Health Behavior Models

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Introduction

Since they define *what* to measure, models and theories of health behavior change are inherently linked to the measurement of health behavior. This chapter reviews different models of health behavior change as an overview, not an in-depth comparison. Furthermore, while we aim to present other models fairly, the authors are biased toward the Transtheoretical model—we present best that with which we are most familiar.

We review here only the four most commonly used models of individual health behavior change, relying primarily on the criteria of Glantz and colleagues.[1] Their review of articles published between 1992-1994 in health education, medicine, and behavioral science that use any theoretical framework (only 45% used a theory)[1] revealed that the most used models were the

Health Belief Model, Theory of Reasoned Action/Planned Behavior, Social Cognitive Theory and The Transtheoretical Model. There are many more theories and models relevant for health behavior covering such important topics as: community organization, communication, diffusion of innovations, social marketing, information processing, stress and coping, relapse prevention, and empowerment. Additional materials are cited in the text and interested readers can pursue these ideas further through these resources. An entire book is devoted to the topics covered in this chapter and is highly recommended for those who want more details.[1]

Theoretical models fundamentally guide both our current and future understanding of health behavior, as well as providing direction for our research and intervention development. As a metaphor, each model or theory provides a different roadmap of the health behavior territory. Of course, it is important to point out that the map is not the territory itself, and different maps (theories) describe the same territory differently. Even so, when we enter new territory, we still need a map. Even a roughly drawn or poorly scaled map is much better than none at all. The map points out the relevant landmarks (constructs) and how they are connected, and, perhaps, how far it is from one landmark to another. As different maps of the same territory evolve over time and are compared, the territory becomes clearer, thus allowing better maps to evolve, perhaps integrating the clearest features of different maps. So it goes with theoretical development as well. There is no final or true map, only a map or theory that best meets our needs right now. Thus, as we evaluate these different theories, we should ask comparable questions of them.

Evaluation and comparison of the different theories reveals that they are not so different in terms of their differential predictions. Most differences really amount to emphasis on one construct over another. Cummings and colleagues conclude that theories which integrate ideas from other competing theories provide more explanatory power.[2] Similarly, Fishbein and colleagues went through an unprecedented consensus conference among theorists to outline the most important variables to study in relation to reducing HIV risk.[3] Many constructs from each theory are actually fairly similar. One excellent research proposal for conducting critical tests of different

theoretical predictions is outlined by Weinstein.[4] In fact, the National Institutes of Health recently issued a cross-agency request for funding applications to systematically test different theoretical predictions.

The Health Belief Model

The Health Belief Model (HBM) has the longest history of all the theories reviewed. It was originally conceived by social psychologists in the public health arena as a way of predicting who would utilize screening tests and/or vaccinations.[3,5–9] According to the HBM, the likelihood that someone will take action to prevent illness depends upon the individual's perception that:

- they are personally vulnerable to the condition;
- the consequences of the condition would be serious;
- the precautionary behavior effectively prevents the condition; and
- the benefits of reducing the threat of the condition exceed the costs of taking action.[9]

These four factors, which are influenced by mediating variables, indirectly influence the probability of performing protective health behaviors by influencing the perceived threat of the illness and expectations about outcome.

The HBM has been used for intervening with health screening, illness, sick role, and precautionary behaviors.[5,8–12] The model has undergone some modifications since its original formulation. Table 1 shows the four-construct model that is the most commonly described form of the HBM. The model's four key components are conceptualized as perceived: 1) susceptibility, 2) severity, 3) effectiveness, and 4) cost.

Perceived susceptibility refers to the probability that an individual assigns to personal vulnerability in developing the condition. The concept of perceived susceptibility has been found to be predictive of a number of health-protective behaviors. From an HBM perspective, the likelihood individuals will engage in precautionary behaviors to prevent cancer (e.g., quit smoking, eat a diet low in fat and high in fiber, exercise, get a mammogram or prostate exam) depends on how much they believe they are vulnerable to or at risk for cancer. In general, it has been found that people tend to underestimate their own susceptibility to disease.

Table 1. Health Belief Model Constructs	
Constructs	**Descriptions**
Perceived Susceptibility	One's evaluation of chances of getting a condition
Perceived Severity	One's evaluation of how serious a condition, its treatment, and its conseuqences would be
Perceived Benefits	One's evaluation of how well an advised action will reduce risk or moderate the impact of the condition
Perceived Barriers	One's evaluation of how difficult an advised action will be or how much it will cost, both psychologically and otherwise
Cues to Action	Events or strategies that increase one's motivation
Self-efficacy	Confidence in one's ability to take action

Perceived severity refers to how serious the individual believes the consequences of developing the condition are. An individual is more likely to take action to prevent cancer if s/he believes that possible negative physical, psychological, and/or social effects resulting from developing the disease pose serious consequences (e.g., altered social relationships, reduced independence, pain, suffering, disability, or even death). Models of Health Belief frequently refer to perceived health threats. The combination of perceived susceptibility and perceived severity constitute a threat.

Perceived effectiveness refers to the benefits of engaging in the protective behavior. Motivation to take action to change a behavior requires the belief that the precautionary behavior effectively prevents the condition. For example, individuals who are not convinced that there is a causal relationship between smoking and cancer are unlikely to quit smoking because they believe that quitting will not protect against the disease.

Perceived cost refers to the barriers or losses that interfere with health behavior change. The combination of perceived effectiveness and perceived costs constitute the notion of outcome expectation. Belief alone is not enough to motivate an individual to act. Taking action involves cognitively weighing the personal costs associated with the behavior against the benefits expected as a result of engaging in the behavior. Benefits have to outweigh the costs involved.

Cues to action involve stimuli that motivate an individual to engage in the health behavior.[9] The stimulus that triggers action may be internal or external. For example, angina may act as an internal cue to initiate action. External cues such as a spouse's illness or the death of a parent may also trigger health behavior changes in an individual who was not otherwise considering them. HBM factors also interact to trigger action. For example, when perceptions of susceptibility and severity are high, a very minor stimulus may be all that is needed to initiate action. However, more intense stimuli may be needed to initiate action if perceived susceptibility and severity are low.

More recent formulations of the HBM have included *self-efficacy* as a key factor. Self-efficacy is influenced by mediating variables and in turn influences expectations. In addition, some forms of the HBM refer to *general susceptibility to illness* as a key factor in the model. However, substitution of the general case over specific consequences is only appropriate if the intention of the precautionary behavior is to improve health in general.[4] The *value of health,* another variable which is sometimes included, refers to interest in and concerns about general health,[9] the extent to which an individual values health.[6] According to this view of HBM, individuals concerned about being healthy in general are more likely to exercise regularly than individuals who place little value on health. Although both cues to action and the value of health have been included in some forms of HBM, their importance in predicting health behavior is unclear since neither variable has been systematically studied.[9]

Mediating factors (demographic, structural, and social variables) have also been explored in applying the HBM. Mediating variables (e.g., educational level) are believed to indirectly affect behavior by influencing an individual's perceptions of susceptibility, severity,

benefits, and barriers.[9] Becker and Maiman added the concept of *motivation* to the HBM.[6] This has also been interpreted as readiness to change behavior.[12]

The Theory of Reasoned Action/Planned Behavior

The Theory of Reasoned Action (TRA) is a widely used behavioral prediction theory which represents a social-psychological approach to understanding and predicting the determinants of health-behavior.[14–16] Over the years, TRA has been applied to many diverse health-related behaviors including: weight loss, smoking, alcohol abuse, HIV risk behaviors, and mammography screening. The theory of reasoned action states that the intention to perform a particular

behavior is strongly related to the actual performance of that behavior. Two basic assumptions that underlie the TRA are: 1) behavior is under volitional control, and 2) people are rational beings. From the perspective of TRA, we behave in a certain way because we choose to do so and we use a rational decision-making process in choosing and planning our actions. The TRA was designed to predict behavior from intention, and proposes quasi-mathematical relationships between beliefs, attitudes, intentions, and behavior. A modified version of TRA includes the addition of perceived control over the behavior and is referred to as the Theory of Planned Behavior (TPB).[3,7] Table 2 describes the main constructs used in TRA and the Theory of Planned Behavior

Table 2. Theory of Reasoned Action/Planned Behavior	
Constructs	**Description**
Behavioral Intention	Perceived likelihood of performing the behavior
Attitudes	The product of the behavioral belief multiplied by the evaluation of it
Behavioral Belief	Evaluation of the likelihood that performance of the behavior is associated with certain outcomes
Evaluation of B.B.	How good or how bad those outcomes would be
Subjective Norm	The product of the normative belief multiplied by the motivation to comply
Normative Belief	Perception of how much each personal contact approves or disapproves of the behavior
Motivation to Comply	Motivation to do what each personal contact person wants
Perceived Behavioral Control	The product of the control belief multiplied by the perceived power
Control Belief	Perceived likelihood of each facilitating or constraining condition occurring
Perceived Power	Perceived effect of each condition in making the performance of the behavior easier or more difficult

Predicting behavior is the ultimate goal of the TRA. According to the TRA, behavior is influenced by the intention to perform the behavior. Intention is influenced by three major variables: subjective norms, attitudes, and self-efficacy. Subjective norms involve an individual's perception of what significant others believe about his or her ability to perform the behavior.

For example, whether or not someone intends to cut down on dietary fat by giving up bacon and red meat could be partly determined by what that person believes his or her spouse's opinion would be if s/he did. Attitudes can be conceptualized in terms of values. That is, an individual develops particular values about behaviors. For example, one attitude might be: eating

a healthy diet is a good way to prevent heart disease and/or cancer. Self-efficacy is the confidence an individual feels that s/he can successfully perform the behavior of eating a healthy diet.

Two of the variables that influence intention, subjective norms, and attitudes are in turn influenced by beliefs. Two general types of beliefs are considered in TRA: *normative* and *behavioral* beliefs. Normative beliefs are situationally based social expectations, which are considered the rule. Normative beliefs influence subjective norms while beliefs about the behavior influence attitudes. An individual's attitudes toward a behavior are determined by his/her expectations about the outcome of performing the behavior, and the extent to which s/he values the outcome. Thus, from a TRA perspective, the likelihood that an individual will engage in health risk reduction depends upon how much s/he is convinced that healthy behaviors will prevent risk, and the degree to which s/he perceives the benefits will outweigh the costs.

The majority of TRA research has focused on the prediction of behavioral intention rather than on the behavior itself.[13] Unfortunately, because the correlation between behavior and intention is not particularly impressive, research on attitudes and behaviors is often dismissed.[14] Despite this shortcoming, Sonstroem has suggested that TRA can still be a useful perspective as long as situation-specific attitude and intention measures are employed that specify congruent action, target, context, and time, and that the interactions between personal determinants and situations are emphasized.[17]

Social Cognitive Theory

This theory goes well beyond individual factors in health behavior change to include environmental and social factors. In fact, this theory may be the most comprehensive model of human behavior yet proposed. Bandura's Social Cognitive Theory (SCT),[18] also referred to as Social Learning Theory, is a behavioral

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Table 3. Social Cognitive Theory Constructs

Constructs	Description
Environmental	Factors outside the person
Situation	One's perception of the environment
Behavioral Capability	One's knowledge and skills to perform a behavior
Expectations	One's anticipation of the outcomes of a behavior
Expectancies	How good or bad one evaluates the outcomes to be
Self-control	Regulation of one's own behavior
Observational Learning	Acquiring a new behavior by watching someone else perform it and observing the outcomes–a.k.a. modeling
Reinforcements	Responses to a person's behavior that affect how likely it is that the behavior will reoccur
Self-efficacy	One's confidence in one's own ability to perform a behavior
Emotional Coping Responses	Strategies used by someone to deal with emotionally challenging thoughts, events, or experiences
Reciprocal Determinism	Dynamic interaction of the person, the behavior, and his/her environment

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prediction theory that represents a clinical approach to health behavior change.[3,7] This theory has been widely applied to health behavior with respect to prevention, health promotion, and modification of unhealthy lifestyles for many different risk behaviors. SCT emphasizes what people think and its effect on their behavior.[19,20] SCT proposes that behavior can be explained in terms of *triadic reciprocity* between three key concepts which operate as determinants of each other. *Reciprocal determinism* forms the basic organizing principle of SCT. This important concept states that there is a continuous, dynamic interaction between the individual, the environment, and behavior. Thus, a change in one of these factors impacts on the other two. SCT involves numerous key concepts, which have been associated with each of the three main constructs for the purpose of describing the SCT. Table 3 describes all the key constructs employed by SCT.

Bandura conceptualized influences on behavior that involved the concept of *person* in terms of basic human capacities that are cognitive in nature.[18] Key concepts associated with the person include: personal characteristics, emotional arousal/coping, behavioral capacity, self-efficacy, expectation, expectancies, self-regulation, observational/experiential learning, and reinforcement.[19,20]

- *Personal characteristics* have been operationalized as multiple, interacting determinants such as demographics (e.g., gender, race/ethnicity, education), personality, cognitive factors (e.g., thoughts, attitudes, beliefs, knowledge), motivation, and skills.
- *Emotional arousal/coping* can interfere with learning and thus influence behavior. This refers to an individual's ability to respond to emotional stimuli with various techniques, strategies, and activities that help one to deal with arousing situations (e.g., fear, anxiety).
- *Behavioral capacity* refers to the individual's possession of both the knowledge and skills necessary to perform a behavior.
- *Self-efficacy* refers to an individual's confidence in his or her ability to perform a behavior in various situations. Self-efficacy has been recognized as an important mediating variable between knowledge, attitudes, skills, and behavior.[13]

- *Expectations* are beliefs associated with the outcome of a behavior. *Expectancies* are the value an individual attributes to the anticipated outcome of performing a behavior.
- *Self-regulation* refers to the individual's ability to manage or control behavior. Individuals use goal setting, self-monitoring, and self-reinforcement to regulate performance of a behavior.
- *Observational/experiential learning* refers to the acquisition of a behavior through observation and experience. Learning can occur either through observation of another's performance of a behavior (modeling), or through personal experience, i.e., trial and error.
- *Reinforcement* refers to the consequences that affect the probability a behavior will be tried again. Individuals are motivated to perform behaviors through rewards and incentives.[20]

In SCT, the relationship between behavior, person, and environment is interactive. The stereotypic picture of the relatively young executive who develops high blood pressure provides an illustration of how variables associated with person, (e.g., personal characteristics), interact with the environment and behavior. Consider a male in his early 40s who is obsessed with achievement, advancement, and recognition. This individual is a highly competitive workaholic who is driven to get things done quickly. Such individuals are sometimes described as being hostile and might be found operating in a highly stressful environment. Although simplistic and stereotypical, this picture represents a classic example of a "Type A personality." From an SCT perspective, this individual's predominant personality type negatively influences his behavior. Thus this individual is less likely to take the time to acquire the cognitive and behavioral skills necessary to successfully perform any risk reduction behavior (smoking cessation, stress management, etc.).

Influences on behavior which involve the *environment* can be physical, social, cultural, economical, political in nature,[21] or situational in nature.[20] In SCT, the person's perceptions of the environment are referred to as *situations;* this key variable can facilitate or inhibit behavior. In this reciprocal, interactive scheme, in which multiple determinants of behavior are assumed, *behavior* also exerts an influence on both the environment and the person. The environment and past experience with a

Table 4. Transtheoretical Model Constructs	
Constructs	**Description**
Stages of Change	
Precontemplation	No intention to take action within the next 6 months
Contemplation	Intends to take action within the next 6 months
Preparation	Intends to take action within the next 30 days and has taken some behavioral steps in this direction
Action	Has changed overt behavior for less than 6 months
Maintenance	Has changed overt behavior for more than 6 months
Decisional Balance	
Pros	The benefits of changing
Cons	The costs of changing
Self-efficacy	
Confidence	Confidence that one can engage in the healthy behavior across different challenging situations
Temptation	Temptation to engage in the unhealthy behavior across different challenging situations
Process of Change	
Consciousness Raising	Finding and learning new facts, ideas, and tips that support the healthy behavior change
Dramatical Relief	Experiencing the negative emotions (fear, anxiety, worry) that go along with unhealthy behavioral risks
Self-reevaluation	Realizing that the behavior change is an important part of one's identity as a person
Environmental Reevaluation	Realizing the negative impact of the unhealthy behavior, or the positive impact of the healthy behavior, on one's proximal social and/or physical environment
Self-liberation	Making a firm commitment to change
Helping Relationships	Seeking and using social support for the healthy behavior change
Counterconditioning	Substitution of the healthier alternative behaviors and/or cognitions for the unhealthy behavior
Reinforcement Management	Increasing the rewards for the positive behavior change and/or decreasing the rewards of the unhealthy behavior
Stimulus Control	Removing reminders or cues to engage in the unhealthy behavior and/or adding cues or reminders to engage in the healthy behavior
Social Liberation	Realizing that social norms are changing in the direction of supporting the healthy behavior change

particular behavior can also provide reinforcement for acting in a particular way. For example, as Americans have demanded the availability of healthier, lower fat, higher fiber choices in their environment, more and more eating establishments have changed their food preparation procedures and menus to reduce dietary fat. There are a wider variety of "heart healthy" menus available now. To reduce their risk, consumers have begun to take advantage of greater environmental choices by: purchasing more fruits and vegetables, substituting available lower fat products instead of high fat ones, changing their food preparation methods to broiling and baking instead of frying, and ordering lower fat food choices offered by restaurants.

Interactions are also assumed to occur between problem behaviors (e.g., eating high fat foods, lack of exercise, smoking) and physiological factors (e.g., nicotine, caffeine addiction).[21] An individual's performance of associated behaviors can have an important impact on disease prevention. Engaging in exercise can trigger hunger, stimulating the desire for high fat food. Finishing a meal can act as a cue that triggers the desire for a cigarette. An individual may use smoking to relax in a high stress environment. To effectively prevent disease, an individual needs to engage in multiple healthy behaviors like exercise adoption, low fat/high fiber eating habits, mammography screening, wearing seatbelts, etc. SCT assumes that most behaviors are learned responses and can be modified. Thus, learning through observing the behavior of others (i.e., modeling) is important from a SCT perspective. SCT also places heavy emphasis on learning both cognitive and behavioral skills for coping with situations and making changes in health behavior. Thus, an individual who wants to quit smoking but lacks the cognitive and behavioral skills to effectively cope with stressful situations without cigarettes is less likely to successfully change smoking behavior in spite motivation to do so.

Self-Efficacy

The concept of self-efficacy is recognized as one of Bandura's most important contributions to psychology and the field of health behavior change in general.[22] Self-efficacy refers to the *confidence* an individual has in his or her own ability to successfully carry out a behavior. The importance of self-efficacy for behavior change has been widely recognized across multiple behaviors relevant to health risk reduction.[23]

Furthermore, its incorporation into almost all major theories of behavior change is further evidence of its important role in the behavior change process.

Bandura proposed that the actual performance of a particular behavior is highly related to an individual's belief in his/her ability to perform that behavior in specific situations. An individual with low self-efficacy is likely to have lower expectations of successfully performing the behavior and be more affected by situational temptations that are counterproductive to promoting and maintaining behavior change. In contrast, an individual who has high self-efficacy not only expects to succeed but is actually more likely to do so. For example, the likelihood that an individual will successfully perform a behavior like exercise is strongly dependent upon how confident that individual is that s/he can actually do activities, such as walking, jogging, swimming, or doing aerobics on a regular basis.[22]

Several factors influence an individual's self-efficacy, including persuasion by others, observing others' behavior (modeling), previous experience with performing the behavior, and direct physiological feedback.[18] For example, individuals are more likely to attempt to quit smoking if: 1) a physician recommends that they do so, thus persuading them that quitting is a good idea, 2) they have observed others who have been able to quit and/or are coping well with trying to quit, 3) they have had past experience with quit attempts, and/or 4) they have been able to cope with the physical symptoms of nicotine withdrawal. Self-efficacy exerts such a strong influence on behavior change that confidence has been found to outperform past performance in predicting future behavior.[24]

The Transtheoretical Model

The past 20 years of Transtheoretical Model-based research has found some common principles of behavior change which have applied to a wide range of health behaviors. These behaviors include: smoking cessation, exercise adoption, sun protection, dietary fat reduction, condom use, adherence to mammography screening, medication adherence, stress management, and substance abuse cessation, to name just a few.[25–29] These problem behaviors are important from both a clinical and a public health standpoint because they are strongly associated with increased morbidity, mortality, and with decreased quality of life. The Transtheoretical Model (TTM) is a model of

intentional behavior change that has produced a large volume of research and service across a wide range of problem behaviors and populations.[25–29] This model describes the relationships among: stages of change; processes of change; decisional balance, or the pros and cons of change; situational confidence, or self-efficacy in the behavior change; and situational temptations to relapse. Table 4 describes all the constructs that collectively comprise the TTM.

This model has several advantages over other models. First, it describes behavior change as a process, as opposed to an event. Then, by breaking the change process down into stages and studying which variables are most strongly associated with progress through the stages, this model provides important tools for both research and intervention development. Secondly, its explicit focus on measurement of constructs has provided a strong foundation for the model. Across different problem behaviors and populations, different variables have been associated with stage movement for each stage of change.[30]

These TTM findings inform the design of individualized, stage-matched, expert system interventions (see below) that target those variables most predictive of progress for individuals at each stage of change. One aspect of this model that often goes unrecognized is that it is the processes of change that drive movement through the stages of change.[31] Thus, although commonly referred to as the "Stages of Change Model" since "stage" is the core construct around which other model constructs are organized, this is a misnomer since it focuses attention on only one construct from this multidimensional model. Naturally, model-based interventions are multidimensional as well. TTM research has found remarkable similarities across different kinds of behavior changes. We have found repeatedly that the stages of change have predictable relationships with the pros and cons of behavior change, confidence in behavior change, temptation to relapse, and the processes of change.

Stages of Change

Individuals do not change their behavior all at once; they change it incrementally or stepwise in stages of change. The stages most commonly used across research areas include: Precontemplation, Contemplation, Preparation, Action, and Maintenance. Individuals do not typically move linearly from stage

to stage, but often progress and then recycle back to a previous stage before moving forward again. This change process is conceptualized most meaningfully as a spiral, which illustrates that even when individuals do recycle to a stage they've been in before, they may still have learned from their previous experiences.

Precontemplation describes individuals who for many reasons do not intend to change within the next six months. Some of these individuals may want to change at some future time, but just not within the next six months. Others may not want to change at all and, in fact, may be very committed to their problem behavior (e.g., a lifelong smoker or someone who regularly cultivates a deep tan).

Contemplation describes individuals who are thinking about changing their problem behavior within the next six months. They are more open to feedback and information about the problem behavior than their counterparts in Precontemplation.

Individuals in the *Preparation* stage are committed to changing their problem behavior soon, usually within the next 30 days. These people have often tried to change in the past and/or have been practicing change efforts in small steps to help them get ready for their actual change attempt.

The *Action* stage includes individuals who have changed their problem behavior within the past six months. The change is still quite new and their risk for relapse is high, requiring their constant attention and vigilance.

Maintenance stage individuals have changed their problem behavior for at least six months. Their change has become more of a habit, and their risk for relapse is lower, but relapse prevention still requires some attention, although somewhat less than for individuals in Action.

Processes of Change

The processes of change describe the ten cognitive, emotional, behavioral, and interpersonal strategies and techniques that individuals and/or change agents (therapists, counselors) use to change problem behaviors.[25,26] Research has demonstrated that successful behavior change depends upon the use of specific processes at specific stages.[32–35] TTM-based research has consistently found that different processes are used to progress to different stages. Thus, the processes mediate the transitions from stage to stage and can represent important intermediate outcomes of

interventions. The processes of change are also ideal tools for process-to-outcome research and in many ways provide the foundation for TTM expert system interventions (see below). The processes of change are consistent with many SCT constructs and are quite similar to most conceptions of coping behaviors as well.[36]

Many studies across problem behaviors[35,37] have found that the ten most used processes of change are organized into two higher order clusters of processes: the experiential processes—Consciousness Raising, Dramatic Relief, Self-Reevaluation, Environmental Reevaluation, and Social Liberation; and the behavioral processes—Helping Relationships, Counterconditioning, Reinforcement Management, Stimulus Control, and Self Liberation. The experiential set of processes are most often emphasized in earlier stages (Precontemplation, Contemplation, and Preparation) to increase intention and motivation; and the behavioral set of processes are most often utilized in later stages (Preparation, Action, and Maintenance) as observable behavior change efforts get underway and need to be maintained.

Decisional Balance

Decisional Balance, or the pros and cons of behavior change, describes the importance or weight of an individual's reasons for changing or not changing. The pros and cons relate strongly and predictably to the stages of change.[38,39] These are the decision-making components of the TTM and also serve as two important intervening, or intermediate outcome variables. Individuals' decisions to move from one stage of change to the next are based on the relative weight given to the pros and cons of adopting the healthy behavior. The pros are the positive aspects of changing behavior, or the benefits of change (reasons to change). In contrast, the cons include the negative aspects of changing behavior, or barriers to change (reasons not to change). These two dimensions have been consistently supported by studies across many different problem behaviors in TTM-based research.[39] Characteristically, the pros of healthy behavior are low in the early stages and increase across the stages of change, and the cons of the healthy behavior are high in the early stages and decrease across the stages of change.

The pros and cons are particularly useful when intervening with individuals in early stages of change.

Decisional balance is an excellent indicator of an individual's decision to move out of the precontemplation stage. The relationship between the stages of change and decisional balance has been shown to be remarkably consistent across at least 12 different problem behaviors.[39] Not only has the relationship between stage and the pros and cons been replicated across problem behaviors, but the magnitude of the change across the stages of change has been replicated as well. Based on these data, the strong and weak principles of behavior change were formulated.[38] The strong principle states that in progressing from precontemplation to action, the pros of change generally increase by about one standard deviation, whereas the weak principle states that correspondingly, the cons of change tend to decrease by about one-half of a standard deviation.

The TTM pros and cons constructs are quite similar to those also proposed by both the HBM (benefits/barriers) and the TRA/TPB (benefits/costs); and the evidence presented by Prochaska and colleagues[39] across 12 problem behaviors does provide some support for all three models. However, only the TTM proposes the specific relationship between these constructs and the stages of change. Also, importantly, the TTM has gone beyond mere specification of components to deductively hypothesize the *degree* of change in the pros and cons that occurs from Precontemplation to Action across problem behaviors.[38] This is an important, innovative step for the TTM and for the development of the science of behavior change in general.

Situational Confidence and Temptations

The self-efficacy construct utilized in the TTM[40] integrates the models of self-efficacy proposed by Bandura,[18,22] and the coping models of relapse and maintenance described by Shiffman.[41] These variables have undergone considerable elaboration over time, with situational temptation to engage in the unhealthy behavior often viewed as an equally important companion construct to the more commonly used situational confidence measures. Confidence and temptation function inversely across the stages, and temptation predicts relapse better. Research has demonstrated that both the confidence and temptation constructs can be conceptualized psychometrically as unifactorial and/or multifactorial. Structural modeling

analyses have repeatedly revealed a global higher order construct (confidence or temptations) which is comprised of several lower order situationally determined components.[40,42,43] The lower order situational factors depend more strongly upon the problem behavior than the higher order construct. A global score is often useful as a general screening tool, while the situational subscale scores provide useful information for targeting intervention feedback to individuals at different stages of change.

Confidence and temptation both vary across the stages of change, with confidence rising and temptation decreasing across longitudinal profiles of smokers.[30] A moderate, reciprocal relationship ($r = -.60$) has been found between temptation and confidence for both smoking cessation and safer sex behaviors.[40,43] Confidence is typically lowest in the Precontemplation stage, since individuals have little performance feedback and/or little interest in change. Confidence is higher during Contemplation, outperforming demographic variables in its ability to predict movement into Preparation and Action stages.[44] Even in the Maintenance stage where subjects have successfully altered the problem behavior for at least six months, temptation is one of the best predictors of relapse and recycling to earlier stages of change.[45]

Expert Systems

An expert system computer program mimics or codifies the reasoning of human experts. The program uses standardized decision rules or algorithms for assessment and providing feedback and applies those algorithms consistently. A TTM expert system is an integrated assessment and intervention delivery computer program.[46-49] Expert systems have been used with many different populations and have been found to be effective for smoking cessation,[33,50] sun protection,[51,52] dietary fat reduction[53] and mammography screening.[54] The more recent development of multimedia expert systems provides nearly immediate feedback to respondents, who sit at the computer and completes a series of questions followed by feedback. Participants respond to several series of questions interspersed with feedback on different TTM constructs.[47,48]

Measurement and Research Foundations

What is not obvious from most descriptions of the TTM is the careful attention to measurement development and validation that is taught and practiced by TTM-Model contributors and originators.[54,55] Construction of measures based on the TTM have typically employed the sequential methods of scale development described by Jackson[56,57] and Comrey.[58] Initial item pools are generated based on theoretical construct definitions. Many of the items are adapted from existing instruments, but item content is then modified to more closely reflect the problem behavior and the language used by the population being studied. This is necessary for intervention development, as well as being an important foundation for any research project. There is a large and increasing volume of research using this model.

Summary/Future Directions

We have presented each of four models of behavior change, with a clear emphasis on the TTM. The TTM has an explanatory advantage since it was conceived later than the other models. The TTM was clearly not conceived in a vacuum. As part of their "Transtheoretical" strategy, model originators consciously incorporated and built upon the strengths of their predecessors. As put so well by Isaac Newton in his letter to Robert Hooke (February 5, 1676), "If I have seen further …it is by standing on the shoulders of giants." Also, importantly, the TTM is not a fixed entity. It must grow and develop over time incorporating and responding to new promising ideas and new challenging data. It is a sign of our times that other theories are now utilizing this same strategy and drawing upon TTM variables, especially stage of change, to integrate within their own framework. Others are also now using various eclectic theoretical frameworks to develop tailored feedback systems.[59-62]

We have made our biases clear. It is now up to the reader to investigate the strength of the evidence further and to keep these questions in mind as he or she evaluates and compares competing theories:

- How well does this model describe health behavior change?
- How parsimonious is this theory?
- How much variance is accounted for in studies applying this model?

- How much intervention development guidance is provided by this theory?
- How useful is this model in practice?
- How effective in practice are interventions based on this theory?
- How well measured or how clear are theoretically defined constructs?
- How well specified and tested are theoretically defined mediating mechanisms?

These are the questions that the science of behavior change will ultimately use to decide which models and which model-based components provide the most useful description of the health behavior territory.

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