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Relation Between Perceived Vulnerability to HIV and Precautionary Sexual Behavior

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Although virtually all major theories of health-protective behavior assume that precautionary behavior is related to perceived vulnerability, the applicability of this assumption to human immunodeficiency virus (HIV) preventive behavior has recently been called into question. This article uses qualitative and quantitative methods to review and integrate the literature relevant to the relation between perceived vulnerability to HIV and precautionary sexual behavior. Specifically, the purpose of the article is to determine whether the extant research supports 2 hypotheses regarding this relation: (a) Perceptions of personal vulnerability to HIV are reflections of current and recent risk and precautionary behavior, and (b) these perceptions motivate precautionary sexual behavior. In addition, it examines the conceptual and methodological strengths and weaknesses of the empirical literature on these questions and provides recommendations for future research.

The relation between perceived vulnerability and precautionary behavior is a central component of virtually all current models of health-protective behavior. In fact, in most theories perceived vulnerability is hypothesized to be the primary motivation for the avoidance of risky behavior and the initiation of precautionary behavior. Implicit in this hypothesis is the more basic assumption that the relation between these perceptions and precautionary behavior is reciprocal. In other words, the perceived vulnerability that influences future preventive behavior is itself a reflection of current and recent risk and precautionary behaviors. Consequently, changes in risk or preventive behavior should result in alterations in estimates of vulnerability.

Although theories of health-protective behavior have focused almost exclusively on the motivational properties of perceptions of vulnerability, for a number of reasons much of the empirical research has addressed the latter part of this reciprocal relation, that is, the congruence between risk behavior and perceptions of vulnerability, and whether individuals who engage in risk behaviors deny their vulnerability to the negative consequences of that behavior. The purpose of this article is to provide a critical review and integration of the research that has examined both aspects of this reciprocal relation as they apply to perceptions of vulnerability to human immunodeficiency virus (HIV) and sexual risk and precautionary behavior relevant to HIV. We begin with an examination of the motivational hypothesis and then turn to the hypothesis that perceptions of vulnerability are, in fact, reflections of risk and precautionary behavior.

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Role of Perceived Vulnerability in Health Behavior Models

Health Belief Model

The health belief model was developed in the 1950s to explain and predict compliance with preventive regimens (Becker, 1974; Rosenstock, 1966, 1974). Like many other models of health behavior, the health belief model contains four "basic ingredients" that are thought to promote (or inhibit) health-relevant actions. These basic components include subjective perceptions of (a) vulnerability to the negative event, (b) severity of the negative event, (c) benefits of specific preventive actions, and (d) barriers to performing preventive actions. In the original version of the model, vulnerability, severity, and benefits of the preventive behavior were multiplied together to form a product term (Hochbaum, 1958; Leventhal, Hochbaum, & Rosenstock, 1960), although more recent studies have not assumed a specific combinational formula (Weinstein, 1993). Regardless, perceived personal vulnerability is usually depicted as a necessary (but not sufficient) motivator of precautionary behavior. In addition, both the original model and its more recent reinterpretation (Becker & Rosenstock, 1987) suggest that emotionality may influence the veridicality of a person's perception of threat.

A number of reviews have concluded that there is substantial support for this model and, in particular, for the role of perceived vulnerability in predicting a variety of subsequent preventive behaviors, including influenza inoculation, blood pressure screening, follow-up appointments, and preventive phy-

sician visits (cf. Becker & Rosenstock, 1987; Harrison, Mullen, & Green, 1992; Janz & Becker, 1984). It should be noted, however, that these reviews did not include studies of preventive behaviors related to sexually transmitted diseases (STDs).

Protection Motivation Theory

The original formulation of protection motivation theory was also designed to investigate the effects of persuasive messages on the adoption of health-protective behaviors (Rogers, 1975). This model suggests that information about a health hazard stimulates a cognitive appraisal of vulnerability to the negative event (along with appraisals of severity and efficacy of the recommended precautionary actions). This appraisal then acts as a mediator of the persuasive effects of the message by arousing a motivation to protect oneself. It is that motivation, according to the theory, that arouses, sustains, and directs preventive or protective behaviors. Thus, perceived vulnerability is a major factor in the formation of motivation to avoid risk. A revision of the model introduced self-efficacy as an additional component, suggesting that a person's perceptions of his or her ability to initiate or sustain a specific precautionary behavior influence motivation to engage in that behavior (Maddux & Rogers, 1983). In his review of the literature, Rogers (1983) concluded that research has supported the major elements of the model, including the role of subjective estimates of vulnerability as a cognitive mediator of precautionary behavior.

Precaution Adoption Process

More recently, Weinstein (1988) introduced a stage model, which he called the precaution adoption process. This model assumes that the process of adopting a preventive behavior follows "an orderly sequence of qualitatively different cognitive stages" (p. 355). Consistent with this idea, Weinstein suggested that acknowledging personal vulnerability is a process involving a series of cumulative stages (rather than a continuum) and that these stages are defined in terms of the beliefs people hold about the particular risk situation. In the first stage, people learn that the hazard (e.g., radon or HIV) exists. In the second stage, they recognize that the hazard is significant for others but have not yet come to the conclusion that they themselves are at risk. By the third stage, they have recognized their own vulnerability to the hazard. Achieving Stage 3 is assumed to be a necessary (but not sufficient) step that precedes the decision to engage in preventive behaviors (Stage 4) and actually acting on that decision (Stage 5).

Summary

There are a number of clear distinctions among these different models, of course. Common to all of them, however, is the hypothesis that perceived vulnerability is the major motivational force behind preventive behavior—what we call the *motivational hypothesis*.[1] In addition, perceptions of vulnerability play a prominent role in the two major theories of AIDS-risk behavior: the AIDS risk reduction model (Catania, Kegeles, & Coates, 1990) and the information motivation behavior model (J. D. Fisher & Fisher, 1992). More pertinent to the current review, the construct of perceived vulnerability has the same underlying meaning in all of the models, and it has been assessed with questions that are essentially interchangeable (Weinstein, 1993).

Current Status of the Motivational Hypothesis

Two of the reviews cited above are particularly noteworthy because of their comprehensive examination of the empirical evidence for the motivational hypothesis. Becker (1974) reviewed studies relevant to this issue published before 1974, and Janz and Becker (1984) reviewed studies published between 1974 and 1984. Both articles concluded that the data supported the hypothesis. Furthermore, Janz and Becker concluded that the prospective studies in their review offered even stronger support for the motivational hypothesis than did the cross-sectional studies. More recently, Harrison et al. (1992) conducted a meta-analysis of studies that examined the relation between various adult health behaviors and the four major components of the health belief model (perceived vulnerability to and severity of the problem, and costs and benefits of preventive actions). They reported a weighted mean effect size for the association between perceived vulnerability and risk reduction in the small to medium range ($r_+ = .20$).[2] Like Janz and Becker, Harrison et al. reported that the prospective studies in their review offered stronger support for the hypothesis than did the cross-sectional studies. In short, these reviews of the literature have supported the hypothesis that perceived vulnerability motivates subsequent precautionary behavior. In spite of this strong support for the hypothesis, two important questions have been raised about this literature, one theoretical and one methodological.

Threat and Complexity

The first question has to do with conditions that limit the applicability of the motivational hypothesis. In particular, it has been suggested that the complexity of the behavior and the severity of the outcome associated with it affect the link between perceived vulnerability and preventive behaviors (cf. Catania, Kegeles, & Coates, 1990; Montgomery et al., 1989; Weinstein, Sandman, & Roberts, 1990, 1991). More specifically, when the disease is extremely threatening, or precautionary measures are either unavailable or perceived to be difficult to implement or sustain, the typical reaction is to ignore or distort the threat rather than to attempt to change one's behavior (see also Beck & Frankel, 1981; Rogers & Mewborn, 1976).

In their examination of this issue, Montgomery et al. (1989) suggested that the role of perceived vulnerability is qualitatively

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[1] Moreover, the construct is also integral to much health-behavior research based on two additional theories that were not initially developed to explain health behaviors but which have frequently been used for that purpose—the theory of reasoned action and subjective expected utility theory (Ajzen & Fishbein, 1977; Edwards, 1954; Fishbein & Ajzen, 1975; Ronis, 1992; Sutton, 1982; cf. Weinstein, 1993.)

[2] According to Cohen (1988), a "small" correlation is .10, a "medium" correlation is .30, and a "large" correlation is .50. Cohen has reported that most of the effect sizes (including correlations) in the social sciences are in the small to medium range.

different when the behavior in question is simple (e.g., attending a screening clinic) than when it is complicated, taxing, or socially complex (e.g., monthly breast self-examination, compliance with an insulin-dependent diabetic regimen, or condom use). Montgomery et al. reexamined the studies reviewed by Janz and Becker (1984) and reported that although about 75% of the studies did find a significant association between perceptions of vulnerability and preventive behavior, a large number investigated negative events that were either not very serious (e.g., influenza) or for which the preventive behaviors were not very complex (e.g., immunization or returning for a follow-up appointment). When Montgomery et al. examined the subset of studies that investigated negative events with extreme threat, complex preventive behaviors, or both, they found that only 25% of these studies reported a significant perceived vulnerability–precautionary behavior relation. This suggests that, under these circumstances, a number of factors may dilute the effect of perceived vulnerability on the adoption of precautionary behavior or that there are intervening variables that interfere with the motivational properties of perceptions of vulnerability.

We chose to focus our review on the relation between perceived vulnerability to acquired immune deficiency syndrome (AIDS) and sexual risk–preventive behaviors because the theoretical and applied implications of this relation are important, and because these behaviors clearly fit the description of health behaviors that are less likely to be related to perceptions of susceptibility. HIV infection poses a serious threat to one's health, and prevention or avoidance of the risk requires a complex series of behaviors. In fact, there are numerous factors that could interfere with the process of perceived vulnerability translating into AIDS-preventive behavior. One is that precautionary sexual behavior generally requires negotiating with a sexual partner and, oftentimes, overcoming strongly ingrained habits or drives associated with sexual behavior. In addition, for most people, AIDS-preventive behavior—like all sexual behaviors—is laden with emotions that are more complex than those associated with most other health and preventive behaviors. Because these social, instinctual, and emotional components are unique to preventive sexual behaviors and have the potential to interfere with AIDS risk reduction, it is appropriate to raise the question of whether beliefs about the likelihood that one will contract HIV or develop AIDS actually motivate reductions in sexual risk behaviors.

Misinterpretations of Correlational Data

The second question about this literature has to do with interpretation of the reported correlations between perceived vulnerability and precautionary behavior. In spite of Janz and Becker's (1984) repeated warnings against interpreting results from cross-sectional studies as evidence of a causal relation, many authors have erroneously assumed that a positive correlation between risk perceptions and concurrent preventive behaviors indicates that people who think they are at risk are engaging in precautionary behavior and that such correlations support the motivational hypothesis.[3] As Weinstein and Nicolich (1993) asserted, however, a more accurate interpretation of these cross-sectional correlations is that perceptions of vulnerability are reflections of precautionary behavior, risk behavior, or both. That is, individuals who engage in preventive behavior do so because these behaviors reduce the likelihood that they will contract HIV, have accidents, and so forth. Adoption of these preventive actions should, in turn, translate into low vulnerability estimates. If this were the case, one would logically expect a negative correlation between precautionary behavior and perceived vulnerability at any given time. Thus, whereas positive correlations between perceptions of vulnerability and subsequent increases in precautionary behavior (in prospective analyses) support the motivational hypothesis, cross-sectional correlations between perceptions of vulnerability and precautionary behaviors should not be interpreted as support for the hypothesis.

Reciprocal Relation Between Vulnerability Estimates and Precautionary Behavior

These misinterpretations of the correlation between perceptions of vulnerability and concurrent behavior result from a failure to recognize that the reciprocal nature of the relation between these constructs is a prerequisite of the motivational hypothesis. More specifically, if HIV vulnerability estimates were not related to current and past behavior, then it is unlikely that people would think that changing their behavior would reduce their risk. Thus, the following hypotheses about this dynamic process are implicit (rather than explicit) in the motivational hypothesis: (a) Most people who have engaged in risky behaviors will report (accurately) that they are vulnerable to the negative consequences associated with those behaviors, (b) those who have practiced effective precautionary measures or avoided risk behaviors will report (again, accurately) that they are not vulnerable, and (c) individuals who change their risk or precautionary behavior will subsequently alter their perceptions of vulnerability. In other words, people who believe they are at risk may begin to engage in preventive actions because of that belief. Then, having practiced preventive behaviors, they should decide that they are less susceptible than they were previously (cf. Ajzen & Timko, 1986; Emmons et al., 1986; J. D. Fisher & Fisher, 1992; Gerrard, Gibbons, Warner, & Smith, 1993; Weinstein & Nicolich, 1993).

The opposite effect would be expected among individuals who increase their risk behaviors. For example, adolescents who become sexually active and do not use condoms or people who leave monogamous relationships and become nonmonogamous should report more vulnerability after they alter their sexual behaviors than they reported before these changes. This responsivity of vulnerability estimates to behavior change has been demonstrated recently for three nonsexual adolescent risk behaviors. Adolescents who smoke, drink, and drive recklessly report higher levels of vulnerability to the potential negative consequences of these behaviors than do those who do not engage in the behaviors. More important, increases in these adolescents' risk behaviors are accompanied by increases in their per-

[3] It should be noted that there is a difference in the terminology used in this review and that used by Janz and Becker (1984). Janz and Becker referred to all studies as either prospective or *retrospective*, thus studies that we classify as cross-sectional would have been included in their retrospective category.

ceived vulnerability to the potential negative consequences of their specific risk behaviors (Gerrard, Gibbons, Benthin, & Hessling, in press). This association between changes in risk behavior and changes in risk perceptions has recently been replicated with college women's perceptions of vulnerability to unplanned pregnancy (Smith, Gerrard, & Gibbons, 1996).

Given that the reciprocal nature of the relation between vulnerability estimates and behaviors has not been stated explicitly in health-protective behavior theories, it is not surprising that the vast majority of researchers who have addressed this relation have not focused on the hypothesis that risk and preventive behavior shape perceptions of vulnerability (for exceptions, see Hansen, Hahn, & Wolkenstein, 1990; Kalichman, Hunter, & Kelly, 1992). In fact, we are not aware of any studies that have directly tested the effect of changes in sexual risk behavior on perceptions of vulnerability to HIV. Nonetheless, the empirical literature offers evidence relevant to the reciprocal nature of the relation. In particular, the cross-sectional analyses of perceived vulnerability and risk behavior that have previously been inappropriately interpreted as tests of the motivational hypothesis can be reinterpreted as tests of the hypothesis that perceptions of vulnerability reflect risk and precautionary behavior. Although these cross-sectional studies cannot demonstrate a causal relation between behavior and risk perceptions, the emerging prospective analyses of the association between changes in behavior and changes in risk estimates (cf. Gerrard et al., in press; Gibbons, Eggleston, & Benthin, in press; Smith et al., 1996) strongly suggest that the relation is causal.

Optimistic Bias

In considering the hypothesis that perceptions of vulnerability are reflections of an individual's behavior, it is important to remember that, in general, people tend to underestimate their vulnerability to negative health events (Perloff & Fetzer, 1986; Weinstein, 1980, 1982, 1984). HIV infections are certainly no exception—optimistic bias regarding HIV has been demonstrated among high-risk gay men (Bauman & Siegel, 1987), college students (Gerrard & Warner, 1990; Linville, Fischer, & Fischhoff, 1993), and female Marines (Gerrard, Gibbons, & Warner, 1991). Thus, the hypothesis that risk perceptions are reflections of risk behavior is a relative hypothesis—although people tend to underestimate their risk, they do not deny their vulnerability. In other words, in spite of optimistic bias, an individual's risk estimates reflect both an awareness that increasing or decreasing risk behaviors affects one's vulnerability and a realization that those who engage in more (or less) risk behavior than themselves are at higher (or lower) risk (Gerrard & Warner, 1994; van der Velde, van der Pligt, & Hooykaas, 1994).

Overview

The present review uses both qualitative and meta-analytic procedures to examine the literature on the relation between perceived vulnerability to HIV and precautionary sexual behavior. We begin with a discussion of the characteristics of the studies, followed by a description of the studies that address the motivational hypothesis and the results of a meta-analysis applied to these studies. We then describe the results of the meta-analytic procedures used to examine the evidence for the hypothesis that risk perceptions reflect risk behavior (i.e., an examination of the cross-sectional studies).

Characteristics of Studies of the Perceived Vulnerability–Precautionary Behavior Relation

Studies that have addressed the relation between HIV-risk perceptions and precautionary sexual behavior have been conducted on a wide variety of populations, including college students, gay men, intravenous drug users, clients at family planning or STD clinics, prostitutes, and women in the U.S. Marine Corps. Methodologically, however, the studies are quite similar, as they have used relatively minor variations in the measurement of perceived vulnerability, a common set of assessments of risk and precautionary behaviors, and three types of designs. These are described below.

Measures

All of the studies have used some variation of the question, "What is the likelihood that you will contract HIV?" or "What is the likelihood that you will develop AIDS?" The most common response scales for these questions contain 5 points (e.g., 1 = *almost certainly will not* to 5 = *almost certainly will;* Joseph, Montgomery, Emmons, Kirscht, et al., 1987). The range of scales does vary, however, from those that use a dichotomous variable (e.g., perception of any personal risk of AIDS vs. no personal risk of AIDS; Weisman et al., 1989) to open-ended responses (e.g., "What is the likelihood that you will contract the AIDS virus? Fill in any number that you think is appropriate. For example, 1 in *1* would suggest that you think that it will definitely happen . . . 1 in 100,000 suggests that you think that it is extremely unlikely"; Gerrard & Warner, 1994, p. 963). Another variation of the perceived vulnerability question specifies a comparison group (e.g., "When you compare yourself to the average gay man, what would you say are your chances of getting AIDS?"; Aspinwall, Kemeny, Taylor, Schneider, & Dudley, 1991, p. 436). These comparative questions are then either analyzed separately or are combined with the absolute risk questions to form a perceived vulnerability index.

These studies all use self-reports of one or more sexual risk behaviors or condom use, with the vast majority including condom use and number of partners. Assessment of the participants' global risk level based on a combination of factors (e.g., an index composed of number of casual or anonymous sex partners, condom use, and receptive anal intercourse) is another approach commonly used in these studies.

Designs

The most common design is *cross-sectional,* that is, studies in which risk perception and risk or preventive behaviors are measured concurrently. The authors of these studies have typically asked participants to report either their current risk perceptions and current risk and preventive behaviors, or their current risk perceptions and their behavior in the recent past (e.g., the 3- to 12-month period preceding data collection). As noted above, results of these cross-sectional studies have often been used inappropri-

ately to test the motivational hypothesis. In the current review, we examine these studies for evidence of the responsivity of perceptions of vulnerability to sexual risk behavior.

The second category includes studies that use *prospective* designs. These studies report assessment of precautionary behavior and perceptions of risk at one time and a subsequent assessment of precautionary behavior. By determining whether changes in behavior are predicted from initial perceptions of risk, these studies can provide a test of the motivational hypothesis. More specifically, in prospective studies, a positive correlation between perceived vulnerability at Time 1 and precautionary behavior at Time 2, controlling for Time 1 precautionary behavior, would provide support for the motivational hypothesis.

The third design category consists of studies that explore behavior change *retrospectively.* In these studies, participants' reports of changes in their risk behavior over a specified period of time in the recent past are compared with their current perceptions of vulnerability. Retrospective studies are distinguished from cross-sectional studies by the fact that participants are asked to describe changes in their risk behaviors rather than the status of their current or recent behavior. Consistent with our reasoning above, a person who reports that he or she has increased precautionary behavior (e.g., condom use) in the recent past logically should report lower perceived vulnerability than a person who has not increased his or her precautionary behavior, assuming, of course, equal prior risk. Because these studies have a number of shortcomings (which are discussed later), it is necessary to interpret their results cautiously. Consequently, retrospective studies are presented as a separate category in this review.

Method

Search Strategy

Our survey of the literature between January 1986 and October of 1994 located 32 studies that examined the relation between perceived vulnerability and AIDS-preventive sexual behavior in a total of 15,440 participants. These studies were identified through both formal and informal methods. First, the *Medline* and *PsycLIT* databases from 1986 to 1994 were searched using the key words *AIDS, HIV, perceived vulnerability,* and *perceived susceptibility.* Next, the contents of five journals published between January 1986 and October 1994 were inspected for relevant articles: *Journal of Sex Research, Health Psychology, Journal of Applied Social Psychology, Journal of Personality and Social Psychology,* and *Personality and Social Psychology Bulletin.* Finally, the reference lists of all articles located through these two methods were combed for additional articles.

There were two criteria for inclusion in this review. First, because both hypotheses are concerned with behavior rather than with intentions, studies that use self-reports of intentions as the outcome variable were excluded (e.g., "If you had sex tomorrow, how likely is it that you would . . ."; Pleck, Sonenstein, & Ku, 1990). Second, studies that used assessments of "anxiety" or "worry" about AIDS or HIV (e.g., "How much do you worry you could get AIDS?"; Hingson, Strunin, Berlin, & Heeren, 1990), rather than explicitly tapping into perceived personal vulnerability or susceptibility were excluded from the review. These studies were excluded because worry and perceived risk are only moderately correlated (i.e., r slightly less than .30; Linville et al. 1993) and because the distinction between the two constructs is important (i.e., an individual could recognize that he or she is susceptible given his or her high-risk sexual habits but could adopt a fatalistic attitude and therefore not increase precautionary behaviors). The studies reviewed are marked with an asterisk in the reference list.

AIDS-related behaviors assessed in these studies fall into the two categories of behaviors typically targeted by preventive interventions: high-risk behaviors (e.g., engaging in intercourse with anonymous partners) and precautionary behaviors (e.g., using condoms). To facilitate comparison across studies, variables assessed in terms of risk behavior rather than preventive behavior were reversed, allowing us to interpret positive correlations between measures of perceived vulnerability and preventive behaviors in the same way as negative correlations between perceived vulnerability and risk behaviors. Thus, for the purpose of this review, correlations (in prospective studies) that are consistent with the motivational hypothesis are positive, and correlations (in cross-sectional studies) consistent with the hypothesis that risk perceptions reflect risk behavior are negative.[4]

Study characteristics were independently coded by two graduate students and one advanced undergraduate student. (See Appendix for a description of the characteristics extracted from each study.) Reliability coefficients were computed with the standard formula for reliability with more than two raters that adjusts for chance agreement (Fleiss, 1971). With one exception, the reliability coefficients were above .95, with a median of 1.00. The coefficient for design was lower (.72) because the criteria for retrospective studies used in this review did not always match the definition used by the authors of the studies. Disagreements between coders were resolved by Meg Gerrard.

Meta-Analytic Strategy

Because many of the measures of perceived vulnerability in these studies were continuous, the effect size estimate used was a weighted average of the sample correlations, r_+. If authors did not report enough information to calculate sample correlations but did report the direction of results or the statistical significance, vote-counting procedures were used to estimate the sample correlations (Bushman, 1994). The sample correlations and vote counts were then combined to obtain an estimate and confidence interval (CI) for the population correlation, rho (Bushman & Wang, 1995).

To obtain a weighted average of the correlations, we first obtained a weighted average of R. A. Fisher's (1921) r-to-z transformation values in which each z value was weighted by the inverse of its variance. Thus, correlations based on larger sample sizes received more weight than did correlations based on smaller sample sizes. Once a 95% CI was obtained for the population z value, it was transformed to a 95% CI for the population correlation rho (see Hedges & Olkin, 1985, pp. 230–232).

Homogeneity analyses were then performed to determine if the variation among the correlations was significantly different from chance. The test statistic for homogeneity, Q, has a chi-squared distribution with $k - 1$ degrees of freedom, where k equals the number of independent correlations (see Hedges & Olkin, 1985, pp. 235–236). If correlations are homogeneous, they are probably from the same population, and r_+ can be used to estimate rho. If the correlations were not homogeneous, and enough independent studies contributed to the correlation, additional analyses were performed to determine if study characteristics (e.g., participant gender) moderate the relation between perceived vulnerability and precautionary sexual behavior.

As noted above, several of these studies contained multiple measures

[4] This procedure allows us to make quantitative comparisons between results of studies in which dependent variables are operationalized in terms of a precautionary behavior and those studies in which dependent variables are operationalized in terms of a risk behavior. We do not suggest that increasing precautionary behavior and decreasing risk behavior are opposite ends of a single behavioral continuum. This issue is discussed later in the article.

and reported statistical tests on each measure. Other studies contained more than one sample and reported separate statistical tests for each sample. To take advantage of the richness of this literature, and to handle the fact that there are several possible units of analysis, the present review used a shifting unit of analysis (Cooper, 1989). First, each statistical test was coded as if it were an independent event. For example, Kline and Strickler (1993) reported five separate analyses relevant to this review: a retrospective analysis regarding the relation between global changes in risk behavior and perceptions of vulnerability, and four cross-sectional analyses regarding the relation of different measures of behavior and perceived vulnerability (i.e., one measure of number of partners, one of anal intercourse, and two different measures of condom use). For the overall estimate of the responsiveness of perceived vulnerability to behavior, the four cross-sectional correlations were averaged so that the study contributed only one correlation. For the analysis of retrospective studies, the study contributed the single correlation from the retrospective analysis. Finally, for the analysis of cross-sectional studies designed to determine if different measures of behavior moderate the relation between behavior and perceptions of vulnerability, this study contributed three correlations: one for multiple partners, one for anal intercourse, and a weighted average of the two correlations for condom use. This procedure retains as much data as possible without violating too greatly the independence assumption that underlies the validity of meta-analytic procedures.

Empirical Evidence

Hypothesis 1: Perceptions of Vulnerability to HIV Motivate Precautionary Behavior

Currently the literature includes only four prospective studies of the relation between HIV infection and precautionary sexual behavior (see Table 1). Two of these studies were conducted with gay men, one in Los Angeles, the other in Chicago (Aspinwall et al., 1991; Joseph, Montgomery, Emmons, Kirscht, et al., 1987, respectively); one study was conducted with college students (Boyd & Wandersman, 1991); and the fourth was conducted with clients of an STD clinic in Amsterdam (van der Velde, Hooykaas, & van der Pligt, 1992). Because there are only four of these studies, each is described in some detail.

Chicago MACS. The first of the studies of gay men included 637 men enrolled in the Chicago Multi-Center AIDS Cohort Study project (MACS; Joseph, Montgomery, Emmons, Kirscht, et al., 1987). In this study, four indicators of risk behavior were assessed at two points in time (approximately 6 months apart): number of partners, number of anonymous partners, total exposures, and receptive anal exposures. The preliminary results appeared to be consistent with the motivational hypothesis: Perceived risk at the initial data collection (Time 1) was positively correlated with three of the four measures of behavior change 6 months later (Time 2). When the researchers adjusted for Time 1 risk behavior, however, this positive association disappeared. In other words, adjusting for Time 1 risk behavior revealed that the relation between perceived vulnerability at Time 1 and precautionary behavior at Time 2 was explained by the correlation between perceived vulnerability and preventive behavior at Time 1. Joseph, Montgomery, Emmons, Kirscht, et al. concluded, "The apparent link between perceived risk and longitudinal changes in behavior is actually explained by the covariability of a sense of risk and behavior at [Time] 1" (p. 242).[5]

This analysis suggests that because Time 1 risk perceptions are a reflection of current or previous risk behavior—assuming the individual had been sexually active at that time—they cannot be considered baseline data (as they would be if they were collected before any sexual behavior had occurred). Likewise, previous risk behavior influences both Time 1 perceived vulnerability and subsequent behavior change. Thus, researchers must either control for these influences statistically or study people who are not sexually active at the initial data collection. It should be noted that prior to this article, Emmons et al. (1986) had published both cross-sectional and retrospective analyses of their data. As they suggest, the "results of the longitudinal analyses . . . are dramatically different from those obtained with [their previous] analyses" (Joseph, Montgomery, Emmons, Kessler, et al., 1987, p. 87). More specifically, unlike earlier analyses of their cross-sectional and retrospective data, the results of this prospective study provided no support for either a direct or an indirect effect of risk perceptions on subsequent AIDS-preventive behavior.[6]

Los Angeles MACS. The second longitudinal investigation (also a MACS) was conducted in Los Angeles. Aspinwall et al. (1991) assessed the AIDS-risk perceptions of 389 exclusively gay men, all of whom knew their antibody status—42% were HIV seropositive and 58% were seronegative—and none of whom had been diagnosed with AIDS-related complex or AIDS at the time of the study. Half of the participants in this study had a primary sexual partner, and half did not. At Time 1, the men were asked about their absolute risks of contracting AIDS ("Considering all of the different factors that may contribute to AIDS, including your own past and present behavior, what would you say are your chances of getting AIDS?") and their relative risk ("When you compare yourself to the average gay man, what would you say are your chances of getting AIDS?"; p. 436). In addition, at both Time 1 and Time 2, participants were asked how many different men they had had sexual intercourse with in the last 6 months, how many of these partners were anonymous, and how many of their partners for anal receptive intercourse never used a condom.

This study was designed to investigate the contributions of a number of variables derived from both the health belief model and protection motivation theory. Aspinwall et al. (1991) reported significant positive correlations between perceived vulnerability and subsequent precautionary behavior when a number of other factors were entered into the regression (i.e., demographics, HIV status, partner status, and health beliefs). For the purpose of the current study, we reported the regressions from

[5] These authors also reported virtually identical results for this set of four continuous variables and another set of six dichotomous variables in this study. Because the continuous variables offer a more sensitive test of the hypothesis, we focus on them here. In addition, the authors reported these analyses in Joseph, Montgomery, Emmons, Kessler, et al. (1987).

[6] Another follow-up of these same gay volunteers from the Chicago MACS sample was reported by Montgomery et al. (1989). This follow-up reported data on risk behaviors obtained at 6, 12, and 18 months after the initial data collection, and the results were quite similar to those reported by Joseph, Montgomery, Emmens, Kessler, et al. (1987) at the 6-month follow-up.

Table 1
Characteristics of Prospective Analyses, Effect Sizes, and Confidence Intervals

Study	N^a	Participants	Results of individual statistical tests	Average correlation
Aspinwall, Kemeny, Taylor, Schneider, & Dudley (1991)	362	Gay men (MACS)	Number of partners .01 [−.10, .12][b] Number of anonymous partners .07 [−.04, .18][b] Unprotected anal intercourse .02 [−.09, .12][b,c]	.03 [−.08, .14]
Boyd & Wandersman (1991)	109	College students	Condom use .40 [.23, .55]	.40 [.23, .55]
Joseph, Montgomery, Emmons, Kirscht, et al. (1987)	637	Gay men (MACS)	Number of partners .08 [−.00001, .15] Number of anonymous partners .08 [.006, .16] Number of exposures[d] .04 [−.03, .12] Anal receptive exposure −.03 [−.11, .05]	.04 [−.03, .12]
van der Velde, Hooykaas, & van der Pligt (1992)	535	Patients at STD clinic	Risk index, direction not reported, *ns*	NA

Note. MACS = Multi-Center AIDS Cohort Study project; NA = not applicable; STD = sexually transmitted disease. Brackets indicate confidence interval.
[a] Largest number of participants in relevant analyses. [b] Personal communication from the authors (February 22, 1994). [c] Dichotomous variable—practicing or not practicing anal receptive intercourse without a condom with partner who is seropositive or more than one partner. [d] Number of receptive anal, receptive oral–genital, or insertive oral–anal exposures.

this study that were comparable with those reported in the Chicago longitudinal MACS (Joseph, Montgomery, Emmons, Kirscht, et al., 1987), that is, those that controlled for only Time 1 behavior and sociodemographic variables. These analyses revealed positive but nonsignificant correlations between perceived vulnerability and all three measures of preventive behavior (L. G. Aspinwall, personal communication, February 22, 1994).

These analyses also revealed that the relation between risk perceptions and risk behavior was moderated by HIV serostatus and presence of a primary partner. The nature of the interactions for the two dependent variables (total number of partners and number of anonymous partners) was as follows: Perceptions of vulnerability predicted decreases in both of the risk behaviors among the seronegative participants without primary partners and decreases in number of anonymous partners among seronegative men without a primary partner. Among seropositive men without a primary partner, however, perceptions of risk were associated with an increase in number of sexual partners. In regard to this latter effect, Aspinwall et al. (1991) speculated that having a steady partner may assist gay men in coping with their increased perceptions of AIDS risk.

Amsterdam study. The purpose of the prospective analyses in van der Velde et al. (1992) was to relate risk judgments to subsequent risk behavior and behavioral intention. The participants were recruited at an STD clinic, and the majority (68%) reported working as prostitutes (the relevant analyses, however, were not reported separately for prostitutes and nonprostitutes). The behavior index used in this study was the product of the following: number of partners for each specific sexual technique, frequency of that technique, and frequency of condom use.

Perceptions of risk were associated with behavioral intentions, such that participants with higher personal risk estimates intended to engage in more precautionary behaviors than did those with lower personal risk estimates. This study, however, provided no support for the motivational hypothesis vis-à-vis subsequent behavior—when previous risk behavior was taken into account, perceptions of vulnerability did not predict subsequent risk behavior.

College student study. In contrast to the two MACS and Amsterdam study, the prospective study of college students did report support for the motivational hypothesis. In this study, Boyd and Wandersman (1991) assessed the condom use and perceived vulnerability of 109 sexually active college students and then conducted follow-up interviews regarding the students' condom use 3 months later. The results indicated that perceived vulnerability at Time 1 was a significant predictor of condom use at Time 2. That is, students who perceived that they were at risk at Time 1 reported more condom use at Time 2 than did those who did not perceive that they were at risk at Time 1. They also reported that condom use at Time 1 predicted condom use at Time 2. Unlike the other two longitudinal studies, however, this study did not control for Time 1 condom use. It is possible, then, that the reported effect of Time 1 perceived vulnerability on Time 2 condom use may (as in Emmons et al., 1986) be a reflection of the relation between condom use and perceived vulnerability at Time 1. In short, although this study was prospective (it did predict Time 2 behavior from Time 1 perceived vulnerability), because the authors did not control for Time 1 preventive behavior, it did not take full advantage of its design; therefore the results cannot be interpreted as support for the motivational hypothesis.[7]

Summary. Our qualitative analysis of these prospective studies suggests that as a group they do not support the motivational hypothesis. Only one (Boyd & Wandersman, 1991) reported significant positive results, and drawing conclusions from that study is problematic because the authors did not report all of the appropriate analyses. The weighted average of the correlations for the prospective studies, including Boyd and Wandersman, revealed a small positive effect, $r_+ = .08$ [.02,

[7] Boyd and Wandersman were unable to provide us with the data for this study; consequently, the appropriate analyses could not be conducted.

.14]; $\chi^2(2, k = 3) = 15.64, p < .001$, where k = the number of independent correlations. (The fact that the 95% CI does not contain the value 0 indicates that the average correlation is significantly different from 0.) If the Boyd and Wandersman study is excluded, the r_+ for the remaining two prospective studies for which correlation coefficients can be calculated is not significantly different from 0, $r_+ = .04$ [−.02, .10]. The correlations for these two studies were homogeneous, $\chi^2(1, k = 2) = 1.55, p = .21$. (A correlation coefficient could not be calculated for van der Velde et al., 1992, because the authors reported that the results were not significant but did not report the direction of the effect.)

Hypothesis 2: Perceptions of Vulnerability to HIV Reflect Risk and Precautionary Behavior

Our discussion of the empirical evidence on this hypothesis begins with a description of the results of the meta-analytic procedure used to estimate the total correlation between precautionary behavior and concurrent perceptions of vulnerability. This is followed by the homogeneity analyses used to determine whether specific characteristics of the studies moderate the relation.

Correlations could be calculated (or estimated with vote-counting procedures) from all 26 of the cross-sectional studies, yielding a total of 51 individual correlations. Inspection of these studies reveals that only 1 of the 26 cross-sectional studies yielded a significant positive average correlation, whereas 10 yielded significant negative correlations (see Table 2). Twelve of the remaining 15 studies reported nonsignificant negative correlations. The weighted average of the correlations from the cross-sectional studies was −.11, with a 95% CI ranging from −.13 to −.09. This average correlation is significantly different from the average correlation for the prospective studies, $p < .0001$.[8] Thus, the results of this quantitative procedure suggest that perceptions of vulnerability are weakly, but significantly, related to risk behavior, suggesting that (to a limited extent) people do take their behavior into account when estimating their vulnerability to HIV.

A homogeneity analysis was used to compare the amount of variance exhibited by the correlations from the 26 cross-sectional studies with the amount expected if only sampling error were operating. This analysis revealed that these correlations were not homogeneous, $\chi^2(25, k = 26) = 199.80, p < .0001$. As can be seen in Table 3, the series of analyses that was conducted to investigate potential moderators of the relation revealed a number of significant departures from the overall mean correlation for the cross-sectional studies. (Study characteristics represented by fewer than three correlations were not included as potential moderators.) The following is a brief description of the significant effects that emerged from the moderator analyses.

Age. There was a significant positive association between the average age of participants and the relation between sexual behavior and perceived vulnerability, $\chi^2(1, k = 15) = 7.09, p < .0001$, slope = .006. More specifically, the hypothesis that risk behavior shapes vulnerability estimates has received more support from analyses with older participants than from analyses with younger participants. This effect supports the stereotype that young people (in this case, primarily adolescents) are less attuned to the potential consequences of their behavior than are adults (see Burger & Burns, 1988; Rotheram-Borus & Koopman, 1990; Whitely & Hern, 1991; but also see Quadrel, Fischhoff, & Davis, 1993). More specifically, these studies appear to indicate that younger participants' risk estimates are not as closely linked to their risk behaviors as are older participants' estimates.

Gender and sexual orientation. The average correlations for men and women were also significantly different, $\chi^2(1, k = 21) = 7.51, p < .01$, such that the relation between risk behavior and vulnerability estimates was significant for women ($r_+ = -.11$) but not for men ($r_+ = -.03$). The average correlation for samples of gay men ($r_+ = -.03$) was significantly different from that for samples of primarily heterosexual (both male and female) participants ($r_+ = -.14$), $\chi^2(1, k = 28) = 20.22, p = .0001$, such that data from samples of heterosexuals supported the hypothesis that perceptions of vulnerability are based on risk behavior, but data from samples of gay men did not.

It should be noted, however, that as a group these studies confounded gender and sexual orientation. More specifically, only four studies reported results for heterosexual men and women separately, and only two of these reported the statistics necessary to calculate separate correlation coefficients. Because comparison of the average correlations across classifications with fewer than three studies is problematic, the existence of this confound impairs our ability to compare the average correlation coefficient for heterosexual men with that for heterosexual women. Thus, although the current studies appear to suggest that women's and heterosexuals' risk estimates are more responsive to their risk and precautionary behavior than are men's and homosexuals' estimates, the confound between gender and sexual orientation does not permit us to draw such a conclusion.

Recruitment sites. Homogeneity analysis also revealed significant differences between the average correlations for samples recruited at colleges, health clinics, and STD clinics and convenience samples from various locations within the communities (e.g., bus stops), $\chi^2(2, k = 19) = 8.45, p < .02$. Although all three locations produced significant negative correlations, the relation between precautionary behavior and risk estimates was significantly stronger among the college students ($r_+ = -.19$) than among the clinic samples ($r_+ = -.10$).

Measurement of risk–precautionary behavior. The operationalization of risk–precautionary behavior also moderated the relation between perceived vulnerability and preventive behavior, $\chi^2(2, k = 31) = 92.13, p < .0001$. As seen in Table 3, in general, analyses in which the measure was an index formed by combining two or more behaviors and those in which number of partners was the measure both supported the hypothesis that behavior shapes vulnerability estimates ($r_+ = -.25$ and $-.13$, respectively). Not surprisingly, those studies that used an index provided stronger support for the hypothesis than did those that used number of partners. Condom use, when used as the sole predictor of perceived vulnerability, however, did not significantly predict perceptions of vulnerability, $r_+ = -.01$. Thus, it

[8] This comparison was nonsignificant whether the correlation from Boyd and Wandersman (1991) was included or excluded from the average correlation for the prospective studies.

appears that people do not base their risk perceptions solely on their condom use, but instead they take a combination of risk factors into account when making judgments about their vulnerability to HIV.

Year of publication. There was a significant negative relation between the publication year and the relation between risky sexual behavior and perceived vulnerability—$\chi^2(25, k = 26) = 58.48$, $p < .0001$, slope = $-.04$—such that risk estimates were more closely related to risk behaviors in the earlier studies than in the later studies.

Summary. These studies indicate that AIDS-risk perceptions vary appropriately, but not strongly, with current and recent preventive behavior. The moderation effects suggest that group differences in the degree to which HIV-vulnerability estimates are based on sexual behavior are worthy of further investigation. More immediately, they also provide useful information regarding the correlates of risk estimates—the most common measure of behavior used in these studies, condom use, is significantly less likely to be related to risk estimates than are indexes that combine two or more risk and preventive behaviors. We defer discussion of the importance of such indexes for assessing behavior until later in the article.

Retrospective Studies

Five studies used retrospective assessments of changes in risk–preventive behavior (see Table 4). These studies typically asked participants to report the degree to which their risk–precautionary behaviors had changed in the recent past as a result of their perceived vulnerability to HIV infection. The earliest of these studies provides a good example of this type of research. Retrospective self-reports of behavior change "since the beginning of the AIDS epidemic" were included in the first phase of a longitudinal study of 909 gay men who were participants in the Chicago MACS (Emmons et al., 1986, p. 337). These authors reported a significant positive relation between current perceived vulnerability to AIDS and retrospective measures of behavior change (i.e., "global behavioral change" and "attempts to reduce the number of sexual partners"), such that men with high-perceived vulnerability were more likely to report that they had increased their precautionary behaviors than were men with low-perceived vulnerability.

Examination of the retrospective studies as a group reveals that two reported positive associations between risk perceptions and self-reports of behavior change and that three reported no relation between these variables. The average correlation for these studies, $r_+ = .09$ [.05, .13], $\chi^2(3, k = 4) = 9.95$, $p < .02$, was not significantly different from that for the prospective studies, $p < .18$. As a group, however, these studies suffer from some important shortcomings, including the very real possibility that positive results could be a reflection of the justification effect mentioned above and the fact that the purpose of these studies and their measures are likely to be particularly transparent (e.g., "Since you first heard about AIDS, what have you done to protect yourself from getting AIDS?" [Abdul-Quader, Tross, Friedman, Kouzi, & Des Jarlais, 1990], and "Has your behavior changed in response to the AIDS epidemic?" [Thurman & Franklin, 1990]). The use of these kinds of assessments of behavior change also raises the question of whether participants are capable of knowing exactly why they have changed their behavior (cf. Nisbett & Wilson, 1977).

In addition, interpreting these studies as support for the motivational hypothesis requires the assumption that increases in precautionary behavior do not alter perceptions of vulnerability or that people who have increased their precautionary behavior have not increased it sufficiently to move into a lower risk category. In other words, if people who have increased their precautionary behavior think that their efforts have been effective in decreasing their risk, the resulting correlation between reports of past increases in precautionary behavior and current perceptions of vulnerability in retrospective studies should be negative. The average correlation for these studies is positive, however, suggesting that low-risk participants do not report increases in precautionary behavior. Furthermore, this correlation suggests that high-risk participants report such increases, but the changes in their precautionary behavior are not sufficient to significantly decrease their perceptions of vulnerability.

Applicability of the Motivational Hypothesis to HIV-Precautionary Behavior

Our review of the research on the relation between sexual precautionary–risk behavior and perceptions of vulnerability to HIV has led us to two conclusions: (a) There is support for the hypothesis that risk and precautionary behaviors influence vulnerability estimates (albeit weakly), but (b) virtually no support for the hypothesis that perceptions of vulnerability to HIV motivate subsequent precautionary sexual behavior.

Interpreting null results is generally hazardous, and the current results are no exception. One possible explanation is that the methods used in these studies have not been sufficiently sensitive to detect the causal link between perceptions of vulnerability and the adoption of precautions or that perceptions of vulnerability are necessary but not sufficient to motivate precautionary behavior. Another is that the unique characteristics of HIV-preventive sexual behavior dilute the power of perceived vulnerability to alter behavior. Although these possibilities should be explored (and are discussed shortly), we are unwilling to recommend that the motivational hypothesis as it applies to HIV be abandoned at this time. Instead, a more limited interpretation of the current results is appropriate; that is, perceptions of vulnerability to HIV infection among high-risk groups are not sufficient to motivate the adoption of precautionary behaviors. More specifically, given that the three strong longitudinal studies reviewed here included only participants in high-risk categories (prostitutes, clients at STD clinics, and gay men), it would be inappropriate to generalize from these studies to lower risk samples. We come to this conclusion for a variety of reasons.

First, the cross-sectional studies indicate that low-risk groups are more likely than high-risk groups to base their risk estimates on their behavior and, as noted earlier, the motivational hypothesis is based on the assumption that people are aware of the relation between their behavior and their risk. If these high-risk groups do not fully acknowledge this relation, either through ignorance or denial, then it is unlikely that their risk perceptions could motivate precautionary behavior. Second, even if the risk is acknowledged, the threat inherent in being a member of an identified high-risk

Table 2
Characteristics of Cross-Sectional Analyses, Effect Sizes, and Confidence Intervals

Study	N[a]	Participants	Results of individual statistical tests	Average correlation
Baldwin & Baldwin (1988)	851	College students	Condom use, direction not reported, *ns* Number of partners −.12 [−.20, −.03] Commitment,[b] direction not reported, *ns*	−.12 [−.20, −.03]
Catania et al. (1992)	1,299	Heterosexual men and women, gay men	Heterosexual men, condom use, negative, *ns* Heterosexual women, condom use, negative, *ns* Gay men, condom use, negative, *ns*	−.04 [−.14, .07]
Catania et al. (1989)	114	Female adolescents at a family planning clinic	Condom use, direction not reported, *ns* Number of partners −.18 [−.39, .05]	−.18 [−.39, .05]
Emmons et al. (1986)	909	Gay men (MACS)	Number of partners −.01 [−.09, .07] Abstinence[c] .01 [−.07, .09] Condom use[d] .08 [−.008, .17]	.02 [−.06, .11]
J.D. Fisher & Misovich (1990)	60[e]	Gay men	Global risk behavior .24 [−.02, .47]	.24 [−.01, .47]
Gerrard & Warner (1994)	637	College students, women Marines	College students, condom use −.13 [−.26, .01] Marines, condom use .03 [−.07, .12]	−.02 [−.13, .09]
Goldman & Harlow (1993)	602	College students	Risk index −.33 [−.40, −.26][f]	−.33 [−.40, −.26]
Gray & Saracino (1989)	459	College students	Number of partners .07 [−.02, .16]	.07 [−.02, .16]
Hansen, Hahn, & Wolkenstein (1990)	222	Convenience sample	Females, risk index −.09 [−.26, .10] Males, risk index, direction not reported, *ns*	−.09 [−.26, .10]
Hays, Kegeles, & Coates (1990)	99	Gay men	Condom use −.35 [−.51, −.16]	−.35 [−.51, −.16]
Kalichman, Hunter, & Kelly (1992)	272	Convenience sample of women	Risk index −.21 [−.32, −.09]	−.21 [−.32, −.09]
Kelly et al. (1990)	481	Gay men who patronized gay bars	Unprotected anal intercourse[g] −.34 [−.47, −.21] Condom use index[h] .16 [.07, .24] Risk index[i] −.30 [−.38, −.22]	−.12 [−.22, −.02]
Kline & Strickler (1993)	152	Women in drug treatment	Condom use[j] −.16 [−.32, .01] Condom use[k] −.05 [−.24, .14] Multiple partners .02 [−.14, .18] Anal intercourse .004 [−.19, .19]	−.05 [−.22, .13]
Maticka-Tyndale (1991)	866	College students	Females, condom use −.16 [−.25, −.08] Males, condom use .02 [−.08, .12]	−.09 [−.18, .01]
McCusker, Zapka, Stoddard, & Mayer (1989)	201	Gay men at general health clinic	Number of partners −.12 [−.26, .02]	−.12 [−.26, .02]
Moore & Rosenthal (1991)	1,008	College students	Number of partners −.40 [−.45, −.35][g] Risk index casual sex[l] −.29 [−.35, −.23] Risk index regular partner[m] −.21 [−.26, −.15]	−.30 [−.36, −.24]
Rickert, Jay, Gottlieb, & Bridges (1989)	99	Female adolescents at a general health clinic	Risk index,[n] direction positive, *ns*	−.04 [−.23, .16]
Rosenthal, Hall, & Moore (1992)	195	College students	Females, risk from casual sex[l] −.33 [−.48, −.17] Females, risk with regular partner,[m] *ns* Males, risk from casual sex,[l] *ns* Males, risk with regular partner,[m] *ns*	−.33 [−.48, −.17]
Simon, Morse, Balson, Osofsky, & Gaumer (1993)	211	Adult male prostitutes	Risk index −.14 [−.27, −.01]	−.14 [−.27, −.01]
St. Lawrence (1993)	195	African American adolescents	Condom −.10 [−.24, .04]	−.10 [−.24, .04]
Valdiserri et al. (1988)	578	Gay men (MACS)	Condom use[o] .12 [.04, .20]	.12 [.04, .20]
van der Velde, Hooykaas, & van der Pligt (1992)	535	Patients at STD clinic	Pessimists, risk index −.19 [−.36, −.01] Optimists, risk index, direction not reported, *ns* Realists, risk index, direction not reported, *ns*	−.19 [−.36, −.01]
van der Velde, van der Pligt, & Hooykaas (1994)	881	Gay men and patients at STD clinic	Low-risk heterosexuals, risk index[p] −.05 [−.18, .08] High-risk gay males, risk index[p] −.26 [−.40, −.10] High-risk heterosexuals, risk index[p] −.13 [−.22, −.04]	−.13 [−.24, −.02]

(*table continues*)

Table 2 (*continued*)

Study	N^a	Participants	Results of individual statistical tests	Average correlation
Weisman et al. (1989)	404	Female adolescents at a family planning clinic	Condom use[q] −.04 [−.13, .06] Number of partners −.11 [−.20, −.01]	−.07 [−.17, .02]
Wulfert & Wan (1993)	212	College students	Condom use −.06 [−.19, .08]	−.06 [−.19, .08]
Zapka, McCusker, Stoddard, Morrison, & Mayer (1990)	266	Gay men at general health clinic	Number of partners −.08 [−.20, .04]	−.08 [−.20, .04]

Note. MACS = Multi-Center AIDS Cohort Study project; STD = sexually transmitted disease. Brackets indicate confidence interval.
[a] Largest number of participants in relevant analyses. [b] Familiarity with most casual partner in last 3 months. [c] Abstinence from receptive anal intercourse. [d] Index includes condom use and asking partner to withdraw before ejaculation in receptive anal intercourse. [e] Personal communication from the authors (J.D. Fisher & S. Misovich, July 20, 1994). [f] Index includes engaging in intercourse, condom use, sex under the influence of alcohol or drugs, and multiple partners. [g] Engaged in unprotected anal intercourse in the last 3 months. [h] Proportion of anal intercourse protected by condoms. [i] Frequency of unprotected anal intercourse X number of partners. [j] Ever used condoms. [k] Used condom in last month. [l] Index includes condom use in various sex acts with casual partners. [m] Index includes condom use in various sex acts with regular partners. [n] Number of partners per month, number of different partners per year, frequency of intercourse, duration of relationship, and use of condoms. [o] Condom use coded *always* or *never*. [p] Index = number of partners per risk behavior × frequency of risk behavior × frequency of condom use. [q] Condom used during last intercourse.

group may interfere with the motivational power of the risk estimate. Third, people in high-risk groups may be at high risk because they are convinced that they cannot change their behavior. This later possibility is consistent with Weinstein and Nicolich's (1993) suggestion that people who are going to adopt precautionary behaviors tend to do so early in the course of a new threat. Thus, over time, the segment of the population that has not changed their behavior includes increasingly larger proportions of people who either think that they cannot adopt precautions or who are unwilling to attempt to do so.

This conclusion notwithstanding, it is important to understand the ways in which HIV-preventive behaviors are different from other health behaviors and the methodological issues raised by these studies (some of which are minor but are encountered repeatedly).

Differences Between HIV Infection and Other Health Threats

As discussed above, it has been suggested that health-protective behavior models were designed to deal with precautionary behaviors related to threats that are not fatal and are reversible rather than with threats like HIV. In addition, Joseph, Montgomery, Emmons, Kirscht, et al. (1987) proposed that these models are most useful in explaining risk behaviors that are less central to identity than are sexual behaviors. Their point is well taken. In fact, there are a number of important distinctions between the characteristics of HIV infection and those of other health threats that may attenuate the relation between an individual's perceptions of vulnerability and their AIDS precautionary behavior. Four of these factors are discussed here: emotions associated with sex; the social nature of precautionary sexual behavior; the lengthy incubation period for HIV; and low probability of, and uncertainty about, the process of infection.

Emotions associated with decisions about sex. The unique nature of the sex drive contributes to the fact that decisions about sex are oftentimes made in the heat of the moment—when the person is emotionally and physically aroused—rather than after careful, or even rational, deliberation. In this regard, research on sexual behavior is consistent with the growing body

Table 3
Weighted Average Correlations and Homogeneity Analyses for Cross-Sectional Studies

Variable	k	r_+	CI	Q
Gender				
Male	11	$-.03_a$	[−.07, .003]	χ^2 (8) = 61.30, $p < .0001$
Female	10	$-.11_b$	[−.14, −.03]	χ^2 (3) = 4.24, $p < .24$
Sexual orientation				
Primarily heterosexual	10	$-.14_a$	[−.17, −.12]	χ^2 (9) = 158.00, $p < .0001$
Lesbians and gay men	9	$-.03_b$	[−.07, .01]	χ^2 (8) = 61.30, $p < .0001$
Major recruitment sites				
Clinics	8	$-.10_a$	[−.15, −.06]	χ^2 (7) = 4.22, $p < .75$
Communities	3	$-.13_{a,b}$	[−.20, −.05]	χ^2 (2) = 3.59, $p < .17$
Colleges	7	$-.19_b$	[−.22, −.15]	χ^2 (7) = 85.30, $p < .0001$
Risk–precautionary behavior				
Condom use	11	$-.01_a$	[−.04, .02]	χ^2(10) = 55.75, $p < .0001$
Number of partners	9	$-.13_b$	[−.16, −.10]	χ^2 (8) = 76.36, $p < .0001$
Risk index	11	$-.25_c$	[−.28, −.21]	χ^2(10) = 40.09, $p < .0001$

Note. k = number of independent correlations; r_+ = weighted average correlation; CI = 95% confidence interval; Q = homogeneity statistic. A p value less than .05 indicates that the correlations are heterogeneous. Correlations sharing the same subscript are not significantly different at the .05 significance level.

Table 4
Characteristics of Retrospective Analyses, Effect Sizes, and Confidence Intervals

Study	N^a	Participants	Results of individual statistical tests	Average correlation
Abdul-Quader, Tross, Friedman, Kouzi, & Des Jarlais (1990)	568	Intravenous drug users	Behavior change,[b] direction not reported, *ns*	NA
DiClemente, Forrest, & Mickler (1990)	1,127	College students	Condom use .09 [.03, .15] Number of partners .08 [.02, .14] Anal intercourse, negative, *ns*	.09 [.03, .14]
Emmons et al. (1986)	909	Gay men (MACS)	Number of partners .08 [.01, .15] Behavior change[b] .07 [.002, .13]	.07 [.01, .14]
Kline & Strickler (1993)	152	Women in drug treatment	Global risk behavior[c] −.05 [−.21, .11]	−.05 [−.21, .11]
Thurman & Franklin (1990)	294	College students	Behavior change[b] .24 [.12, .34]	.24 [.12, .34]

Note. MACS = Multi-Center AIDS Cohort Study project. Brackets indicate confidence interval.
[a] Largest number of participants in relevant analyses. [b] Behavior change = reports of any behavior change since learning about AIDS. [c] Any change in sexual behavior in the last 6 months because of AIDS.

of evidence on the impact of affective states and emotional responses on judgment and decision making (Isen & Geva, 1987; Isen & Patrick, 1983; Johnson & Tversky, 1983; Leventhal, Diefenbach, & Leventhal, 1992; Zajonc, 1980). More specifically, one of the most consistent findings in the literature on the psychology of sexual behavior is that such decisions are heavily influenced by an emotional predisposition that is likely to interfere with rational risk assessments, that is, one's emotional responses to sexuality. There is evidence that negative emotional responses to sexuality (called "sex guilt" or "erotophobia"; Mosher, 1966, 1968; White, Fisher, Byrne, & Kingma, 1977) are associated with the lack of use of effective birth control methods and inconsistent use of effective birth control methods (W. A. Fisher, Byrne, & White, 1983; Gerrard, 1982, 1987; Mosher, 1973). For example, among women who use oral contraceptives, those who are erotophobic are less likely to take their pills everyday as prescribed than are other women and, therefore, are more likely to get pregnant (Gerrard, 1977). In addition, these attitudes predict discomfort with purchasing condoms and underestimation of the likelihood of engaging in intercourse (which presumably leads to an underestimation of the need for protection; W. A. Fisher, 1984; W. A. Fisher, Fisher, & Byrne, 1977).

This literature suggests that decisions regarding sexual risk taking are highly vulnerable to emotional interference and, therefore, may not be as rational as decisions involving precautionary behaviors that are less emotion laden, such as wearing a seat belt or getting a flu shot. It is reasonable to assume that these emotional barriers also interfere with the motivational properties of perceived risk and affect AIDS-precautionary behaviors in the same ways that they affect practicing effective contraception, that is, by interfering with the consistency of precautionary efforts.

Social behavior. A related issue is that sexual precautionary behaviors are significantly more social than many other preventive behaviors. For many people, the processes of communicating with one's sexual partner and negotiating cooperation in practicing safe sex may be exceedingly difficult (Miller, Bettencourt, DeBro, & Hoffman, 1993). For such people, it is doubtful that risk perceptions are powerful enough to overcome the barriers of embarrassment and uncooperative partners, thus communication problems can be so overwhelming as to effectively sabotage the best intentions to practice preventive behavior. When these problems are insurmountable, they can preclude the translation of risk perceptions into precautionary behaviors.

Symptom delay. The fact that HIV has a prolonged incubation, sometimes as long as 12 years with averages between 8 and 11 years (Bacchetti, Segal, Hessol, & Jewell, 1993; Lui, Darrow, & Rutherford, 1988; Munoz et al., 1989), also distinguishes it from many other preventable negative events. For many people, this delay is likely to diminish the capacity of perceived risk to motivate behavior change, that is, preventive behavior is more likely if the consequences of risk taking are relatively immediate. For example, consider the difference between a hypothetical situation in which a young person knows that there is a 30% probability that a risk behavior will result in a specific negative consequence within 24 hours, and a situation in which there is a 30% probability that the same risk behavior will result in the same negative consequences but 10 years hence. Although there is little empirical evidence on this issue, it is logical to assume that the more proximal the risk behavior is to the negative consequences, the stronger the relation between risk perceptions and preventive behavior (see Weinstein, 1988, for a related discussion of the effect of perceived cost and benefits of precautionary behaviors over time).

Low probability and uncertainty of infection. The risk associated with a single incident of unprotected intercourse with a partner who is not a member of a high-risk group is estimated to be about 1 in 5 million, approximately equal to the risk of being killed in an automobile accident while driving 10 miles to the encounter. The risk of infection from a single, unprotected encounter with a member of a high-risk group is also relatively low—estimated to be between 1 in 1,000 and 1 in 10,000 (Hearst & Hulley, 1988). Thus, the objective risk of disobeying precautionary recommendations in any single sexual encounter may be well within the acceptable range for most people, and it would not be surprising if this extremely low probability translated into decreased motivation to comply with precautionary recommendations.

Another issue is the uncertainty and ambiguity surrounding the process of infection. Unlike many risk behaviors, the relation between exposure to HIV and infection is far from linear.

For example, a woman with diabetes knows exactly what happens if she does not monitor her insulin level, and a man with bipolar disorder should know what happens if he does not take lithium. Transmission of HIV, however, is a function of a combination of factors, including the infectivity of the donor, characteristics of the recipient, and the nature and frequency of the risk behaviors (Lawrence, Jason, Holman, & Murphy, 1991). As a result, some people who engage in high-risk behaviors do not contract the virus, whereas other people appear to contract it from a single exposure. Knowledge of the seemingly capricious nature of the virus is likely to further erode the motivational properties of perceived vulnerability.

Summary. A number of factors, such as emotionality and the distal nature of the outcome, may reduce the likelihood that perceptions of vulnerability to HIV infection will translate into precautionary sexual behavior. It is impossible to know how much these factors are responsible for the null results of the prospective studies reviewed here. Although efforts should be made to assess these various factors in future research, it is important to be aware that some of these factors may weaken the causal relation between perceptions of vulnerability and precautionary behavior in some populations, but they probably do not have equal effects on all risk groups. In other words, just as the correlations between risk behavior and concurrent risk perceptions are not identical across all groups, specific factors may have differential effects on the motivational power of vulnerability estimates across different segments of the population.

Methodological Issues

Reliability and validity of self-reported sexual behavior. Many people have questioned the reliability and validity of self-reports of sexual behavior and condom use (cf. Catania, Gibson, Chitwood, & Coates, 1990). Conscious distortions of self-reports of such intimate behavior can certainly be motivated by a number of factors, including embarrassment and fear of reprisals, or self-presentational concerns, such as the desire to conceal or embellish specific sexual behaviors. Participants' self-reports may also be affected by less conscious motives, such as sexual attitudes (e.g., sex guilt or erotophobia; Mosher, 1966, 1968; White et al., 1977).

The reliability of such self-reports has been examined by comparing partners' individual (or independent) reports of how often they, as a couple, engage in specific sexual behaviors or use condoms over a given period of time. For example, in a study of the reliability and validity of recall measures of intercourse among gay men, McLaws, Oldenburg, Ross, and Cooper (1990) found reliability coefficients between .73 and .98 for partners' self-reports of number of partners and frequency of intercourse. In a similar study, Coates et al. (1986) reported reliability coefficients between .98 and .99. Evidence of reliability has also been found with heterosexual adolescents and adults. For example, in one study where sexual partners aged 18–20 described their contraceptive use separately, the intracouple agreement on current contraceptive practices was .94 (Gerrard, Breda, & Gibbons, 1989).

Perhaps the best way to determine the validity of self-reports is to establish an external objective criterion with which to compare those self-reports. Unfortunately, no such "gold standard" is available for assessing self-reports of specific sexual practices (Catania, Gibson, et al., 1990). However, evidence of the validity of self-report measures of heterosexual intercourse and contraceptive use does exist. In a study of 955 women Marines, self-reports of the frequency of intercourse and the use of specific methods of birth control were collected (Gerrard & Warner, 1990). The proportion of women reporting use of each method, the typical failure rate for each method, the reported frequency of intercourse for women using each specific method, and the proportion of women who were sexually active in the sample were used to predict a 1-year pregnancy rate for the sample.[9] The results of this procedure suggest that the women's self-reports of their sexual activity and contraceptive behavior were valid—the projected 1-year pregnancy rate was 23%, and the actual pregnancy rate was 25%.

A number of studies have used similar approaches to examine the validity of gay respondents' self-reports of safe sex practices. For example, Winkelstein et al. (1987) found that reports of increases in safe sex practices paralleled declines in seroconversion rates in San Francisco; Coates, Stall, Catania, Dolcini, and Hoff (1989) reported similar parallels between safe sex practices and reductions in anal gonorrhea in the same population. Thus, although the reliability and validity of measures of sexual behavior are frequently questioned, the evidence suggests that they are reasonable and that the weaknesses in these measures are unlikely to explain the lack of support for the motivational hypothesis.

Measurement issues. The estimated probability of contracting HIV varies from 1 in 50 million when a person has a single encounter with a low-risk partner and uses a condom, to close to 100% for repeated, unprotected intercourse with multiple high-risk partners (Fineberg, 1988; Hearst & Hulley, 1988). Thus, it is imperative that assessments of perceived vulnerability be able to adequately distinguish between the risk perceptions of those who are at the high end versus those at the low end of the risk continuum and also distinguish between the small differences in risk perceptions of people at the lower end of this continuum (cf. Linville et al., 1993).

Many of the studies reviewed here, however, have used methods of measuring risk perceptions that do not appear to be sufficiently sensitive to allow an adequate test of the motivational hypothesis. This is especially true for studies whose participants' behavior places them at the lower end of the risk continuum. For example, the most common vulnerability assessment uses a 5-point scale (e.g., "What is the chance that you will get AIDS in the next 5 years?" where 1 = *very sure that it will not happen* and 5 = *very sure that it will happen*; Baldwin & Baldwin, 1988; Weisman et al., 1989). When this question is asked of college students (for whom the overall infection rate is estimated at 0.02%; Gayle et al., 1990), or any other relatively low-risk sample, the vast majority of the participants respond with a 1. This, of course, is the most accurate response on such a scale, but it creates a serious problem with regard to restricted

[9] The formula for this computation is $\sum_{i=1}^{n} (P_i \times FR_i \times FQ_i + C)(P)$, where P_i = proportion of women using method i; FR_i = typical failure rate for method i; FQ_i = adjusted frequency of intercourse for women using method i; C = correction factor for missing data; and P = proportion of women who are sexually active.

range and variance for the measure. Fortunately, three of the four prospective studies cited (Aspinwall et al., 1991; Joseph, Montgomery, Emmons, Kirscht, et al., 1987; van der Velde, Hooykaas, & van der Pligt, 1992) do not suffer from this problem because the participants had engaged in a range of risk behaviors, thus the researchers have reported adequate variance in risk estimates.

Another problem with the measurement of risk estimates should be noted. Almost all of these studies have used a single item to assess perceived vulnerability. The studies that have used two items have combined relative risk with comparative risk items (Aspinwall et al., 1991, reported a reliability coefficient of .88 for these two items). Although the results of the cross-sectional studies suggest that these measures are reasonably valid reflections of actual risk behavior, the studies reviewed in this article have operationalized perceived risk strictly as a cognitive representation of likelihood. Thus, they have not examined the possibility that perceived vulnerability is multidimensional or explored the possibility that dimensions of perceived risk other than subjective likelihood (e.g., salience or vividness of the threat or affective response to the threat) may be critical to the adoption of precautionary behavior.

Analytic issues. Closely related to these measurement issues are two problems associated with the statistical analyses reported in most of these studies. The first is the possibility that an association between perceived vulnerability and HIV-preventive behavior does exist, but it has not been detected because it is not linear. In particular, the correlational techniques and covariance analyses used in most of the studies may not be capable of adequately capturing the relationship. This would definitely be the case if the relationship involved some form of threshold effect; namely, beyond a certain level increased perceived vulnerability does not motivate additional preventive behavior (cf. Becker & Joseph, 1988; Weinstein, 1988). It should be noted that none of the studies described above reported use of statistical methods appropriate for detecting such effects.

The second possibility is that a vulnerability–behavior link does exist, but it is moderated by or linked to one or more additional variables that have not been included in these studies. For example, if the vulnerability–behavior relation is moderated by a third variable (e.g., self-efficacy), it is possible that the association would go undetected unless this moderating variable were measured and entered into the model. A good example of this is found in the study by Aspinwall et al. (1991), which suggests that the relation among gay men is moderated by HIV serostatus and the presence of a primary sexual partner. If there are important moderator variables that have yet to be discovered, it may be that the motivational hypothesis is not incorrect but rather that perceived vulnerability is a necessary, but not a sufficient, prerequisite for precautionary behavior.

Likewise, if the relation between perceived vulnerability and behavior is, in fact, linked to a third variable (cf. H. M. Blalock, 1971), then the vulnerability–behavior relation can be only as strong as the relation between the product of the various links in the model. For example, the precaution adoption process (Weinstein, 1988) suggests that a decision to act is a necessary prerequisite for behavior change. Similarly, the theory of reasoned action (Ajzen & Fishbein, 1977; Fishbein & Ajzen, 1975) suggests that intention to act is necessary to translate attitudes such as perceptions of vulnerability into action. Thus, these models would predict that the relation between perceived vulnerability and precautionary behavior can be only as strong as the product of the two relevant relations: the relation between perceived vulnerability and decision to change (or intention) *and* the relation between the decision (or intention) and actual behavior. The resulting correlation between risk estimates and precautionary behaviors could easily be too small to be detected except with extremely sensitive analyses. One way of testing this possibility is through the use of structural equation modeling, a technique that none of the authors of the prospective studies has reported applying to his or her data. Structural equation modeling also provides a tool for comparing the fit of different models of the causal direction between perceptions of vulnerability and risk behaviors in cross-sectional data. For example, Bollen (1989) suggested using iterative tests of models of the direction of influence between variables, including specification of models that allow for reciprocal causation. This procedure allows for an examination of the statistical significance of each effect, as well as the comparison of the goodness of fit of a variety of different models. Although such model comparisons cannot provide definitive statements about the direction of causality, they can be useful in eliminating models that do not fit the data.

Conclusions

Motivational Hypothesis

There have been well-documented, dramatic decreases in HIV-related sexual risk behaviors in the last decade that have clearly paralleled the growth in public awareness of, and concern about, the threat of AIDS (Golubjatnikov, Pfister, & Tillotson, 1983; Joseph, Montgomery, Emmons, Kirscht, et al., 1987; Martin, 1986; McKusick et al., 1985; Winkelstein et al., 1987). As two researchers in the area have suggested, these changes are perhaps "the most rapid and profound response to a health threat which has ever been documented" (Becker & Joseph, 1988, p. 407). That being the case, how can they be unrelated to perceptions of vulnerability? Is it possible that people have altered their sexual behavior, often dramatically, but that these changes were not motivated by beliefs that they were at risk? The answer to this question appears to be a guarded yes—the extant research does not support the motivational hypothesis regarding AIDS-preventive behavior among high-risk individuals. Because the empirical literature provides tests of the hypothesis only with high-risk populations, however, it is premature to draw conclusions regarding the applicability of the hypothesis to low-risk populations.

Risk Behavior Shapes Perceptions of Vulnerability

As stated earlier, the 26 cross-sectional studies reviewed here point to the conclusion that estimates of vulnerability to HIV infection are, in fact, reflective of risk and precautionary sexual behaviors. People who engage in more risk behaviors tend to have higher estimates of their likelihood of contracting HIV than do people who engage in fewer risk behaviors. The analyses presented here also indicate that this is more true for some groups (e.g., older participants, women, and college students)

than for others (e.g., younger participants, gay men, and clients at health clinics) and suggest that future research should examine the reasons for these group differences and explore interventions designed to increase the degree to which people base their estimates on their actual behavior.

Recent research has suggested that this finding generalizes beyond HIV. For example, women use both their frequency of intercourse and their contraceptive use to calculate their risk of unplanned pregnancy (Gerrard & Luus, 1995), and adolescents increase their risk estimates when they increase their drinking, smoking, and reckless driving (Gerrard et al., in press). It should not be assumed, however, that this finding generalizes to the relation between risk behavior and vulnerability estimates for all diseases and health risks. The risks in each of these studies are unusual in that they have been the target of extensive mass media and school education campaigns for some time. In the case of HIV, a multitude of such programs over the last decade has ensured that people are relatively knowledgeable about both the dangers of risky sexual behavior and the effectiveness of preventive measures (Baldwin & Baldwin, 1988; J. D. Fisher & Misovich, 1990; Hatcher et al., 1990). We cannot assume that vulnerability estimates are equally reflective of risk behaviors when the risk behaviors are less well defined by medical science or less well known by the public (e.g., breast cancer).

Prescriptions for Future Research

The conclusion that participant characteristics moderate the relation between HIV-preventive behavior and perceptions of vulnerability to AIDS highlights the importance of a systematic examination of a number of moderating variables in order to expand theoretical and practical knowledge of this relation. The cross-sectional studies reported here suggest that age, gender, experience with risk behaviors, and risk status may all affect whether risk perceptions are a reflection of current risk behavior and the motivational power of those perceptions once they are formed. In addition, Aspinwall et al. (1991) suggested that the presence of a regular sexual partner influences how gay men respond to their perceptions of vulnerability. As Aspinwall et al. pointed out, past failures to consider these (and other) moderators may explain some of the contradictory (and null) results in the literature.

In addition, this review leads to a number of other suggestions regarding both conceptual and methodological considerations for the next generation of studies on the relation between perceptions of vulnerability to HIV infection and AIDS-precautionary behavior.

Prospective designs. Longitudinal designs are necessary to determine whether perceptions of vulnerability predict subsequent precautionary behavior and whether changes in risk perceptions predict changes in behavior. Longitudinal research, however, is not without problems. For example, we do not know what the optimal interval between assessments is—Is a 3-month period sufficient for people to change their risk behavior? Or does it take 6 months, a year, or even more? This question is complicated by the fact that these changes happen in the context of relationships, and the answer may be different for individuals with primary partners than for those without primary partners. Likewise, shifts in the public awareness of AIDS and knowledge of HIV infection over the course of a longitudinal study can obscure the relation between perceptions of vulnerability and behavior changes.

Perhaps the largest threat to longitudinal studies, however, is the possibility that most adults' risk and precautionary behaviors have stabilized, resulting in insufficient variance in behavioral change to detect the effects of perceived vulnerability (cf., Weinstein & Nicolich, 1993). If most adults have already adopted precautionary behavior, or have decided that they cannot or will not decrease their risk behaviors, then prospective studies of adults may have a reasonable amount of between-subject variance in behavior but not have sufficient within-subject variance to detect the effects of vulnerability perceptions on changes in these behaviors. In fact, of the four prospective studies covered in the current review, only one reported evidence that the participants' behavior changed during the course of the study (Joseph, Montgomery, Emmons, Kirscht, et al., 1987). Thus, it is possible that the risk–preventive behavior in the other prospective studies was stable and, therefore, did not permit a true test of the hypothesis. The solution to this problem is clear, but it is not easy to implement—the populations of primary interest for this research should be people who are likely to undergo changes in risk and precautionary behaviors (e.g., people whose sexual habits or relationships are in transition) or people who are initiating sexual risk behaviors (e.g., adolescents). Thus, it becomes important to identify these populations and study the relation between perceptions of vulnerability and risk behaviors as they undergo such transitions.

There are a number of theoretical and practical questions that can best be addressed with longitudinal data from one group in particular—samples that are younger (less experienced) than those represented in the existing prospective studies. These questions have to do with the development and antecedents of perceptions of risk as individuals move from simply possessing the knowledge that HIV poses a risk for others to recognition that they themselves are vulnerable (i.e., as they move from Stage 2 to Stage 3 of Weinstein's, 1988, precaution adoption model). Although the prospective studies reviewed above examine the association between risk perceptions and changes in risk behavior, they do not assess the impact of the initial recognition of personal vulnerability on behavior because they have used samples of high-risk adults who undoubtedly had recognized some degree of susceptibility before their participation in the study (for an exception, see Boyd & Wandersman, 1991).

Nature of perceived vulnerability. As noted earlier, in this review we excluded studies that assessed worry or anxiety about AIDS rather than perceptions of personal vulnerability to HIV infection. One consequence of this decision is that our conclusions are limited to the relation between behavior and perceived vulnerability operationalized relatively narrowly as a cognitive representation of likelihood. Although few studies assessed likelihood *and* other potential dimensions of perceptions of vulnerability (e.g., vividness of the threat, affective response to the threat, and salience or chronicity of fears about HIV infection), such factors are potential motivators of behavior change. The vast majority of the research has, in fact, assumed that perceived vulnerability is unidimensional and that dimension can be captured by a likelihood estimate. This limitation in the re-

search raises two possibilities. It could be that subjective likelihood is a necessary, but not sufficient, motivator of precaution adoption and that other dimensions of the construct are necessary cues to action. Alternately, it could be that the more affective components of perceptions of vulnerability, rather than the cognition representation of likelihood, are the critical motivators of precaution adoption.

Interdependence of risk behaviors and preventive behaviors. Often studies (and, for that matter, theoretical models) in health behavior fail to consider the possibility that the goal of reducing risk can be achieved in two distinct ways: by decreasing or ceasing potentially harmful behaviors and by initiating or increasing the frequency or efficacy of preventive behaviors. For example, a woman may attempt to lower the probability that she will contract HIV by reducing the frequency with which she engages in intercourse with potentially high-risk partners. Alternatively, she could lower her risk by increasing her use of condoms. Of course, she could also practice both of these strategies simultaneously. The problem lies in the fact that these two behaviors are not independent. After the woman has decided to use condoms, she may no longer feel that it is necessary to refrain from casual sex. Likewise, after she decides to avoid high-risk partners, she may decide that condoms are not necessary. In other words, risk perceptions may motivate some behavior changes but not others. In fact, our analysis of specific behavior measures in the cross-sectional studies provides evidence that indexes that combine multiple measures of risk *and* precautionary behavior are the best predictors of perceived risk. This is not surprising given that people's objective levels of risk logically should reflect all of their risk-increasing and risk-decreasing behaviors. Thus, risk behavior indexes that combine multiple measures of behavior (e.g., van der Velde et al., 1992) offer more promise of capturing the complex relation between the various behaviors.

Use of experimental paradigms. Although the study of the relation between health cognitions such as perceived vulnerability and health-protective behaviors has relied almost exclusively on nonexperimental studies, a small number of experimental studies can be found in the literature. More important, these studies have provided ample evidence of the efficacy of using experimental methods to understand many of the theoretical issues raised in this article. For example, Jemmott and his colleagues have designed an experimental paradigm in which they manipulate diagnostic information by telling participants that they have an enzyme deficiency that makes them susceptible to a number of diseases (e.g., Croyle & Ditto, 1990; Croyle & Sande, 1988; Jemmott, Croyle, & Ditto, 1988; Jemmott, Ditto, & Croyle, 1986). Using this paradigm, they have demonstrated that receiving a diagnosis leads to reductions in perceived seriousness, and to increases in the estimated prevalence of the problem, and to distortion of the diagnostic information (see Croyle & Ditto, 1990, for a review). Experimental studies that have demonstrated the effects of comparison with others' relevant behaviors, or review of one's own behavior, have also provided significant theoretical insight into the nature and antecedents of perceived vulnerability (Gerrard et al., 1991; Weinstein & Lachendro, 1982).

Of more applied interest, however, are studies demonstrating that increasing individuals' perceptions of vulnerability can increase their precautionary behaviors. For example, Wurtele (1988) implemented an intervention that raised young women's perceptions of vulnerability to osteoporosis and found that this change was associated with subsequent increases in precautionary behavior (cf. S. J. Blalock, DeVellis, Affifi, & Sandler, 1990). The success of these experimental studies and quasi-experimental interventions in providing information that is difficult to extract from nonexperimental findings suggests that further use of these paradigms is an important area of investigation into the relation between perceived vulnerability and precautionary behavior. The urgency created by the continued and rapid proliferation of HIV, and the opportunity to examine important theoretical issues about health behavior, suggests that this remains a vital area for research.

References

References marked with an asterisk indicate studies included in the meta-analysis.

*Abdul-Quader, A. S., Tross, S., Friedman, S. R., Kouzi, A. C., & Des Jarlais, D. C. (1990). Street-recruited intravenous drug users and sexual risk reduction in New York City. *AIDS, 4,* 1075–1079.

Ajzen, I., & Fishbein, M. (1977). Attitude–behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin, 84,* 888–918.

Ajzen, I., & Timko, C. (1986). Correspondence between health attitudes and behavior. *Basic and Applied Social Psychology, 7,* 259–276.

*Aspinwall, L. G., Kemeny, M. E., Taylor, S. E., Schneider, S. G., & Dudley, J. P. (1991). Psychosocial predictors of gay men's AIDS risk-reduction behavior. *Health Psychology, 10,* 432–444.

Bacchetti, P., Segal, M. R., Hessol, N. A., & Jewell, N. P. (1993). Different AIDS incubation periods and their impacts on reconstructing human immunodeficiency virus epidemics and projecting AIDS incidence. *Proceedings of the National Academy of Science, 90,* 2194–2196.

*Baldwin, J. D., & Baldwin, J. I. (1988). Factors affecting AIDS-related sexual risk-taking behavior among college students. *Journal of Sex Research, 25,* 181–196.

Bauman, L., & Siegel, K. (1987). Misperception among gay men of the risk for AIDS associated with their sexual behavior. *Journal of Applied Social Psychology, 7,* 329–357.

Beck, K., & Frankel, A. (1981). A conceptualization of threat communication and protective health behavior. *Social Psychology Quarterly, 44,* 204–217.

Becker, M. H. (1974). The health belief model and personal health behavior. *Health Education Monographs, 2,* 324–508.

Becker, M. H., & Joseph, J. G. (1988). AIDS and behavioral change to reduce risk: A review. *American Journal of Public Health, 78,* 394–410.

Becker, M. H., & Rosenstock, I. M. (1987). Comparing social learning theory and the health belief model. In W. B. Ward (Ed.), *Advances in health education and promotion* (Vol. 2, pp. 245–249). Greenwich, CT: JAI Press.

Blalock, H. M. (1971). *Causal models in the social sciences.* Chicago: Aldine.

Blalock, S. J., DeVellis, B. M., Afifi, R. A., & Sandler, R. S. (1990). Risk perceptions and participation in colorectal cancer screening. *Health Psychology, 9,* 792–806.

Bollen, K. A. (1989). *Structural equations with latent variables.* New York: Wiley.

*Boyd, B., & Wandersman, A. (1991). Predicting undergraduate condom use with the Fishbein and Ajzen and the Triandis attitude be-

havior models: Implications for public health interventions. *Journal of Applied Social Psychology, 21,* 1810–1830.

Burger, J. M., & Burns, J. L. (1988). The illusion of unique invulnerability and the use of effective contraception. *Personality and Social Psychology Bulletin, 14,* 264–270.

Bushman, B. J. (1994). Vote-counting procedures in meta-analysis. In H. Cooper & L. V. Hedges (Eds.), *The handbook of research synthesis* (pp. 193–213). New York: Russell Sage Foundation.

Bushman, B. J., & Wang, M. C. (1995). A procedure for combining sample correlation coefficients and vote counts to obtain an estimate and a confidence interval for the population correlation coefficient. *Psychological Bulletin, 117,* 530–546.

*Catania, J. A., Coates, T. J., Kegeles, S., Fullilove, M. T., Peterson, J., Marin, B., Siegel, D., & Hulley, S. (1992). Condom use in multi-ethnic neighborhoods of San Francisco: The population-based AMEN (AIDS in multi-ethnic neighborhoods) study. *American Journal of Public Health, 82,* 284–287.

*Catania, J. A., Dolcini, M. M., Coates, T. J., Kegeles, S. M., Greenblatt, R. M., Puckett, S., Corman, M., & Miller, J. (1989). Predictors of condom use and multiple partnered sex among sexually-active adolescent women: Implications for AIDS-related health interventions. *Journal of Sex Research, 26,* 514–524.

Catania, J. A., Gibson, D. R., Chitwood, D. D., & Coates, T. J. (1990). Methodological problems in AIDS behavioral research: Influences on measurement error and participation bias in studies of sexual behavior. *Psychological Bulletin, 108,* 339–362.

Catania, J. A., Kegeles, S. M., & Coates, T. J. (1990). Towards an understanding of risk behavior: An AIDS risk reduction model. *Health Education Quarterly, 17,* 53–72.

Coates, T. J., Soskolne, C. L., Calzavara, L. M., Read, S. E., Fanning, M. M., Shephard, F. A., Klein, M. M., & Johnson, J. K. (1986). The reliability of sexual histories in AIDS-related research: Evaluation of an interview-administered questionnaire. *Canadian Journal of Public Health, 778,* 343–348.

Coates, T., Stall, R., Catania, J., Dolcini, P., & Hoff, C. (1989). Prevention of HIV infection in high risk groups. In P. Volderding & M. Jacobson (Eds.), *1989 AIDS clinical review* (pp. 29–52). New York: Marcel-Dekker.

Cohen, J. (1965). Some statistical issues in psychological research. In B. B. Wolman (Ed.), *Handbook of clinical psychology* (pp. 95–121). New York: McGraw-Hill.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Cooper, H. M. (1989). *Integrating research: A guide for literature reviews* (2nd ed.). Newbury Park, CA: Sage.

Croyle, R. T., & Ditto, P. H. (1990). Illness cognition and behavior: An experimental approach. *Journal of Behavioral Medicine, 13,* 31–52.

Croyle, R. T., & Sande, G. N. (1988). Denial and confirmatory search: Paradoxical consequences of medical diagnosis. *Journal of Applied Social Psychology, 18,* 473–490.

*DiClemente, R. J., Forrest, K. A., & Mickler, S. (1990). College students' knowledge and attitudes about AIDS and changes in HIV-preventive behaviors. *AIDS Education and Prevention, 2*(3), 201–212.

Edwards, W. (1954). The theory of decision making. *Psychological Bulletin, 51,* 380–417.

*Emmons, C., Joseph, J. G., Kessler, R. C., Wortman, C. B., Montgomery, S. B., & Ostrow, D. G. (1986). Psychosocial predictors of reported behavior change in homosexual men at risk for AIDS. *Health Education Quarterly, 13,* 331–345.

Fineberg, H. V. (1988, February 5). Education to prevent AIDS: Prospects and obstacles. *Science, 239,* 592–596.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Fisher, J. D., & Fisher, W. A. (1992). Changing AIDS-risk behavior. *Psychological Bulletin, 111,* 455–474.

*Fisher, J. D., & Misovich, S. (1990). Social influence and AIDS-preventive behavior. In J. Edwards, R. S. Tinsdale, L. Heath, & E. J. Posavac (Eds.), *Social influences processes and prevention* (pp. 39–70). New York: Plenum Press.

Fisher, R. A. (1921). On the "probable error" of a coefficient of correlation deduced from a small sample. *Metron, 1,* 1–32.

Fisher, W. A. (1984). Predicting contraceptive behavior among university men: The role of emotions and behavior intentions. *Journal of Applied Social Psychology, 14,* 104–123.

Fisher, W. A., Byrne, D., & White, L. A. (1983). Emotional barriers to contraception. In D. Byrne & W. A. Fisher (Eds.), *Adolescents, sex, and contraception* (pp. 207–239). Hillsdale, NJ: Erlbaum.

Fisher, W. A., Fisher, J. D., & Byrne, D. (1977). Consumer reactions to contraceptive purchasing. *Personality and Social Psychology Bulletin, 3,* 293–296.

Fleiss, J. L. (1971). Measuring nominal scale agreement among many raters. *Psychological Bulletin, 76,* 378–382.

Friedman, H. (1968). Magnitude of experimental effect and a table for its rapid estimation. *Psychological Bulletin, 70,* 245–251.

Gayle, H. D., Keeling, R. P., Garcia-Tunon, M., Kilbourne, B. W., Narkunas, J. P., Ingram, F. R., Rogers, M. F., & Curran, J. W. (1990). Prevalence of the human immunodeficiency virus among university students. *New England Journal of Medicine, 323,* 1538–1541.

Gerrard, M. (1977). Sex guilt in abortion patients. *Journal of Consulting and Clinical Psychology, 45,* 708.

Gerrard, M. (1982). Sex, sex guilt, and contraceptive use. *Journal of Personality and Social Psychology, 42,* 153–158.

Gerrard, M. (1987). Sex, sex guilt, and contraceptive use revisited: Trends in the 1980s. *Journal of Personality and Social Psychology, 52,* 975–980.

Gerrard, M., Breda, C., & Gibbons, F. X. (1989). Gender effects in couples' sexual decision making and contraceptive use. *Journal of Applied Social Psychology, 20,* 449–464.

Gerrard, M., Gibbons, F. X., Benthin, A. C., & Hessling, R. M. (in press). The reciprocal nature of risk behaviors and cognitions: What you do shapes what you think and vice versa. *Health Psychology.*

Gerrard, M., Gibbons, F. X., & Warner, T. D. (1991). Effects of reviewing risk-relevant behavior on perceived vulnerability of women Marines. *Health Psychology, 10,* 173–179.

Gerrard, M., Gibbons, F. X., Warner, T. D., & Smith, G. E. (1993). Perceived vulnerability to AIDS and AIDS preventive behavior: A critical review of the evidence. In J. Pryor & G. Reeder (Eds.), *The social psychology of HIV infection* (pp. 59–84). Hillsdale, NJ: Erlbaum.

Gerrard, M., & Luus, C. E. (1995). Judgments of vulnerability to pregnancy: The role of risk factors and individual differences. *Personality and Social Psychology Bulletin, 21,* 160–171.

Gerrard, M., & Warner, T. D. (1990). Antecedents of pregnancy among women Marines. *Journal of the Washington Academy of Sciences, 80,* 1–15.

*Gerrard, M., & Warner, T. D. (1994). A comparison of women Marines' and college women's HIV relevant sexual behaviors. *Journal of Applied Social Psychology, 24,* 959–980.

Gibbons, F. X., Eggleston, T. J., & Benthin, A. C. (in press). The role of self-esteem in risk perceptions change after smoking relapse. *Journal of Personality and Social Psychology.*

*Goldman, J. A., & Harlow, L. L. (1993). Self-perception variable that mediate AIDS-preventive behavior in college students. *Health Psychology, 12,* 489–498.

Golubjatnikov, R., Pfister, J., & Tillotson, T. (1983). Homosexual promiscuity and the fear of AIDS. *Lancet, 2,* 681.

*Gray, L. A., & Saracino, M. (1989). AIDS on campus: A preliminary

study of college students' knowledge and behaviors. *Journal of Counseling and Development, 68,* 199–202.

*Hansen, W. B., Hahn, G. L., & Wolkenstein, B. H. (1990). Perceived personal immunity: Beliefs about susceptibility to AIDS. *Journal of Sex Research, 27,* 622–628.

Harrison, J. A., Mullen, P. D., & Green, L. W. (1992). A meta-analysis of studies of the health belief model with adults. *Health Education Research, 7,* 107–116.

Hatcher, R. A., Stewart, F., Trussel, J., Kowal, D., Guest, F., Stewart, G. K., & Cates, W. (1990). *Contraceptive technology 1990–1992.* New York: Irvington.

*Hays, R. B., Kegeles, S. M., & Coates, T. J. (1990). High HIV risk-taking among young gay men. *AIDS, 4,* 901–907.

Hearst, N., & Hulley, S. B. (1988). Preventing the heterosexual spread of AIDS. *Journal of the American Medical Association, 259,* 2428–2432.

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis.* New York: Academic Press.

Hingson, R. W., Strunin, L., Berlin, B. M., & Heeren, T. (1990). Beliefs about AIDS, use of alcohol and drugs, and unprotected sex among Massachusetts adolescents. *American Journal of Public Health, 80,* 295–299.

Hochbaum, G. (1958). *Public participation in medical screening program: A sociopsychological study* (U.S. Public Health Service Publication No. 572). Washington, DC: U.S. Government Printing Office.

Isen, A. M., & Geva, N. (1987). The influence of positive affect on acceptable level of risk: The person with a large canoe has a large worry. *Organizational Behavior and Human Performance, 39,* 145–154.

Isen, A. M., & Patrick, R. (1983). The effect of positive feelings on risk taking: When the chips are down. *Organizational Behavior and Human Performance, 31,* 194–202.

Janz, N. K., & Becker, M. H. (1984). The health belief model: A decade later. *Health Education Quarterly, 11,* 1–47.

Jemmott, J. B., Croyle, R. T., & Ditto, P. H. (1988). Commonsense epidemiology: Self-based judgments from laypersons and physicians. *Health Psychology, 7,* 55–73.

Jemmott, J. B., Ditto, P. H., & Croyle, R. T. (1986). Judging health status: Effects of perceived prevalence and personal relevance. *Journal of Personality and Social Psychology, 50,* 899–905.

Johnson, W., & Tversky, A. (1983). Affect, generalization, and the perception of risk. *Journal of Personality and Social Psychology, 45,* 20–31.

Joseph, J. G., Montgomery, S. B., Emmons, C., Kessler, R. C., Ostrow, D. G., Wortman, C. B., O'Brien, K., Eller, M., & Eshlerman, S. (1987). Magnitude and determinants of behavioral risk reduction: Longitudinal analysis of a cohort at risk for AIDS. *Psychology and Health, 1,* 73–96.

*Joseph, J. G., Montgomery, S. B., Emmons, C., Kirscht, J. P., Kessler, R. C., Ostrow, D. G., Wortman, C. B., & O'Brien, K. (1987). Perceived risk of AIDS: Assessing the behavioral and psychological consequences in a cohort of gay men. *Journal of Applied Social Psychology, 17,* 231–250.

*Kalichman, S. C., Hunter, T. L., & Kelly, J. A. (1992). Perceptions of AIDS susceptibility among minority and nonminority women at risk for HIV infection. *Journal of Consulting and Clinical Psychology, 60,* 725–732.

*Kelly, J. A., St. Lawrence, J. S., Brasfield, T. L., Lemke, A., Amidei, T., Roffman, R. E., Hood, H. V., Smith, J. E., Kilgore, H., & McNeill, C. (1990). Psychological factors that predict AIDS high-risk versus AIDS precautionary behavior. *Journal of Consulting and Clinical Psychology, 58,* 117–120.

*Kline, A., & Strickler, J. (1993). Perceptions of risk for AIDS among women in drug treatment. *Health Psychology, 12,* 313–323.

Lawrence, D., Jason, J., Holman, R., & Murphy, J. (1991). HIV transmission from hemophilic men to their heterosexual wives. In N. Alexander, H. Gabelnick, G. Hodgen, & J. Spieler (Eds.), *The heterosexual transmission of AIDS: Proceedings of the CONRAD 2nd international workshop* (pp. 35–57). New York: Alan R. Liss.

Leventhal, H., Diefenbach, G. M., & Leventhal, E. A. (1992). Illness cognition: Using common sense to understand treatment adherence and affect cognition interactions. *Cognitive Therapy and Research, 16,* 143–163.

Leventhal, H., Hochbaum, G. M., & Rosenstock, I. (1960). *The impact of Asian influenza on community life: A study in five cities.* (U.S. Public Health Service Publication No. 766). Washington, DC: U.S. Government Printing Office.

Linville, P. W., Fischer, G. W., & Fischhoff, B. (1993). AIDS risk perceptions and decision biases. In J. B. Pryor & G. D. Reeder (Eds.), *The social psychology of HIV infection* (pp. 5–37). Hillsdale, NJ: Erlbaum.

Lui, K. J., Darrow, W. W., & Rutherford, G. W. (1988, June 3). A model based estimate of the mean incubation period for AIDS in homosexual men. *Science, 240,* 1333–1335.

Maddux, J., & Rogers, R. (1983). Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change. *Journal of Experimental Social Psychology, 19,* 469–479.

Martin, J. L. (1986). AIDS risk reduction recommendations and sexual behavior patterns among gay men: A multifactorial categorical approach to assessing change. *Health Education Quarterly, 13,* 347–358.

*Maticka-Tyndale, E. (1991). Sexual scripts and AIDS prevention: Variations in adherence to safer-sex guidelines by heterosexual adolescents. *Journal of Sex Research, 28,* 45–66.

*McCusker, J., Zapka, J. G., Stoddard, A. M., & Mayer, K. H. (1989). Responses to the AIDS epidemic among homosexually active men: Factors associated with preventive behavior. *Patient Education and Counseling, 13*(1), 15–30.

McKusick, L., Wiley, J. A., Coates, T. J., Stall, R., Saika, G., Morin, S., Charles, K., Horstman, W., & Conant, M. A. (1985). Reported changes in the sexual behavior of men at risk for AIDS: San Francisco, 1982–1984—The AIDS behavioral research project. *Public Health Report, 100,* 622–629.

McLaws, M., Oldenburg, B., Ross, M. W., & Cooper, D. A. (1990). Sexual behavior in AIDS-related research: Reliability and validity of recall and diary measures. *Journal of Sex Research, 27,* 265–281.

Medline [Database]. (1986–1994, October). Bethesda, MD: National Library of Medicine [Producer]. Available from: SilverPlatter.

Miller, L. C., Bettencourt, B. A., DeBro, S. C., & Hoffman, V. (1993). Negotiating safer sex: Interpersonal dynamics. In J. B. Pryor & G. D. Reeder (Eds.), *The social psychology of HIV infection* (pp. 85–123). Hillsdale, NJ: Erlbaum.

Montgomery, S. B., Joseph, J. G., Becker, M. H., Ostrow, D. G., Kessler, R. C., & Kirscht, J. P. (1989). The health belief model in understanding compliance with preventive recommendations for AIDS: How useful? *AIDS Education and Prevention, 1,* 303–323.

*Moore, S., & Rosenthal, D. (1991). Adolescent invulnerability and perceptions of AIDS risk. *Journal of Adolescent Research, 6*(2), 164–180.

Mosher, D. L. (1966). The development and multitrait–multimethod matrix analysis of three measures of three aspects of guilt. *Journal of Consulting Psychology, 30,* 25–29.

Mosher, D. L. (1968). Measurement of guilt in females by self-report inventories. *Journal of Consulting and Clinical Psychology, 32,* 690–695.

Mosher, D. L. (1973). Sex differences, sex experience, sex guilt and explicitly sexual films. *Journal of Social Issues, 29,* 95–112.

Munoz, A., Wang, M. C., Bass, S., Taylor, J. M. G., Kingsley, L. A., Chimiel, J. S., Polk, B. F., & Multicenter AIDS Cohort Study Group. (1989). AIDS-free time after HIV Type I seroconversion in homosexual men. *American Journal of Epidemiology, 130,* 530–539.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84,* 231–259.

Perloff, L. S., & Fetzer, B. K. (1986). Self–other judgments and perceived vulnerability to victimization. *Journal of Personality and Social Psychology, 50,* 502–510.

Pleck, J. H., Sonenstein, F. L., & Ku, L. C. (1990). Contraceptive attitudes and intention to use condoms in sexually experienced and inexperienced adolescent males. *Journal of Family Issues, 11,* 294–312.

PsycLIT [Database]. (1986–1994, October). Washington, DC: American Psychological Association [Producer]. Available from: SilverPlatter.

Quadrel, M. J., Fischhoff, B., & Davis, W. (1993). Adolescent (in)vulnerability. *American Psychologist, 48,* 102–116.

*Rickert, V. I., Jay, S., Gottlieb, A., & Bridges, C. (1989). Adolescents and AIDS: Females' attitudes and behaviors toward condom purchase and use. *Journal of Adolescent Health Care, 10,* 313–316.

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change. *Journal of Psychology, 91,* 93–114.

Rogers, R. W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In J. Cacioppo & R. Petty (Eds.), *Social psychophysiology* (pp. 153–176). New York: Guilford Press.

Rogers, R. W., & Mewborn, C. (1976). Fear appeals and attitude change: Effects of a threat's noxiousness/probability of occurrence and the efficacy of coping responses. *Journal of Personality and Social Psychology, 34,* 54–61.

Ronis, D. L. (1992). Conditional health threats: Health beliefs, decision, and behaviors among adults. *Health Psychology, 11,* 127–134.

Rosenstock, I. M. (1966). Why people use health services. *Milbank Memorial Fund Quarterly, 44,* 94.

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs, 2,* 1–8.

*Rosenthal, D. A., Hall, C., & Moore, S. M. (1992). AIDS, adolescents, and sexual risk taking: A test of the health belief model. *Australian Psychologist, 27,* 166–171.

Rotheram-Borus, M. J., & Koopman, C. (1990). AIDS and adolescents. In R. Lerner, A. Peterson, & J. Brooks-Gunn (Eds.), *Encyclopedia of adolescence* (pp. 29–36). New York: Garland Press.

*St. Lawrence, J. S. (1993). African American adolescents knowledge, health-related attitudes, sexual behavior, and contraceptive decisions: Implications for the prevention of adolescent HIV infection. *Journal of Consulting and Clinical Psychology, 61,* 104–112.

*Simon, P. M., Morse, E. V., Balson, P. M., Osofsky, H. J., & Gaumer, H. R. (1993). Barriers to human immunodeficiency virus related risk reduction among male street prostitutes. *Health Education Quarterly, 20*(2), 261–273.

Smith, G. E., Gerrard, M., & Gibbons, F. X. (1996). *Effects of behavioral review and changes in risk behavior on optimistic bias: The role of self-esteem.* Manuscript submitted for publication.

Sutton, S. R. (1982). Fear arousing communications: A critical examination of theory and research. In J. R. Eiser (Ed.), *Social psychology and behavioral medicine* (pp. 303–338). New York: Wiley.

*Thurman, Q. C., & Franklin, K. M. (1990). AIDS and college health: Knowledge, threat, and prevention at a northeastern university. *Journal of American College Health, 38,* 179–184.

*Valdiserri, R. O., Lyter, D., Leviton, L. C., Callahan, C. M., Kingsley, L. A., & Rinaldo, C. R. (1988). Variables influencing condom use in a cohort of gay and bisexual men. *American Journal of Public Health, 78,* 801–805.

*van der Velde, F. W., Hooykaas, C., & van der Pligt, J., (1992). Risk perception and behavior: Pessimism, realism, and optimism about AIDS-related health behavior. *Psychology and Health, 6,* 23–38.

*van der Velde, F. W., van der Pligt, J., & Hooykaas, C. (1994). Perceiving AIDS-related risk: Accuracy as a function of differences in actual risk. *Health Psychology, 13,* 25–33.

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology, 39,* 806–820.

Weinstein, N. D. (1982). Unrealistic optimism about susceptibility to health problems. *Journal of Behavioral Medicine, 5,* 441–460.

Weinstein, N. D. (1984). Why it won't happen to me: Perceptions of risk factors and susceptibility. *Health Psychology, 3,* 431–457.

Weinstein, N. D. (1988). The precaution adoption process. *Health Psychology, 7,* 355–386.

Weinstein, N. D. (1993). Testing four competing theories of health-protective behavior. *Health Psychology, 12,* 324–333.

Weinstein, N. D., & Lachendro, E. (1982). Egocentrism as a source of unrealistic optimism. *Personality and Social Psychology Bulletin, 8,* 195–200.

Weinstein, N. D., & Nicolich, M. M. (1993). Correct and incorrect interpretations of correlations between risk perceptions and risk behaviors. *Health Psychology, 12,* 235–245.

Weinstein, N. D., Sandman, P. M., & Roberts, N. E. (1990). Determinants of self-protective behavior: Home radon testing. *Journal of Applied Social Psychology, 22,* 783–801.

Weinstein, N. D., Sandman, P. M., & Roberts, N. E. (1991). Perceived susceptibility and self-protective behavior: A field experiment to encourage home radon testing. *Health Psychology, 10,* 25–33.

*Weisman, C. S., Nathanson, C. A., Ensminger, M., Teitelbaum, M. A., Robinson, J. C., & Plichta, S. (1989). AIDS knowledge, perceived risk and prevention among adolescent clients of a family planning clinic. *Family Planning Perspectives, 21,* 213–217.

White, L. A., Fisher, W. A., Byrne, D., & Kingma, R. (1977, May). *Development and validation of a measure of affective orientation to erotic stimuli: The Sexual Orientation Survey.* Paper presented at the meeting of the Midwestern Psychological Association, Chicago.

Whitely, B., & Hern, A. (1991). Perceptions of vulnerability to pregnancy and the use of effective contraception. *Personality and Social Psychology Bulletin, 17,* 104–110.

Winkelstein, W., Samuel, M., Padian, N., Wiley, J., Lang, W., Anderson, R., & Levy, J. (1987). The San Francisco men's health study: III. Reduction in HIV transmission among homosexual/bisexual men, 1982–1986. *American Journal of Public Health, 76,* 685–689.

*Wulfert, E., & Wan, C. K. (1993). Condom use: A self-efficacy model. *Health Psychology, 12,* 346–353.

Wurtele, S. K. (1988). Increasing women's calcium intake: The role of health beliefs, intentions, and health value. *Journal of Applied Social Psychology, 18,* 627–639.

Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35,* 1541–1575.

*Zapka, J. G., McCusker, J., Stoddard, A. M., Morrison, C. S., & Mayer, K. H. (1990). Psychosocial factors and AIDS-related behavior of homosexual men. *Evaluation and the Health Professions, 13,* 283–297.

Appendix

Characteristics Extracted From Each Research Report

Source Characteristics

1. Year of publication.
2. Publication outlet (i.e., journal article, book chapter, or unpublished paper).

Participant Characteristics

1. Participant characteristics (i.e., age, gender, health care professional, drug use, sexual orientation, clinic patient, college student, or prostitute).
2. Recruitment sites (i.e. bar, bus stop, college, clinic, or drug treatment program).

Study Characteristics

1. Number of levels of perceived vulnerability measure (i.e., 2, 3, 4, 5, 6, 7, 9, 15, up to 100,000).
2. Behavior measure (i.e., condom use, no. of partners, risk-behavior index, or behavior change).
3. Number of levels of behavior measure (i.e., 2, 3, 6, 7, 14, up to 100).

Primary Study Results

1. Direction of effect (i.e., positive, negative, or null).
2. Significance of effect (i.e., nonsignificant or significant at .05 significance level).
3. Magnitude of effect (i.e., Pearson product–moment correlation coefficient r). When correlations were not reported, but t tests or F tests with 1 degree of freedom in the numerator were reported, we used the formulas

$$r = \sqrt{\frac{t^2}{t^2 + df_{\text{ERROR}}}},$$

$$r = \sqrt{\frac{F}{F + df_{\text{ERROR}}}},$$

respectively (Cohen, 1965; Friedman, 1968). When both variables were dichotomous, we used the formula

$$r = \phi = \sqrt{\frac{\chi^2(1)}{N}}$$

(Cohen, 1965; Friedman, 1968).

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