REVIEW

Testing Four Competing Theories of Health-Protective Behavior

Neil D. Weinstein

Four competing theories of health-protective behavior are reviewed: the health belief model, the theory of reasoned action, protection motivation theory, and subjective expected utility theory. In spite of their commonalities, these models are seldom tested against one another. The review points out the similarities and differences among these theories and the data and analyses needed to compare them. In addition to describing the content of the models, their conceptualization of key variables, and the combinatorial rules used to make predictions, some general problems in theory development and testing for health behaviors are examined. The article's goal is to help investigators design studies that will clarify the strengths and weaknesses of these models, leading toward a better understanding of health behavior.

Key words: health behavior, health belief model, theory of reasoned action, protection motivation theory, subjective expected utility theory

Many theories have been proposed to explain the adoption of health-protective behavior. Because these theories contain at least a grain of truth, empirical tests typically yield some degree of confirmation, enough to keep the theory under scrutiny from being rejected. Rarely, though, is one theory pitted against another. Thus, despite a large empirical literature, there is still no consensus that certain models of health behavior are more accurate than others, that certain variables are more influential than others, or that certain behaviors or situations are understood better than others. In general, researchers have failed to carry out the winnowing process that is necessary for scientific progress.

This article reviews four theories of health protective behavior—the health belief model (Becker, 1974; Janz & Becker, 1984; Kirscht, 1988), subjective expected utility theory (Edwards, 1954; Ronis, 1992; Sutton, 1982), protection motivation theory (Maddux & Rogers, 1983; Prentice-Dunn & Rogers, 1986; Rogers, 1983), and the theory of reasoned action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975)—with special emphasis on the differences among these theories and the kinds of data and analyses needed to compare them.[1] These theories were chosen for two reasons. First, the theories emphasize beliefs about health hazards and health-protective behaviors and have many features in common, although the similarities are seldom recognized. Second, as a group, the theories under discussion are probably used more frequently than any other type of model in research on health behavior.

Because of the similarities among the four theories, little effort would be needed in an investigation to compare their relative success. Nevertheless, such comparisons are rare; researchers typically select one theory to test or to guide their choice of explanatory variables as if the other theories did not exist. A recent search of the PsychLit database (SilverPlatter, Inc., 1992) revealed 205 articles between 1974 and 1991 which mentioned one of these four theories in the title, abstract, or index terms. Nevertheless, there were only 10 articles that listed more than one theory, and only 4 of these articles were empirical comparisons.

Many reviews of these and other theories of health-protective behavior exist (e.g., Becker, 1991; Cummings, Becker, & Maile, 1980; Glanz, Lewis, & Rimer, 1990; Hays, 1985; Mullen, Hersey, & Iverson, 1987; Nelson & Moffit, 1988; Wallston & Wallston, 1984), but they overlook many of the similarities (an exception is Sutton, 1987) and do not offer the detailed, point-by-point comparison that will be provided here. This article will also discuss several areas of theory development and testing that need further attention. The intent is not to review the available empirical research or to conclude that one theory is better than another. Rather, the goal is to help investigators design studies that will clarify the strengths and weaknesses of these models. Such studies should eventually lead to models of greater accuracy, either by suggesting refinements in the present models or, if the results of rigorous testing so indicate, by leading researchers to reject this type of model and develop different theoretical approaches.

Mental Content and Motivation to Take Action

Each of the four theories assumes that anticipation of a negative health outcome and the desire to avoid this outcome or reduce its impact creates motivation for self-protection. The

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[1] Subjective expected utility theory and the theory of reasoned action were not developed to explain health-protective behavior, although they have been used frequently for that purpose. The versions discussed here are those used in health research and are not, especially for subjective expected utility theory (see Luce & Raiffa, 1957), necessarily identical to the initial formulations.

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expected aversiveness of the outcome is discussed in terms of the *perceived severity* of health consequences in the health belief model and in protection motivation theory, negative *utility* in subjective expected utility theory, and negative *evaluation* in the theory of reasoned action. These various terms have the same underlying meaning, and the questions used to assess these terms are essentially indistinguishable from one theory to another.

The models agree that the impact of a negative outcome on the motivation to act also depends on beliefs about the likelihood that this outcome will occur. Likelihood is usually referred to as *perceived vulnerability* or *perceived susceptibility* in the health belief model and in protection motivation theory, *subjective probability* in subjective expected utility theory, and *expectancy* in the theory of reasoned action. Again, these differing terms have the same underlying meaning and are assessed with questions that are essentially interchangeable. (Sometimes susceptibility is misinterpreted as general susceptibility to illness rather than as referring to the likelihood of specific consequences. This interpretation would only be appropriate if the precaution in question, such as exercise or good diet, were intended to improve overall health.) I will use SEV (severity) to refer to the individual's evaluation of the health outcome that might occur assuming no change in behavior and PROB (probability) to refer to the perceived likelihood that this outcome will occur.[2]

According to these theories, the motivation to act arises from the expectation that action can reduce the likelihood or severity of harm. In subjective expected utility theory and in the theory of reasoned action, the expected benefit can be determined from the difference between (a) beliefs about the magnitude and likelihood of harm assuming no change in behavior and (b) beliefs about these same issues assuming the adoption of a protective measure. In practice, though, research that is based on the theory of reasoned action frequently omits questions about present behavior (Sutton, 1987). Sometimes this omission can be justified because outcomes are phrased in terms of changes that would occur from adopting the recommended action (e.g., Brubaker & Wickersham, 1990). For example, an outcome may be described as an earlier detection of cancer, and this outcome can be rated for likelihood (i.e., will detection actually be earlier) and desirability (i.e., how beneficial is early detection). However, researchers often forget to consider current behavior and ask questions that have no logical implications for action. For example, subjects can rate the likelihood that if they perform a testicular self-examination, it will be possible to "treat cancer when curable" (Steffen, 1990, p. 690), but this rating does not tell us whether subjects think cancer is more likely to be curable if they perform a self-examination than if they do not. Thus, a careful application of the theory of reasoned action requires rating expectations from current behavior and from the alternative behavior under consideration (or, alternately, phrasing all outcomes in terms of changes). The health belief model and protection motivation theory, in contrast, are typically presented in terms of the likelihood and severity of health consequences if current behavior does not change and a separate variable is used to indicate the perceived effectiveness or efficacy (EFFECT) of the precaution.

Nonrisk Variables

All four theories assume that the expected benefits in risk reduction must be weighed against the expected costs of acting (COST) to predict changes in behavior. The costs considered by these theories include time, effort, money, inconvenience, and the loss of satisfactions obtained from current behavior. In the health belief model these various costs or barriers are represented by a single variable, though multiple questions may be asked to evaluate the costs. Protection motivation theory explicitly separates the perceived cost of performing a new protective behavior from the perceived self-efficacy (SE) for performing this response and the loss of current internal rewards (IR) and external rewards (ER) that will result from this behavioral change.

The theory of reasoned action differs from the health belief model and protection motivation theory by considering a much wider range of consequences of continuing the current behavior (not just the possibility of health problems) and by considering a wider range of consequences of the alternative behavior under consideration (not just the explicit cost and the reduced health risk). The list of consequences that need to be considered is not stated a priori but is developed during pilot research in which subjects are asked about the consequences that they foresee. The impact of each possible consequence on the motivation to act is determined by its expected value (VALUE) and by the expectation (i.e., PROB) that the consequence will occur. Thus, in the theory of reasoned action some consequences can be seen as costs, some as health outcomes, and others as nonhealth outcomes (such as the amount of worry about an illness). Investigators often seem to think that perceptions of the likelihood and severity of health outcomes are not part of the theory of reasoned action (e.g., Henning & Knowles, 1990; Hoogstraten, de Haan, & ter Horst, 1985; Ried & Christensen, 1988; Steffen, 1990). This is incorrect.

The theory of reasoned action also differs from the preceding models by explicitly incorporating social influence. It does this in terms of how much other relevant people want the individual to perform a given behavior (i.e., normative beliefs; NB), and how much the individual is motivated to comply (MC) with each of their preferences.

Research based on subjective expected utility theory may use COST as a single variable to be estimated by subjects or list various costs as possible outcomes and ask subjects to rate the likelihood and undesirability of each cost. A wide range of positive outcomes can also be accommodated by subjective expected utility theory, but often applications focus on the perceived reduction of risk likelihood, severity, or both (Ronis, 1992; Sutton, 1982).

Combinatorial Rules

Aside from variations in the range of nonrisk issues that are considered, the greatest differences among these four models

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[2] To show the many similarities among these theories, a consistent set of symbols will be used, even if these symbols are not the ones used by the theories' creators. The translation between the current symbols and those used elsewhere for the same variables should be straightforward.

Table 1
Four Cognitive Theories of Health-Protective Behavior

Theory	Principle variables	Prediction of health-protective behavior[a]
Health belief model (HBM)	$PROB_c$, SEV_c, EFFECT, COST	$w_1PROB_c + w_2SEV_c + w_3EFFECT - w_4COST$[b]
Protection motivation theory (PMT)	$PROB_c$, SEV_c, EFFECT, COST[c], IR, ER, SE	$w_1PROB_c + w_2SEV_c + w_3EFFECT - w_4COST_{PMT}$ (where $COST_{PMT} = COST + w_5IR + w_6ER - w_7SE$)
Subjective expected utility theory (SEU)	$PROB_c$, SEV_c, $PROB_a$, SEV_a, COST, $PROB_{c'}$, $VALUE_{c'}$, $PROB_{a'}$, $VALUE_{a'}$	$PROB_cSEV_c - PROB_aSEV_a - COST_{SEU}$ or $PROB_cSEV_cEFFECT - COST_{SEU}$[d] (where $COST_{SEU} = \Sigma_{a'}\ PROB_{a'}VALUE_{a'} - \Sigma_{c'}\ PROB_{c'}\ VALUE_{c'}$)
Theory of reasoned action (TRA)	$PROB_c$, SEV_c, $PROB_a$, SEV_a, $PROB_{c'}$, $VALUE_{c'}$, $PROB_{a'}$, $VALUE_{a'}$, $NB_{c,k}$, $NB_{a,k}$, MC_k	$PROB_cSEV_c - PROB_aSEV_a - COST_{TRA}$ (where $COST_{TRA} = \Sigma_{a'}\ PROB_{a'}VALUE_{a'} - \Sigma_{c'}\ PROB_{c'}VALUE_{c'} - \alpha\ \Sigma_k\ [(NB_{a,k} - NB_{c,k})\ MC_k]$)

Note. PROB = Perceived probability that a particular outcome will occur; SEV = Perceived severity of a health outcome; EFFECT = Perceived effectiveness of the precaution; IR = Perceived internal rewards from current behavior; ER = Perceived external rewards from current behavior; SE = Self-efficacy; NB = Normative beliefs (strength of the desire of another person that the individual perform a particular behavior); MC = Motivation to comply with the other person's desire; COST = Perceived costs and barriers to action; VALUE = Perceived value of a nonhealth outcome; a = Health consequences under alternate behavior (the precaution); a′ = Consequences of alternate behavior other than health effects; c = Health consequences under current behavior; c′ = Consequences of current behavior other than health effects; k = Various individuals whose desires might influence behavior; $w_1, w_2, \ldots, \alpha$ = Parameters (>0) to be determined empirically.
[a]The relative likelihood of action is assumed to be proportional to the value of the expression in the table.
[b]The HBM is not explicit about the functional relationship between the independent variables and behavior. It is presented here in the simplest possible form, the form examined in most research.
[c]In PMT, COST refers to all anticipated barriers to action other than IR, ER, and SE.
[d]See Footnote 7.

concern the rules they use to combine the independent variables when predicting action.

It is important, though, to recognize that none of these models actually predicts the amount of precautionary behavior that will occur. Instead, what is predicted is the relative likelihood of action by different individuals or by individuals in different treatment groups.[3] It is a telling sign of the incompleteness of existing theories that they do not even attempt to predict the amount of action that will occur. Finding that the correlation between predicted behavior and observed behavior is .6 may seem reassuring, but it does not allow us to predict whether 20%, 50%, or 80% of the population will act.

The prediction rule associated with each theory is presented in Table 1. A subscript *c* on variables in Table 1 indicates beliefs about what might happen assuming no change in *c*urrent behavior, and subscript *a* refers to beliefs about what might happen if an *a*lternative behavior (i.e., the precaution) were adopted. The expressions in Table 1 have been deliberately arranged to reveal the strong similarities among the models. The rule presented for the theory of reasoned action assumes that both the current behavior and the alternative behavior are examined in reaching a prediction. The rule listed for subjective expected utility theory assumes a detailed calculation of costs in terms of the perceived likelihood and utility of nonhealth consequences.

One major difference in these four combinatorial rules is that protection motivation theory assumes severity and probability are additive in influencing behavior, whereas subjective expected utility theory and the theory of reasoned action assume a multiplicative relationship.[4] The multiplicative relationship reflects the assumption (compatible with both expectancy–value theory and probability theory) that threats will be ignored if either their severity or their likelihood is zero. This assumption certainly seems reasonable, but many studies, both experimental and nonexperimental (Beck & Lund, 1981; Rogers & Mewborn, 1976; Ronis & Harel, 1989; Steffen, 1990; Sutton & Eiser, 1990), have not found such an interaction.[5]

A common misinterpretation of the theory of reasoned action is to add together the likelihood ratings of the various consequences, add the desirability ratings, and then multiply these sums together (e.g., Henning & Knowles, 1990; Ried & Christensen, 1988). According to the theory, the likelihood and desirability of each outcome should be multiplied together, and then these products should be added (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975).

The health belief model as originally proposed (Hochbaum, 1958; Leventhal, Hochbaum, & Rosenstock, 1960) involved the product of severity, likelihood, and effectiveness, but more

[3] Subjective expected utility theory has been used to predict the actual frequency of several other types of behaviors, including retirement and child-bearing (Davidson & Beach, 1981; Prothero & Beach, 1984).

[4] The similarity of the theory of reasoned action to other models has been emphasized in Table 1 by separating out the perceived likelihood and severity of expected health consequences from the perceived likelihood and desirability of the other possible consequences of each behavior. When the issue is the adoption of a recommended health-protective behavior, health consequences are likely to be among the various consequences salient to people, but proponents of the theory of reasoned action would not separate these health consequences from other consequences. The rule presented in Table 1 thus highlights one type of consequence, but this highlighting is only an algebraic rearrangement of the standard expression and does not affect the predictions that would be made from the theory.

[5] Several complications encountered in tests of multiplicative terms are discussed later in this article.

recent uses of the theory (e.g., Cummings, Jette, Brock, & Haefner, 1979; Peterson, Farmer, & Kashani, 1990; Sheppard, Solomon, Atkins, Foster, & Frankowski, 1990) have not assumed any particular relationship among the four central variables. Without any combinatorial rule, the health belief model is more accurately described as a short list of variables than as a theoretical model.[6]

A second difference concerns the number of parameters in the prediction rule that are not specified by the theory and must be determined from the data. With probability measured on a 0–1 scale and with severity and cost measured on a common scale of utility, subjective expected utility theory has no adjustable parameters. For this reason, no unspecified coefficients are shown in front of the terms in the subjective expected utility theory prediction rule in Table 1. With probabilities and expectancies measured on the same 0–1 scale and with severity, cost, and value all measured on a common scale, the theory of reasoned action has only one adjustable parameter, α, indicating the relative importance of perceived social pressure versus perceived direct consequences.[7] In contrast, the addition of variables in protection motivation theory and the health belief model that have different units (e.g., probability, severity, self-efficacy) means that there are unspecified coefficients that need to be determined after measurement scales are selected. These theories seem to suggest, though, that once these coefficients are determined, the coefficients should remain constant from one study to the next so long as the scales are not changed.

There is a problem in protection motivation theory concerning the interaction effects that are assumed to occur. Regarding these interactions, Prentice-Dunn and Rogers (1986, p. 156) state that

> if response efficacy and/or self-efficacy are high, then increases in severity and/or vulnerability will produce a positive main effect [on the motivation to act]. On the other hand, if response efficacy and/or self-efficacy are low, then increases in severity and/or vulnerability will either have no effect or a boomerang effect, actually reducing intentions to comply with the health recommendation.

This statement is internally inconsistent. If, for example, response efficacy is high and self-efficacy is low, the first part of the statement says that action increases with severity and/or vulnerability, whereas the second part of the statement says that increases in severity and/or vulnerability will either have no effect or will boomerang. It does not seem possible to combine the two components of protection motivation theory, perceptions of the *adaptive response*—which is said to be dependent on the sum of self-efficacy and response effectiveness—and perceptions of the *maladaptive response*—which is said to be dependent on the sum of severity and likelihood—and produce an interaction like that quoted.[8]

Other Points of Comparison

Costs

The theories under discussion differ in the extent to which they specify various kinds of costs. The health belief model implies that general questions about the costs or barriers to action might be sufficient, or at least that different types of costs can all be added together. Protection motivation theory adds distinct variables concerning the internal and external rewards lost by giving up the current behavior. Empirical research can determine whether various kinds of costs have differential effects, and need to be kept separate, or whether they can simply be added together to form a single variable. For example, the loss of internal rewards, which is often experienced multiple times, might have more impact on behavior than an external, monetary cost that is experienced only once.

Self-Efficacy

Protection motivation theory differs from the health belief model, subjective expected utility theory, and the theory of reasoned action in explicitly referring to self-efficacy (Bandura, 1977). Self-efficacy is assessed with questions that refer to the problems individuals expect to encounter in adopting the precaution or to doubts about their ability to change current patterns of behavior. Although theorists (e.g., Beck & Lund, 1981; Rogers, 1983) point out the difference between self-efficacy and response efficacy, they overlook the similarity between self-efficacy and barriers to action. Many of the problems people expect to encounter in carrying out protective measures (e.g., "Taking calcium supplements on a daily basis would be hard for me to do"; Wurtele, 1988, p. 631) would simply be labeled costs or barriers to action by other theories, not self-efficacy. Health belief model researchers, for example, might see the difficulty of acting as part of the expected cost of acting. Thus, the distinction between self-efficacy (as typically measured) and costs is not clear.

People are sometimes unsure about their ability to carry out health precautions (such as losing weight or stopping smoking). Doubts about one's ability to carry out an action are not

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[6] Sometimes other variables have been added to the health belief model. These include cues to action (Rosenstock, 1974), susceptibility to illness in general, and the valuation of health by the individual (Becker & Maiman, 1975). Most research using the health belief model, however, is based on the four-variable model described in the text.

[7] Since interpersonal influences are also consequences of taking a behavior, it is not clear why interpersonal influences need to be differentiated from the remaining consequences. If all other consequences can be assessed on a common metric, it seems that interpersonal consequences could be assessed in the same way (on the basis of the expected likelihood of different reactions from each significant person and the value placed on each reaction). This formulation would eliminate the arbitrary constant α.

[8] Protection motivation theory is not explicit about how perceptions of the adaptive response (AR) and of the maladaptive response (MR) should be combined to predict protection motivation. Of the simple rules, only two seem plausible: that protection motivation depends on the difference AR − MR or that it depends on the ratio AR:MR. When experimenters test this theory (e.g., Wurtele & Maddux, 1987), they look for main effects from each of the variables contributing to MR or AR, using analysis of variance models in which the effects are linear. This suggests that the difference between AR and MR is what the developers of protection motivation theory have in mind for protection motivation, and this is the rule listed in Table 1.

the same as beliefs about the cost or trouble involved. It is one thing to ask whether the benefits of some precaution will outweigh the costs; it is something else to ask whether an attempt to carry out this precaution, because it may fail, will provide any benefits at all. In discussing applications of subjective expected utility theory to smoking, for example, Sutton (1987) suggests that the perceived likelihood that stopping smoking will lead to desired outcomes, such as lowered risk of heart disease (i.e., action efficacy) should be multiplied by the perceived likelihood that a quit attempt will lead to stopping smoking (i.e., self-efficacy) to correctly describe the expected benefits of attempting to stop. However, the effects of self-efficacy and action efficacy on quit attempts were additive in the data reported by Sutton.

The theory of planned behavior (Ajzen, 1985; Ajzen & Madden, 1986) modifies the theory of reasoned action to recognize that doubts about one's ability to carry out an action (i.e., perceived behavioral control) can affect the motivation to act. Perceived behavioral control is described as the perceived probability of succeeding in enacting the behavior and is equated in discussions of the theory of planned behavior with self-efficacy. Like Sutton (1987), the theory of planned behavior introduces the likelihood of succeeding as a multiplicative factor (i.e., multiplying the attitude toward taking the action).

Although self-efficacy, when defined as the likelihood of successfully carrying out a preventive action, can be differentiated from the perceived barriers that must be overcome, these two variables are likely to be strongly correlated. It may be that the nature of their influence on behavior is similar. To test this idea one must determine whether predictions of behavior are significantly better when self-efficacy is kept separate (and allowed to have an independent effect on action) or when it is combined with variables (either added to other measures of the costs to be borne or, as suggested by Sutton and the theory of planned behavior, multiplying the benefits expected from the precaution).

The Range of Nonhealth Considerations

The theory of reasoned action differs from the other models in trying to identify all of the main consequences of action or inaction, including consequences from obeying or disobeying the preferences of important others. (Some applications of subjective expected utility theory also take this approach.) The fundamental question raised by this difference is the extent to which hazard reduction is the reason for action and can explain and predict such action. Although there are some actions for which hazard reduction appears to be the dominant motive (e.g., taking blood pressure medication or avoiding foods with additives), the performance of many health-related actions (e.g., losing weight or using a condom during sexual intercourse) appears to be governed by a much wider array of motives. The importance of motives other than hazard reduction in any particular instance is indicated by the accuracy of action predictions based only on risk considerations and by the improvement in accuracy that can be achieved by adding nonrisk variables to these predictions.

Effectiveness

Another difference concerns the perceived effectiveness of the precaution. The health belief model and protection motivation theory usually ask respondents directly about the effectiveness of the precaution in reducing risk (e.g., Seydel, Taal, & Wiegman, 1990; Wurtele, 1988). Subjective expected utility theory and some theory of reasoned action studies ask respondents about the likelihood and severity of harmful outcomes under the current behavior and under the alternative behavior and infer perceptions of effectiveness from the answers (e.g., Ronis, 1992; Ronis & Harel, 1989; Sutton & Eiser, 1990). Other theory of reasoned action studies have used *changes* in health—such as a reduction in risk or an improved chance of successful treatment—as the consequences considered by subjects, asking subjects about the likelihood of these changes and the value they place on this change. Logically, these different strategies should yield the same results. For example, effectiveness in the health belief model assessed through direct questioning should be the same as effectiveness in subjective expected utility theory inferred from beliefs about the risk present with and without preventive action. After all, the effectiveness *is* the reduction in risk.[9] Nevertheless, the way that people naturally think about these issues may be closer to one conceptualization than another. A person, for example, may have a definite opinion about the effectiveness of automobile seat belts but be unable to answer questions about the probability and severity of injuries for drivers who buckle up and those who don't. Which approach produces the best predictions has never been tested.

These alternative ways of looking at effectiveness raise a general issue. Theories framed in terms of concepts that people actually use in thinking about hazards will undoubtedly lead to better predictions and interventions than theories framed in terms of concepts that might appear to be logically equivalent but do not match the actual mental representations of these issues.

The Process That Leads to Health-Protective Behavior

These four theories specify variables that are supposed to determine whether someone will view a health-protective action as more attractive than current behavior. The health belief model and subjective expected utility theory say nothing about factors that might intervene between the perceived attractiveness of a precaution and precaution adoption. Although subjective expected utility theory, with its decision-theory origin, might be interpreted as specifying which of two actions will be selected, it is only used to predict the relative likelihood of action (i.e., it is used to predict that Person A is more likely to act that Person B but not to predict whether

[9] Note that if the perceived effectiveness of the precaution is defined in terms of the fractional reduction in expected harm, EFFECT = $(PROB_c SEV_c - PROB_a SEV_a)/(PROB_c SEV_c)$, then action in subjective expected utility theory is assumed to be a linear function of the expression $PROB_c SEV_c EFFECT - COSTS$. Expressed in this way, subjective expected utility theory uses the same four variables as the health belief model, but combines them in an explicit algebraic formula.

Person A will or will not act). This usage reflects the implicit assumption that knowing which action is most attractive is not sufficient to predict what people will do. Nevertheless, neither the health belief model nor subjective expected utility theory make any additional testable predictions about the process that leads to behavior change.

The theory of reasoned action, however, is formulated in terms of behavioral intentions, not behavior, and the prediction rule in Table 1 actually concerns the prediction of these intentions. The theory of reasoned action is explicit in assuming that intentions are sufficient for predicting behavior when they are stable and measured at the same level of specificity as behavior and when the behavior is under volitional control.[10] Although intentions are said to be sufficient for accurate predictions, the fact that the intentions (like Equation 1 in subjective expected utility theory) are only used to predict the relative likelihood of action implies that other issues must intervene. Whether these intervening factors are essentially random, as implied by the theory of reasoned action, or identifiable, is a testable question. Studies can examine whether variables within or outside the theory of reasoned action have a direct effect on behavior beyond their contributions to behavioral intentions. This issue is one that has received a considerable amount of empirical attention (e.g., Brubaker & Wickersham, 1990; Sutton & Eiser, 1990; Sutton & Hallett, 1988; for a thorough review, see Liska, 1984).

Protection motivation theory, like the theory of reasoned action, was formulated in terms of an intervening variable, protection motivation, rather than in terms of health behavior. It asserts that protection motivation is most appropriately assessed by behavioral intentions (Prentice-Dunn & Rogers, 1986). As just discussed, the adequacy of describing the process that leads to the adoption of precautions solely in terms of the formation of intentions is open to question. However, Prentice-Dunn and Rogers also discuss the role of self-efficacy in determining an individual's persistence in the face of obstacles. Thus, they are implicitly suggesting a temporal process in which people form intentions to act, attempt to carry out these intentions, encounter difficulties, and eventually either succeed or fail. If this is the process of precaution adoption, intentions and action are certainly not interchangeable.

Implications for Model Testing and Development

The preceding review suggests a number of critical issues that must be addressed to advance our understanding of health-promotive action. These issues can be classified under three broad headings: model testing, concept differentiation, and static versus dynamic models. *Model testing* refers to the specific strategies to be followed and problems to be overcome in establishing the accuracy of existing theories. *Concept differentiation* emphasizes the need for a better understanding of key variables and their origins. Tension will exist between those who advocate more carefully controlled tests of current models and variables (e.g., "Are the effects of susceptibility and severity on behavior additive or multiplicative?") and those who advocate a reexamination of the underlying concepts and phenomena themselves ("What does the term *susceptibility* really mean? Is it a single concept or does it refer to a set of concepts?"). The research designed to answer these questions will look quite different.

The *static versus dynamic* distinction separates those researchers who search for a single prediction rule to explain health-protective behavior from researchers who see the adoption of health behaviors as the end of a sequence of stages, with different issues—and hence different prediction rules—involved at different stages. A researcher interested in stages would be particularly interested in people who have only vague opinions about the health hazard and who give "don't know" answers on survey questions. Investigators searching for the single best prediction rule, however, may not even allow respondents to give "don't know" answers.

Model Tests Matched to Model Content

Two fundamental questions are encountered in model testing: (a) "Which variables need to be included in the model?" and (b) "How do these variables combine to influence behavior?" An example of the first question concerns the necessity of including variables pertaining to social influence on health behavior, as suggested by the theory of reasoned action.

Testing integration rules, more difficult statistically, requires multivariate research designs. In nonexperimental research, one would normally test the accuracy of a prediction rule—and the superiority of one rule over another—in terms of the correlation between the behavior predicted by the theory and the behavior actually observed. Note, however, that all these theories predict the relative likelihood of *changes* in behavior (i.e., certain factors in the model are assumed to lead people to take new actions), and generally require prospective designs to test them. For example, the correlation between perceived risk and current risk behavior indicates the accuracy of these perceptions (i.e., a strong positive correlation implies accuracy), whereas the correlation between perceived risk and future risk behavior indicates the effects of perceptions on behavior (i.e., a strong negative correlation implies that perception of risk leads people to adopt safer behavior). It is usually not appropriate to test the theories by examining the correlation between predicted behavior and current behavior (Weinstein & Nicolich, 1993).

In addition to examining the overall prediction of behavior change, hierarchical regression, path analysis (i.e., sequential, hierarchical regression), or structural modeling should be used to determine whether the specific relationships between the independent variables and behavior claimed by the theory match the relationships actually observed.

Furthermore, the more completely specified theories, such as the theory of reasoned action and subjective expected utility theory, prescribe not only the presence of particular terms, but the coefficients of these terms in the prediction rule. In

[10] The theory of planned behavior (Ajzen, 1985; Ajzen & Madden, 1986) holds that many problems may intervene between intentions and successful action. It uses perceived behavioral control as an indirect measure of the actual control an individual has over his or her behavior.

subjective expected utility theory, for example, the coefficients of the three terms in Table 1, $PROB_cSEV_c$, $PROB_aSEV_a$, and COST, are all supposed to be the same. Similarly, the theory of reasoned action assumes that all outcomes have equal influence on behavior once perceptions of likelihood and value are taken into account (hence all terms have equal coefficients within the summations in Table 1). One should investigate these theories with statistical models that include all of the variables in the theory and their interactions, and test whether the coefficients that are predicted to be the same (or to be zero) really are.

Testing details like these is essential. There is considerable evidence, for example, that people do not act like the optimal problem solvers assumed by subjective expected utility theory (Fischhoff, Goitein, & Shapira, 1982; Schoemaker, 1982). Their behavior, for example, may be influenced more by a concrete short-term cost than by a hypothetical reduction in future vulnerability. Such an effect would appear in the statistical analysis as a difference in the size of the coefficients for these terms. The difference would be missed, however, if only the overall agreement between predicted and observed behavior were examined.

In an experimental paradigm, one would test the predicted main and interaction effects. However, because a single experiment is unlikely to manipulate more than a few variables, it will not test the overall prediction rule. There is no reason, however, why experimental designs cannot assess variables that are not manipulated and perform nonexperimental tests of prediction rules using a combination of manipulated and nonmanipulated variables. Because some of the theories differ only slightly from one another, researchers should always test the various integration rules that differentiate among these theories and take care to include the variables that are present in one theory but not in another.

Problems in Model Testing

When predicted effects fail to appear, why don't researchers trust their own results and reject the theory they have been testing? Among the more familiar problems are questions of reliability and validity. Researchers may doubt, for example, that a survey has adequately measured abstract concepts like susceptibility or self-efficacy or may be skeptical that self-reports of health behavior are an adequate substitute for independent observation.

Adequacy of experimental manipulations. Expected effects may also fail to appear because an intervention does not sufficiently alter independent variables. Not only are most experimental treatments quite brief, but ethical considerations further limit the potential differences between experimental and control conditions. No one wants to leave study participants with the impression that a serious health problem presents no danger. The further one moves from the laboratory, where debriefing is possible (and behavioral intentions rather than actual behavior are the outcome measured), toward realistic, community-based investigations, the narrower the range of experimental treatments that is ethically defensible.

The apparent success of the intervention, however, may be exaggerated because of the demand characteristics of the experimental setting. Subjects who have just been told that they are susceptible to an illness may be reluctant to indicate on manipulation checks that they remain unconvinced. (Demand characteristics may also exaggerate the apparent effects of the experimental intervention on behavioral intentions.) The persistence of the changes produced is also open to question. Manipulation checks are almost always conducted immediately after the intervention; changes in behavior, in contrast, are usually assessed much later when the effects of the treatments may have worn off.

Finally, even when the intervention produces a highly significant change in an independent variable, and the relationship between the independent variable and the behavioral outcome is relatively strong, the impact of the treatment on the behavioral outcome may not be statistically significant. Experiments are actually tests of simple, two-step models in which an intervention is presumed to affect the independent variable, which is then supposed to affect the behavior under study (Weinstein, Sandman, & Roberts, 1990). In such a model, the proportion of the variance in behavior explained by the intervention is the product of the variances explained in each separate step. For instance, assume that the intervention affects the independent variable, such that 20% of the postintervention variance in the independent variable is accounted for by experimental condition. Furthermore, assume that the independent variable accounts for 20% of the variance in behavior (in correlational terms, $r = .45$). The intervention will then account for only 4% of the variance in behavior (20% of 20%). Unless the sample is large, the effects of the intervention may not be statistically significant, even though the premise of the experiment, that the independent variable has a substantial, causal influence on behavior is perfectly correct.

Effects dependent on the levels of other variables. Particularly in studying health behaviors, the effects of one variable may depend on the values of other relevant variables; that is, there may be interactions. Fear appeals, for example, may lead people to adopt a precaution only if this precaution is believed to be effective in reducing the risk. If investigators believe that the failure of the experimental manipulation to have an effect is a consequence of the levels of the other variables, they should feel an obligation to specify these proposed interactions and should acknowledge that a theory without such interactions is inadequate to explain their data.

It is difficult to determine whether the level of a secondary variable might explain the absence of treatment effects unless the value of this variable is known. Consequently, experimenters should assess and report, in addition to the levels and variance of the variable they have set out to manipulate, the mean levels and variances of other potentially important variables. Given a series of such research reports, it might be discovered, for example, that variations in perceptions of illness likelihood are important when perceived severity is high but not when it is low.

The absence of predicted interaction effects cannot be evaluated without knowing whether both of the independent variables involved are distributed over a suitably wide range. Frequently this requirement is not met. Variances may be small because there is little variation in a sample (e.g., the range of perceived severity in any study dealing with cancer is likely to be small), because the variation that is observed is due to errors of measurement, or because the intervention failed to effect the variables involved. Only if both the variables in a two-way interaction term are successfully manipulated in an experiment is it possible for interaction effects to appear.

Problems in testing multiplicative models. Improper statistical analysis of models containing multiplicative terms is common (Evans, 1991). Except under unusual circumstances, the effects of multiplicative terms should be tested after the variables are first added individually to the statistical model, even if the theory does not assume the presence of such main effects.

It is also important to recognize that statistical tests of multiplicative terms in survey data are strongly affected by the reliability of measurement of their components (Busemeyer & Jones, 1983). The poorer the measurement, the less significant the interaction will be. Furthermore, as declining reliability causes a decrease in the variance explained by the interaction term, significant main effects of the separate variables (i.e., simple additive terms) will appear (Dunlap & Kemery, 1988; Evans, 1985). These phantom main effects are due solely to the imperfect measurement. This reliability-related phenomenon may explain why tests of the probability by severity interaction using survey data often do not prove significant.

Concept Differentiation

We have already noted a number of instances in which the conceptualization of similar variables differs across theories. These instances include various ways of specifying costs (raising the issue of which types of costs need to be considered and whether they need to be treated separately), whether self-efficacy needs to be distinguished from other barriers to action, and whether people think of effectiveness as a distinct concept or as the difference between the risk one faces with and without precautionary action.

Similarly, we need to ask whether the threat to health that is presumed to form the motivation to act is always built from separate perceptions of likelihood and severity—as the theories suggest—or whether people can have a conception of threat without having any ideas about these separate perceptions (Weinstein, 1988). In other words, is threat an essential, intervening construct, and what variables other that perceptions of likelihood and severity (the only hazard attributes explicitly considered by these theories) might influence perceived threat.

Even concepts shared by many of these theories, like susceptibility, fear arousal, or efficacy need critical examination. How many different dimensions are concealed beneath these individual labels? Research on the perceived risk of various technologies and activities suggests that risk is a multidimensional concept (Slovic, Fischhoff, & Lichtenstein, 1985). It can not be summarized by a single probability statistic; in fact, laypeople have great difficulty understanding such statistics. Moreover, we know that concrete case histories have more impact on decisions than abstract statistics (Borgida & Nisbett, 1977). The health hazard attributes that may influence the perceived need for action include not only beliefs about likelihood and severity, but also the vividness of images of harm, the frequency of reminders, the availability of the issue in memory, the sensory experiences associated with the hazard, the time till onset and expectations of warnings prior to onset, the social meaning attached to victimization, and even the part of the body affected. Meyer, Leventhal, and Gutmann (1985), for example, hypothesize that responses to illness threats reflect their labels and symptoms, their causes, their consequences, and their duration. We need to discover which dimensions of health hazards need to be kept separate because of their differential effects on behavior and which can be combined because of their simple additive effects.

Similarly, none of these theories provides a conceptual model of protective behaviors. In addition to difficulty and effectiveness, there may be other issues (such as familiarity vs. novelty or initiating new behaviors vs. stopping old behaviors) that influence decisions to act. What attributes of these issues other than beliefs about likelihood and value are important?

Static Versus Dynamic Models

The four theories examined here try to specify the combination of variables that determines whether people take action. They differ in the particular variables considered, but all aim toward a single prediction rule. Recently, however, there has been growing interest in the idea that the adoption of health behaviors is too complex to be summarized by one decision rule (Baranowski, 1989–1990; Prochaska & DiClemente, 1983, 1984; Safer, Tharps, Jackson, & Leventhal, 1979; Weinstein 1988; Weinstein & Sandman, 1992). According to this perspective, an adequate view of precautionary behavior has to explain several distinct steps along the route to action. Not only must we explain why people decide that they should act, but we must also explain how people first come to consider a problem as requiring their attention and describe the issues that intervene between decisions and action. Furthermore, the factors that lead people to initiate actions are not sufficient to explain whether they are successful in maintaining these actions (Leventhal, Diefenbach, & Leventhal, 1992; McCaul, Glasgow, & O'Neill, 1992).

The identification of more than two distinct stages suggests that progress toward taking health-protective action cannot be adequately explained by the change in the value of a single prediction rule. Since different issues may be important at different stages, a series of prediction rules may be required. Stage theories thus require specification of the different stages (how they are defined; how they can be assessed; how people at one stage differ from those at another) and specification of the rules that govern transitions from one stage to the next. This is clearly more complicated than generating a single prediction rule, but may better reflect the reality of the precaution adoption process.

Conclusion

Although each of the theories discussed here is presented in various forms in the literature, some readers may argue that the version presented in this article is not the right one. The real goal, however, should not be to decide which theory is

Table 2
Key Questions Suggested by Model Comparisons

1. To what extent do beliefs about the likelihood and severity of health outcomes combine to influence behavior? Are their effects additive, multiplicative, or some other function?
2. How important are perceptions of risk compared to beliefs about other nonrisk issues in influencing behavior? Are there categories of nonrisk issues (such as emotional experience, self-esteeem, social approval, etc.) that are useful to distinguish? Are there certain nonrisk issues that are always relevant, or is each health threat unique?
3. Do doubts about one's ability to carry out a precaution have a different impact on behavior than do other obstacles (such as perceived cost and inconvenience)? Does the expected cost of carrying out a precaution need to be considered separately from the expected loss of internal and external rewards resulting from abandoning current behavior or can they be combined?
4. Do people derive notions of risk reduction effectiveness from separate beliefs about the risk presented from current behavior and from the recommended alternative, or do they have notions of effectiveness that arise separately?
5. What variables intervene between intentions and actions? Is reaching a decision to take action a discrete event that can be defined by a dichotomy, or should decisions to act be described along a continuum? Are there other distinct stages to the precaution adoption process that can be identified?
6. Do dimensions of risk other than likelihood and severity (e.g., familiar vs. novel, visible vs. invisible, imminent vs. delayed) need to be considered? How do they affect behavior?
7. What attributes of precautions other than the beliefs about costs and effectiveness considered in these models (e.g., past patterns of behavior, complexity of action, need for repetition, elimination of risk vs. reduction in risk, etc.) influence behavior?

best, but to decide which variables and processes in these theories improve our understanding of health-protective behavior. Finding that one theory correlates .4 with observed behavior and that another theory correlates .5 is not nearly so helpful as discovering what features of the theories account for the difference. The substantive issues that have been identified in the preceding pages are summarized in Table 2. These are the questions that really need to be addressed, and these are the questions whose answers will lead to better theories of health-protective behavior.

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