risk groups saw themselves as being at higher risk. For example, in addition to the Johnson et al. (2002), Chapin (2001b), and Gerrard et al. (1996) studies noted previously, Cohn, Macfarlane, Yanez, and Imai (1995) found that adolescents with more risk-taking experience (e.g., getting drunk) perceived that they were at greater risk than did those with less experience. Similarly, adolescents engaged in high-risk sexual behavior acknowledged being at significantly higher risk for HIV infection (Murphy, Rotheram-Borus, & Reid, 1998; see also Sneed et al., 2001). As Johnson et al. (2002) point out, estimates of general risk might be expected to differ from those of personal risk or risk of specific negative outcomes. For instance, smokers rated themselves as more vulnerable than nonsmokers on smoking-related items but not on other items (Milam, Sussman, Ritt-Olson, & Dent, 2000). Therefore, adolescents engaged in higher-risk activities sometimes seem to be aware that they are at higher risk but engage in those behaviors despite this awareness (and perhaps because of it—i.e., hopelessness may lead to self-destructive behaviors; Chapin, 2001b).

This seems counterintuitive from the perspective of many models because, as we have discussed, these models assume that higher risk perceptions should produce less risk-taking behavior. Many studies have shown that those engaging in risk taking perceive less risk than those who refrain from engaging in such behavior—a finding consistent with rational models (Fig. 10). For example, Benthin et al. (1993) found that adolescents who had experience with risky behaviors perceived the risks to be smaller, better known, and more controllable than did inexperienced adolescents. Ben-Zur and Reshef-Kfir (2003) showed that risk perception for HIV/AIDS decreased as relevant personal-risk behaviors increased; as in the Benthin et al. study, those taking more risks perceived those risks to be smaller. A longitudinal study of over 7,000 participants showed that smokers between ages 11 and 18 perceived less general and personal risk associated with smoking than nonsmokers did (Chassin, Presson, Rose, & Sherman, 2001; see also Halpern-Felsher, Biehl, Kropp, & Rubinstein, 2004). Arnett (2000) found that although only 18% of adolescent smokers denied that most lifelong smokers eventually die of smoking-related illnesses, 29% of them denied that this would happen to them if they smoked 30 to 40 years. Moreover, longitudinal studies have identified high risk perception as a deterrent to smoking (Brynin, 1999). Analogous findings have been reported for use of

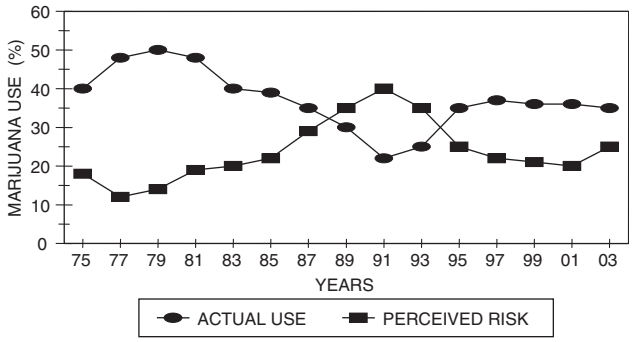


**Fig. 10.** Percentage of 12th graders who reported having used marijuana from 1975 to 2003, plotted against the percentage who perceived occasional marijuana use as risky (based on Johnston, O'Malley, Bachman, & Schulenberg, 2004).

alcohol (Gullone & Moore, 2000; Lundborg, & Lindgren, 2002; Wild, Hinson, & Cunningham, 2001) and marijuana (Hemmelstein, 1995; Lee, Su, & Hazard, 1998). Risk perception has also been associated with degree of use as well: Heavy smokers reported significantly lower perceived risk of smoking than did occasional smokers, and heavy marijuana users perceived lower risk than occasional users (Resnicow, Smith, Harrison, & Drucker, 1999).[7]

The literature that we have just reviewed presents an apparent conundrum, namely, evidence for both a positive and a negative relation between perceived risk and risk-taking behaviors: Those adolescents at higher risk because of their behavior often accurately perceive that they are at higher risk; and yet, other studies support the rational hypothesis that high risk perception is a protective factor, a counterbalance against perceived benefits. As Kotchik et al. (2001) explain, each of these inconsistent findings "conceptually make[s] some sense" (p. 502): Knowing that one is engaging in risky activities may lead to a heightened sense of personal risk, and it also makes sense that a reduced sense of vulnerability may contribute to greater risk taking.

One explanation for the contradictory findings has to do with different types of measurement. Fishbein (e.g., 2003) has shown that specific risk assessments that are conditional on protective behaviors reveal the theoretically expected relation that higher levels of perceived risk are associated with higher levels of protective behaviors or less risk taking (e.g., "How likely do you think it is that you could get AIDS by having vaginal sex with an occasional partner without wearing a condom?"). According to Fishbein, theoretically, it is the behavior-specific risk measures (or outcome expectancies) that are linked to attitudes, which are, in turn, linked to intentions and behaviors. It could also be reasonably argued that more specific questions are less ambiguous and, thus, better reflect true assessments of risk. However, none of these arguments explains negative correlations between general risk assessments and protective behavior, other than that these correlations reflect an awareness by those who are engaging in risky behavior that they are likely to be at risk—which begs the question (but see Brewer et al., 2004). In addition, research suggests that judgments of risk are unlikely to be influenced by underlying conditionals, which are rarely spontaneously unpacked (e.g., Fischhoff, Slovic, & Lichtenstein 1978; Reyna & Adam, 2003). Thus, although specific risk assessments may be better measures of risk perceptions (and these perceptions relate positively to protective behaviors), without specific cues, people are more likely to think about risk in general terms (and these perceptions also relate to behaviors, but in the opposite direction—namely, negatively).

Another explanation for this inconsistency (i.e., evidence for both a positive and a negative relation between perceived risk and risk-taking behaviors)—one that is not incompatible with the measurement explanation—is that adolescents who engage in risky behaviors but fail to experience or only rarely experience negative outcomes may adjust risk estimates downward (Halpern-Felsher, Millstein, Ellen, Adler, Tschann, & Biehl, 2001). In this case, high risk perception is not necessarily protective—these adolescents have simply not put their perceptions to the test and discovered that bad outcomes are statistically rare. This explanation is more compelling for outcomes that are in fact rare, such as HIV infection, as opposed to pregnancy, which has a cumulative probability that approaches certainty after less than a year of unprotected sex (e.g., Reyna & Adam, 2003). Other high-risk groups who report high risk perception might, then, be those who had experienced bad outcomes more frequently. On analogy with the experiential learning studies such as the Bechara card task, however, some adolescents might be less able to learn from experience, persisting in self-destructive behaviors despite negative outcomes.

Although available evidence that bears on this experiential explanation is not yet extensive, preliminary support can be found in a handful of studies. In a longitudinal study of 395 adolescents, Goldberg, Halpern-Felsher, and Millstein (2002) reported that "good" alcohol outcomes were significantly related to later increases in drinking. In another longitudinal study, Katz, Fromme, and D'Amico (2000) found similar results for drug use (positive outcome experience at time 1 was associated with subsequent drug use at time 2)—but results for alcohol did not mirror the Goldberg et al. study. Any experience—with positive or negative outcomes—was positively associated with subsequent heavy alcohol use. A few studies have examined the effect of negative outcomes on risk perception rather than on risk-taking behaviors. Failing to experience negative outcomes

[7]One might question whether estimates of personal or objective risk have any stability or whether adolescents understand probability scales. First, estimates of objective risk sometimes differ by orders of magnitude from actual risk, so that an inference that objective and subjective estimates differ is probably a safe bet (e.g., Reyna & Adam, 2003). Second, statistically significant relations between risk estimates and other measures show that risk estimates have some degree of reliability. If adolescents could not use such scales reliably, risk estimates could not covary reliably with other measures. This is not to say that responses are interval scale measures or that respondents do not have any difficulties interpreting risk or probability scales.

decreased risk perception for drinking and driving in one study (Nygaard, Waiters, Grube, & Keefe, 2003). However, Halpern-Felsher, Millstein, Ellen, Adler, Tschann, and Biehl (2001) found that adolescents with negative experiences rated their risks for driving drunk, STDs, HIV, and pregnancy as lower than inexperienced adolescents did.

It is possible to imagine causal scenarios that might reconcile these apparently conflicting results. For example, a set of factors might dispose some adolescents to underestimate risks and, thus, to engage in risky behaviors. Once negative outcomes were experienced—which would vary as a function of the rarity of those outcomes and the vagaries of personal experience—perceptions of risk could increase and, then, exceed those of adolescents not disposed to engage in risky behaviors. (Conversely, extensive risk taking without experiencing negative outcomes would lead to complacency and lowered risk estimates.) Additional studies with longitudinal designs and better measures of putative causal factors are essential in order to disentangle the roles of risk perception and experience in explaining risky behavior.

Beyond these recommendations about longitudinal designs and improved measures, however, more sophisticated causal models that can be tested experimentally, as well as examined using correlational techniques, are also required. Opposing causal forces (events that both increase and decrease risky behavior for different underlying reasons) would need to be specified, properly measured, and actively manipulated. In other words, process models of adolescent risky decision making are needed. Hypothesis-driven research with true experiments would represent a sea change from the usual approach in this literature, which mainly consists of correlating survey ratings. Making experiments relevant to real-world problems requires ingenuity, but behavior in some laboratory risky decision-making tasks has been found to generalize to real life (e.g., Bechara et al., 1994; Zuckerman, 1994; 1999). As these conflicting results about perceived vulnerability so readily demonstrate, correlational and observational studies are necessary in studying adolescent risk taking, but they are not sufficient. If we are to solve practical problems produced by adolescent risk taking, we must have a deeper understanding of causal processes. The time has come for a more theory-driven approach in which alternative process models are tested in the laboratory and the real world.

Although the literature comparing risk perceptions of low- and high-risk adolescents has yielded contradictory findings, a clearer picture has emerged from comparing risk perceptions across age groups. Such developmental comparisons have focused on adolescents versus adults, because of developmental theories such as Elkind's (1967) that characterize adolescence as a fantasy period of personal fables, imaginary audiences, and feelings of invulnerability. Despite the lack of systematic evidence for Elkind's theory, the belief that adolescents consider themselves to be invulnerable is widespread among clinicians and members of the public; it is considered a truism and has rarely been challenged. However, Fischhoff and Quadrel (1991) compared 86 matched pairs of adolescents and parents and found that adolescents did not exhibit the optimistic bias more than adults did (see also Millstein, 1993; Quadrel, Fischhoff, & Davis, 1993). In fact, both groups viewed parents as being at lower risk (i.e., as relatively less vulnerable) than adolescents. Quadrel et al. also examined beliefs about absolute invulnerability by comparing how many adults and adolescents affirmed that they were facing "no risk at all" for a given event such as an automobile accident. Again, subjects exhibited an optimistic bias because they assigned no risk about twice as often to themselves as to comparable acquaintances and friends; parents were also seen as at no risk more often than adolescents were, by both themselves and the adolescents. These results run contrary to Elkind's hypothesis that adolescents perceive themselves to be more invulnerable than adults perceive themselves to be.

In this connection, Millstein and Halpern-Felsher (2002a) noted that questions about risk should specify conditions that affect risks (e.g., risk of STDs if one has sex without a condom) and that parents who volunteer with their children for studies of risk may differ systematically from other, unrelated adults. Therefore, they compared risk estimates of 14 outcomes (ranging from natural hazards to personal risks, such as getting an STD) from 433 adolescents to those of 144 unrelated, childless adults, using specific questions. As in the earlier studies, adolescents gave significantly higher assessments of their own risk, compared to adults, even when differences in numeracy (the ability to think quantitatively) were controlled for. A greater proportion of adults (23.6%) demonstrated absolute invulnerability (risk estimates of 0%) than adolescents did (14.0%), again replicating earlier results. Boone, Lefkowitz, Romo, Corona, Sigman, and Kit-Fong Au (2003) found similar results for 111 Latino mother–adolescent pairs; adolescents believed that they were more at risk for AIDS than their mothers (see also Whaley, 2000).

Cohn et al. (1995) examined perceptions of both harmfulness and invulnerability, comparing 376 adolescents to 160 parents for the leading causes of their morbidity and mortality. These researchers, too, replicated age differences in results for optimistic bias, finding adolescents to be less optimistic than their parents were about avoiding injury and illness. However, they also found that adolescents rated experimental, occasional, and frequent engagement in risky activities as significantly less harmful than their parents did. Adolescent–parent differences were largest when the researchers evaluated the harmfulness of trying an activity "once or twice." The latter finding is consistent with fuzzy-trace theory's prediction (demonstrated in laboratory tasks, e.g., Reyna & Ellis, 1994) that adults process risks categorically or qualitatively rather than as a matter of degree, reflecting a developmental shift toward greater gist-based reasoning with age and experience (Reyna, 2004a; Reyna et al., 2005). In other words, adults would be more likely than adolescents to think about activities as harmful or not, rather than

making fine-grained distinctions about low frequencies of exposure to potential harm.

Consistent with these findings about perceived harmful consequences, Beyth-Marom, Austin, Fischhoff, Palmgren, and Jacobs-Quadrel (1993) reported that adults spontaneously provided more consequences for decisions (e.g., to drink and drive or smoke marijuana), and Halpern-Felsher and Cauffman (2001) reported that adults were more likely than adolescents were to spontaneously mention risks and benefits associated with decisions (see also Slovic, 1998). Overall, there was a modicum of evidence for differences in the ability to spontaneously consider outcomes or consequences of risk taking (see also Baron & Brown, 1991; Furby & Beyth-Marom, 1992). However, developmental differences between adolescents and adults in perceived harmfulness were generally small, and research directly addressing invulnerability uniformly disputed the widespread belief that adolescents think that they are more invulnerable than adults.

It is possible for relative risk perceptions of adolescents and adults to be ordered correctly, but for absolute risk perceptions to fall far from their objective marks. For a limited number of risks, each groups' estimates can be compared to actuarial or published estimates. Millstein and Halpern-Felsher (2002a) found that adolescents were more likely than adults were to overestimate risks for every outcome that could be evaluated, including low-probability events such as hurricanes, earthquakes, and HIV transmission from unprotected sex, as well as higher-probability events such as acquiring an STD (e.g., gonorrhea and chlamydia; Fig. 11). Fischhoff, Parker, Bruine de Bruin, Downs, Palmgren, Dawes, and Manski (2000) reported outcome expectations for a nationally representative sample of 3,544 adolescents from the 1997 National Longitudinal Study of Youth. Adolescents' estimates were close to actual statistical norms (e.g., the probability of becoming a mother by age 20), or they overestimated risks (e.g., the probability of serving time in jail or prison by age 20). The probabilities given to "die from any cause—crime, illness, accident, and so on" in the next year or by age 20 were much higher than statistical estimates.

Halpern-Felsher, Millstein, Ellen, Adler, Tschann, and Biehl (2001) also found consistent overestimation of eight risk-related outcomes—three related to alcohol, three related to unprotected sex, and two related to natural hazards. In other studies, adolescents have been found to overestimate some risks and to underestimate others (Cvetkovich & Grote, 1983; Foreit & Foreit, 1981; Kershaw, Ethier, Niccolai, Lewis, & Ickovics, 2003; Namerow, Lawton, & Philliber, 1987; Quadrel, 1990). Within adolescence, age trends in risk perception have been inconsistent, although there is some suggestion that risk perception decreases (Bernstein & Woodall, 1987; Brynin, 1999; Lundborg, & Lindgren, 2002; Smith & Rosenthal, 1995) or is U-shaped (Urberg & Robbins, 1984; for a review see Millstein & Halpern-Felsher, 2002b). (Once again, experience may play a role in older adolescents' decreased perception of risks; engaging in risk taking without immediate consequences may lower risk estimates.) Although there is some variability in the direction of differences between objective and subjective risk estimates, adolescents typically overestimate important risks, such as those associated with HIV infection, alcohol use, and smoking (i.e., lung cancer risk, Romer & Jamieson, 2001; Fig. 12).

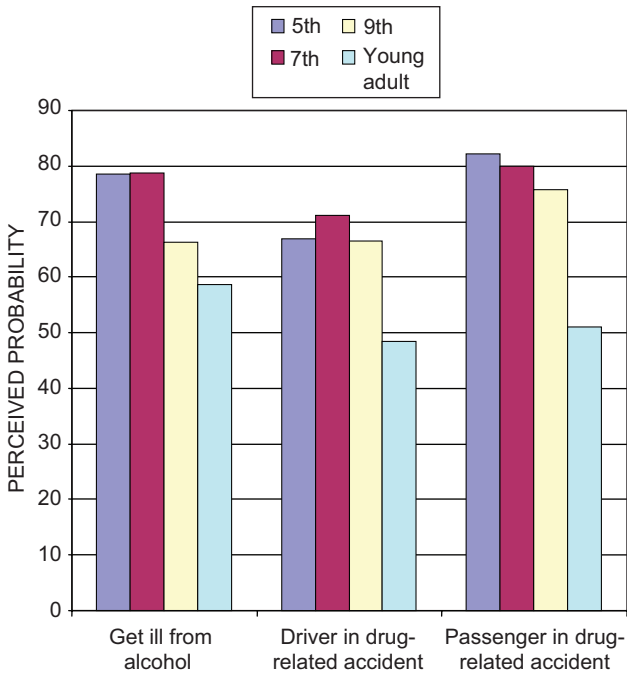


**Fig. 11.** Perceived probability of getting ill from alcohol, being the driver in a drug-related accident, and being the passenger in a drug-related accident for 5th, 7th, and 9th graders and a comparison group of young adults (based on Millstein & Halpern-Felsher, 2002a).

If adolescents often overestimate risks and they do not perceive themselves to be invulnerable, then why do they engage in risky behaviors? Many proponents of the behavioral decision-making approach and of other rational models have argued that perceptions of benefits outweigh perceptions of risks. Consistent with this view, Halpern-Felsher, Biehl, Kropp, and Rubinstein (2004) found that adolescents who had tried smoking rated benefits higher (and risks lower) than did those who had never tried smoking; ratings of both benefits and risks were significant predictors of behavioral experience and intentions. Gilpin and Pierce (2003) also found that smokers were more likely to view smoking as beneficial. Goldberg et al. (2002) reported a similar pattern of perceived benefits and risks for experience with alcohol (see also Fromme, Katz, & Rivet, 1997; Parsons, Halkitis, Bimbi, & Borkowski, 2000). Parsons et al. (1997) found that perceived benefits were a stronger predictor of behavioral intention and change than were perceived risks for five risk-behavior categories; Benthin, Slovic, and Severson (1993) reported similar results for a larger sample of 30 activities but a smaller sample of students. Shapiro, Siegel, Scovill, and Hays (1998)

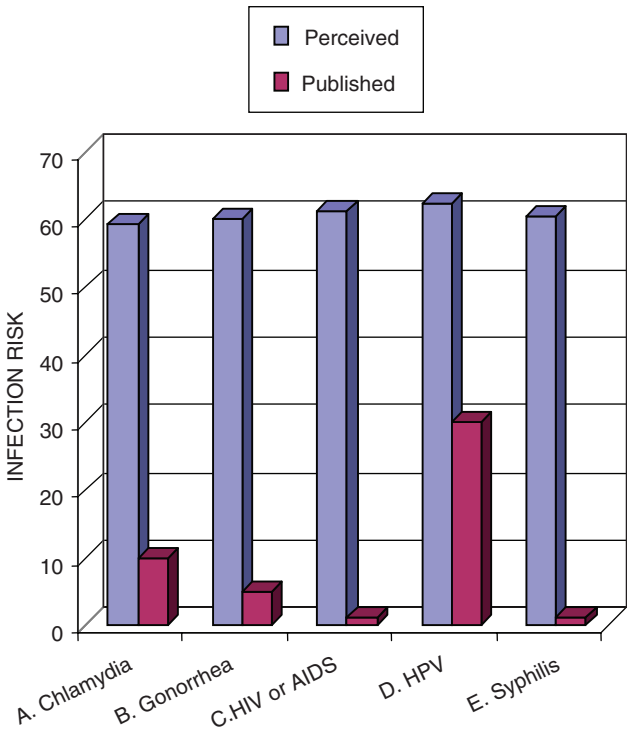


**Fig. 12.** Perceived probability, as judged by 254 9th to 12th graders, that a sexually active teenage girl would be at risk for sexually transmitted infections, compared to published estimates of risk (based on Reyna & Adam, 2003, and unpublished data).

found that perceived benefits were a significant predictor of a broad range of risky behaviors (from sexual to financial), but perceived risks were not significant (see also Ben-Zur & Reshef-Kfir, 2003). Only one study found that perceived risk was a better predictor of behavior than perceived benefits, but even that study found that both were significant (Rolison & Scherman, 2002). Thus, as rational decision-making theories suggest, consideration of the role of benefits is important in predicting adolescent risk taking: Perceived benefits may loom larger than perceived risks and offset them.

In summary, the key descriptive findings regarding adolescents' perception of risks are these:

- Much like adults do, most adolescents exhibit an optimistic bias, in which they view their own risks as less than those of comparable peers
- Research with adults suggests that this optimistic bias is probably due to egocentric focus rather than motivational factors, but little research on this point has been done with adolescents
- Objectively higher-risk groups sometimes estimate their risk as higher, and sometimes as lower, than lower-risk groups do, but different ways of asking questions change the answers
- The role of experienced outcomes may also explain these variable findings but preliminary evidence on this point is meager
- The optimistic bias is no more prevalent in adolescents than it is in adults, and, indeed, adolescents perceive themselves as more vulnerable than adults do
- When subjective and objective estimates of risk can be compared, adolescents tend to overestimate important risks (although they may underestimate harmful consequences and long-term effects, such as addiction; Weinstein, Slovic, & Gibson, 2004)
- Despite overestimation of risks, perceived benefits may drive adolescents' reactive behaviors and behavioral intentions, thereby accounting for risk-taking behaviors

## DEVELOPMENTAL DIFFERENCES IN JUDGMENT AND DECISION MAKING

### Précis of Developmental Findings Discussed Thus Far

Throughout this monograph, we have pointed out robust developmental trends. Compared to adults, children and adolescents have been found to be less able to delay gratification, inhibit their behavior, plan for or anticipate the future, spontaneously bring consequences to mind, or learn from negative consequences; and adolescents do not view consequences as being as harmful as adults do, especially if risky behaviors are engaged in only "once or twice." Children and adolescents also behave more impulsively (beyond individual differences that may linger into adulthood), reacting to immediate temptations without thinking and discounting future rewards more heavily than adults do, and their goals evolve in predictable directions that promote healthier long-term outcomes. Brain maturation is incomplete in adolescence, and changes in particular structures of the brain have been linked (correlationally) to these developmental differences in behavior.

Cognitive differences include a shift toward categorical or qualitative gist-based thinking, which explains increases in cognitive illusions with age (reflecting greater social knowledge and other globally adaptive but locally flawed thinking processes); increases in risk aversion in laboratory tasks (degrees of risk and reward matter less with maturity, compared to winning something versus nothing); and developmental differences in how degree of harm is viewed (adults do not make as fine-grained distinctions between experimenting with risky behaviors once or twice and experimenting more often). Thus, some risk taking in adolescence may be the result of quantitative trading off of benefits against risks, which gives way to more categorical risk avoidance with age. We have argued that developmental trends can be used as clues about what is rational; specific behaviors or thought processes that increase with maturity and experience are likely to be more advanced than those that decrease.

Because of the developmental differences that we have described, highly sophisticated logical and probabilistic reasoning competence, which can be demonstrated in children as young as 5 and 6 years old, is often not manifested under real-world