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Expectancies and Mental Models as Determinants of Adolescents' Smoking Decisions

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Cigarette smoking has been identified as the single most preventable source of mortality and morbidity in the United States. Experimentation with tobacco typically begins in adolescence, and smoking during this period is one of the strongest and most consistent predictors of adult smoking status. In the present paper, we review several prominent decision models that have been applied to adolescent smoking, and point out important limitations of these models. We then propose a new process-oriented framework of decision-making based on the concept of mental models, and discuss the implications of this framework for developing effective smoking prevention and cessation interventions for adolescents.

Smoking has been linked to a host of health problems including heart disease, cancer, chronic bronchitis and emphysema (Schwartz, 1987), and has been repeatedly identified as the single most preventable source of mortality and morbidity in the United States (Fielding, 1985; Russell, 1990). In Canada, smoking is responsible for approximately 40,000 deaths per year, more than four times the number attributed to alcohol, AIDS, car accidents, suicide, and murder combined (Schabas, 1996).

Initial experimentation with tobacco typically begins in early adolescence (Russell, 1990; Sussman et al., 1995), and even limited exposure to cigarettes during this period substantially raises the probability of regular smoking in adulthood. For example, Chassin et al. (1990) report that individuals who smoked at least once per month during their teenage years were more than sixteen times more likely to be regular smokers as adults. Similar findings have been reported elsewhere. Based on a re-analysis of a representative survey of 984 adults from the United Kingdom, Russell (1990) concluded that over 90 percent of respondents

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who had smoked four or more cigarettes during adolescence developed a long-term smoking habit that lasted into adulthood. An Irish study conducted by O'Connor and Daly (1985) produced comparable, although slightly less dramatic, results: 75 percent of all respondents who had experimented with cigarettes during adolescence became regular smokers.

The prevalence of smoking among adolescents is high and rising. A recent survey of Southern California youth found 60 percent of seventh-graders, 65 percent of eighth-graders, and 70 percent of ninth-graders had tried smoking (Sussman et al., 1995). In 1991, 28 percent of high-school seniors had smoked within the previous thirty days. By 1993 the proportion had increased to 30 percent (Kessler, 1995). A similar trend is evident in Canada. The smoking rate for Canadian youth increased from 21 percent in 1991 to 27 percent in 1994 (*Health Canada Survey on Smoking*, cited in Payne, 1995).

Given the prevalence of tobacco use among young people, and the health and social costs associated with this behavior, it is important to understand why increasing numbers of adolescents are choosing to smoke. In this paper, we address this important social issue from a decision-making perspective. We begin the paper with an overview of several prominent models of decision making, and discuss what they can and cannot tell us about adolescent smoking. In the second section, we propose a process-oriented model of decision making based on the concept of mental models, and explore the implications of this model for developing effective smoking prevention and cessation interventions.

Expectancy-Value Approaches to Adolescent Smoking Decisions

Decision making is the process of making choices among alternative courses of action. Most people make several important decisions about tobacco use during their lives. Nonsmokers face decisions about whether or not to smoke their first cigarette, regular smokers face decisions about quitting, and exsmokers face decisions about beginning again.

Over the years, numerous models of decision making have been proposed. Expected utility theory (EU), initially developed by von Neumann and Morgenstern (1947), represents one of the earliest of these models. According to the theory, the expected utility of a given choice is the sum of the subjective values attached to the possible consequences of the choice, each weighted by the probabilities that the choice will lead to those consequences. The theory can be displayed algebraically as follows:

$$E\,U = \sum V_i P_i$$

where V is the subjective value associated with a given outcome, and P is the probability that the outcome will occur. The theory predicts that when decision makers

are faced with several courses of action (e.g., smoking versus not smoking), they will choose the option that is most likely to bring them the most desirable outcomes or highest utility.

One important limitation of EU is that it assumes that the probabilities of outcomes are known exactly by the decisionmaker, an assumption that is violated in many real-world decision contexts. This limitation was addressed by Savage (1954), who extended EU to situations in which probabilities were uncertain. This new approach, known as subjective expected utility theory (SEU), relies on the same principle of expected-utility-maximization as EU. However, whereas in EU the probabilities of anticipated events are given, in SEU these probabilities are estimated by the decision maker. Thus, the formula for computing SEU is:

$$S\ E\ U = \sum V_i P_i$$

where (as in EU) V is the subjective value associated with a given event, and P is the subjective probability that the event will occur as estimated by the decision maker.

SEU is a very general decision model that can be adapted readily to decisions both to begin smoking (smoking initiation) and to quit smoking (smoking cessation). For example, when deciding whether or not to experiment with tobacco, an individual may (consciously or unconsciously) combine the subjective values and probabilities of several potential consequences associated with smoking (e.g., receiving peer approval, feeling mature, getting cancer, etc.) and not smoking (e.g., being ridiculed by peers, receiving parental approval, etc.). To the extent that the subjective expected utility for smoking outweighs the subjective expected utility for not smoking, the model predicts smoking behavior to occur. In terms of smoking cessation, the same basic logic applies: The smoker is faced with a choice between continuing to smoke and attempting to quit. If the subjective expected utility for quitting outweighs that for continuing, the model predicts that the smoker will attempt to quit.

Other Expectancy-Value Models

SEU has spawned a number of other decision models, which are collectively known as expectancy-value models of behavior (Stroebe & Stroebe, 1995; Sutton, 1987). Several of these SEU-derived models, such as the health-belief model (Becker, 1974), and protection-motivation theory (Rogers & Mewborn, 1976; Rogers, 1983), focus directly on health-related behaviors. Others, such as the theory of reasoned action (Fishbein & Ajzen, 1975) and the theory of planned behavior (Ajzen, 1988), are intended as more general models of behavior. A summary of the principal variables and combination rules used in each of these models is presented in Table 1.

As the expectancy-value label suggests, all of these models assume that anticipated outcomes, and in particular the values and probabilities placed on these out-

Table 1. Variables and Combination Rules for Expectancy-Value Models

	Variables and Combination Rule
Health-Belief Model	LPA = V + P + (B - C)
Protection-Motivation Theory	PM = (V + L - B) + (RE + SE -C)
Theory of Reasoned Action	BI = A + SN, where $A = \sum V_i P_i$
Theory of Planned Behavior	BI = A + SN + CO, where $A = \sum V_i P_i$

Note: For the health-belief model, LPA refers to the likelihood of preventative action, V refers to perceived severity of a specified negative health outcome (i.e., value in SEU terms), P is perceived personal vulnerability to the negative health outcome (i.e., probability in SEU terms), B is perceived benefit of taking preventative action, and C is perceived cost of taking preventative action. For protection-motivation theory, PM refers to protection motivation (the intention to engage in a preventative health behavior), V is perceived severity of a specified negative health outcome, L is perceived likelihood of the negative health outcome, B is perceived benefit associated with continuing the health-threatening behavior (smoking), RE is perceived effectiveness of preventative action (response efficacy), SE is the belief that preventative action can be effectively performed (self-efficacy), and C is perceived costs associated with engaging in the preventative action. For the theories of reasoned action and planned behavior, A is attitude toward the behavior defined in SEU terms, SN refers to the subjective norms associated with the behavior, and CO is perceived personal control over the behavior. For these last two theories, behavior is assumed to follow directly from behavioral intentions (BI).

comes, are important determinants of decision-making and/or behavior. Despite this basic similarity, expectancy-value models differ from one another in several respects (Weinstein, 1993). The most important of these differences include: (1) the extent to which nonexpectancy factors are incorporated into the models, (2) the specificity with which relevant outcomes are identified *a priori* by the model, and (3) the rules used in the models to combine variables to predict behavior.

Inclusion of nonexpectancy factors. Like SEU, the health-belief model assumes that behavior is completely determined by anticipated outcomes. No additional non-outcome-based variables are specified in either model. Contrary to this view, protection motivation theory, the theory of reasoned action, and the theory of planned behavior all assume that anticipated outcomes alone are not sufficient to fully account for behavior. All three models posit that the impact of anticipated outcomes on behavior is indirect, being mediated by behavioral intentions. According to the theory of reasoned action, behavioral intentions are determined by two main cognitive components: attitudes and subjective norms. Attitudes are defined in expectancy-value terms as a function of the perceived likelihood and value of personal outcomes stemming from a given behavior. Subjective norms are defined as the product of (1) peoples' personal beliefs about how important others want them to act, and (2) their motivation to comply with those expectations. Thus, according to

this model, expectancies about future outcomes are necessary but not sufficient to provide a complete account of adolescents' smoking intentions and behavior. The normative influence of significant others (e.g., peers, parents, teachers, etc.) also must be taken into account.

The theory of planned behavior (Ajzen, 1988) is an extension of the theory of reasoned action, and assumes that behavioral intentions are determined by a third cognitive factor in addition to attitudes and subjective norms. This third factor, perceived controllability of behavior, refers to the decision maker's perceptions of personal control over the successful completion of a behavior, a construct very similar to Bandura's (1986) notion of self-efficacy. According to the theory, low perceived control over a given behavior reduces the probability that intentions for that behavior will be formed. For example, in terms of smoking initiation, the theory predicts that adolescents who are more confident in their abilities to use tobacco successfully (e.g., lighting a cigarette without difficulty, not coughing, etc.) will be more likely to develop intentions to begin smoking. Similarly, smokers who believe that they lack the self-control needed to give up cigarettes should be less likely to formulate intentions to quit. The notion that perceived control (self-efficacy) plays an important role in determining health behavior intentions is also evident in protection-motivation theory (Rippetoe & Rogers, 1987; Rogers, 1983).

Specificity of outcomes. The health-belief model and protection-motivation theory both attempt to specify which anticipated outcomes are most relevant to predicting health behaviors. For example, the health-belief model is based on the assumption that people consider three main types of consequences when making health-protective decisions: the negative health consequences associated with current behavior; the perceived costs associated with taking preventative action; and the perceived benefits of taking preventative action. Protection-motivation theory assumes that the same three consequences are relevant, and adds a fourth: the perceived benefits of continuing the current health-threatening behavior.

Unlike these two health-behavior models, SEU makes no predictions about the specific types of consequences or outcomes that a person will consider when making a decision. Some people will base their decisions primarily on health outcomes, whereas others may focus more on the social and financial consequences of smoking. SEU simply provides a rule for combining value and expectancy weights for outcomes that have been identified as relevant by the decision maker. The same can be said for the theories of reasoned action and planned behavior, which define attitudes according to the general SEU model. This high degree of flexibility can be viewed as both a strength and a weakness of this approach. On the one hand, it implicitly recognizes the importance of individual and group differences in structuring decisions. On the other hand, it makes no attempt to specify what these differences might be.

Combination rules. As discussed earlier, SEU theory assumes that decision makers employ a multiplicative rule to compute the subjective expected utility associated with any given anticipated outcome, and an additive rule to combine these utilities across the set of anticipated outcomes associated with any given behavior. For the theories of reasoned action and planned behavior, attitudes are computed using the same combinatorial rules specified by SEU. In turn, attitudes are assumed to combine additively with subjective norms and perceived control to predict behavioral intentions. The health-belief model makes no assumptions about how the variables in the model should be combined to best predict behavior (Sutton, 1987; Weinstein, 1993). However, Seibold and Roper 1979 (cited in Stroebe & Stroebe, 1995) suggest that the simple additive model presented in Table 1 accurately reflects how most health-belief researchers discuss the model and analyze their data. The most recent revision of protection-motivation theory is also based on the assumption that the main variables in the model should be combined additively (Rippetoe & Rogers, 1987).

Empirical support for expectancy-value models. Numerous studies have applied the expectancy-value approach to tobacco use, and most have found expectancies (or attitudes defined in expectancy-value terms) to be important predictors of smoking intentions for both adults (e.g., Fishbein, 1982; Swinehart & Kirscht, 1966) and adolescents (e.g., Chassin et al., 1981; Chassin et al., 1984). Evidence linking expectancies to actual smoking behavior has been less consistent. Some studies report significant effects (e.g., Bauman & Chenoweth, 1984; Marshall, 1990; Mausner & Platt, 1971), whereas others do not (e.g., Godin et al., 1992). This pattern of results (i.e., expectancies consistently predicting smoking intentions but not smoking behavior) is probably at least partly attributable to the addictive properties of nicotine. Smokers who associate positive outcomes with quitting may develop strong intentions to quit, but their physiological addiction may make it difficult to sustain these intentions during withdrawal. Although, as we discuss later, other factors also likely contribute to the breakdown between intentions and behavior.

Several studies that have applied the theories of reasoned action and planned behavior to smoking have found subjective norms and/or perceived control over behavior (self-efficacy) to account for a significant amount of variance in smoking intentions over and above that accounted for by expectancies (e.g., Chassin et al., 1981; deVries, Kok, & Dijkstra, 1990; Fishbein, 1982). Comparisons of the relative importance of expectancies, subjective norms, and behavior control have produced mixed results. Some studies suggest that expectancies are the strongest predictor of smoking intentions (e.g., Babrow, Black, & Tiffany, 1990; Sutton, 1987), whereas others do not (Godin et al., 1992). Other nonexpectancy variables not specified by the theories of reasoned action or planned behavior (e.g., past experience with tobacco and previous quitting attempts) have also been linked to smoking intentions and behavior (Chassin et al., 1984; Sutton, 1987). This sug-

gests smoking decisions (intentions) may be only partly under the control of expectancies.

The significant relationship between overall expectancies and behavioral intentions and/or behavior reported in many smoking studies suggests that there is a degree of internal consistency between the consequences that people associate with smoking and the decisions that they make about smoking. However, it tells us little about which anticipated outcomes are most strongly related to smoking intentions and behavior. Several studies have addressed this issue. Brandon and Baker (1991) had 382 undergraduates provide value and likelihood ratings for eighty possible consequences of smoking. Principal components analysis produced four interpretable components, three of which discriminated between daily smokers and individuals who had never smoked. Daily smokers tended to provide higher value and probability ratings for items related to the positive reinforcing effects of smoking (e.g., pleasant taste, relaxation, enjoying life), the negative reinforcing effects (e.g., stress management, anger control), and appetite-weight control than nonsmokers. A similar study focusing on smoking cessation found that expectancies related to health, finances, social relations, and self-esteem discriminated between individuals who intended to quit smoking and those who did not (Sutton, Marsh, & Matheson, 1990).

A Mental Models Decision Framework for Adolescent Smoking

Although expectancy-value models of smoking have received considerable empirical support, as descriptive models of decision making they are limited in several respects. One limitation is that they tend to place too much emphasis on how expectancies are best weighted and combined to predict behavior, while telling us little about the actual cognitive processes involved in making a decision. A second related problem is that these models are not sufficiently grounded in cognitive theory. No attempt is made to provide an account of the basic information processing and memory processes that that underlie decision making. We believe that these basic processes represent an important key to understanding adolescents' smoking decisions, and provide a useful theoretical basis for developing effective smoking prevention and cessation interventions.

In this section of the article, we introduce the concept of mental models and propose a process-oriented decision framework based on this construct. We argue that our proposed framework extends the expectancy-value approach by addressing the two deficiencies outlined above. We also discuss the implications of this framework for developing effective smoking prevention and cessation interventions for adolescents.

Mental Models: An Overview

Various definitions of mental models have been offered. Jungermann, Schütz, and Thüring (1988, p. 148) defined mental models as "a mapping from a domain into a mental representation that contains the main characteristics of the domain." From a more functional perspective, Craik (1943) proposed that mental models are small-scale representations of external reality that enable organisms to

> try out various alternatives, conclude which is the best of them, react to future situations before they arise, utilize knowledge of past events in dealing with the present and the future, and in every way react in a much fuller, safer, and more competent manner to the emergencies that face it (p. 61).

A similar view has been offered by Johnson-Laird (1983, p. 379), who noted that "mental models enable individuals to make inferences and predictions, to understand phenomena, to decide what action to take and to control its execution, and above all to experience events by proxy." Finally, Rouse and Morris (1986, p. 351) described mental models as "the mechanisms whereby humans are able to generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states." Thus, a primary function of mental models is to enable the decision maker to mentally simulate possible future outcomes (i.e., develop expectancies) for different courses of action, without actually physically engaging in those actions. Based on the outcomes of the mental simulations, choices can be made about what constitutes the most appropriate course of action.

A Mental Models Decision Framework

Integrating previous work by Jungermann and Thüring (1987) on scenario production and by Furby and Beyth-Marom (1992) on behavioral decision theory, we propose the following process-oriented decision framework. A summary of the framework is presented in Figure 1.

Knowledge activation. The first step in the model involves the activation of knowledge stored in memory that is relevant to the decision at hand. Knowledge in memory is often conceptualized as a collection of nodes, representing concepts, linked together in a complex associative network (Anderson, 1983). According to these network models of memory, knowledge activation is a neurophysiological process in which an external or internal stimulus activates a node or series of nodes in the network. This activation is assumed to spread through the network activating related nodes. The stronger the relationship between concepts, the stronger and faster the activation is assumed to spread (Anderson, 1983).

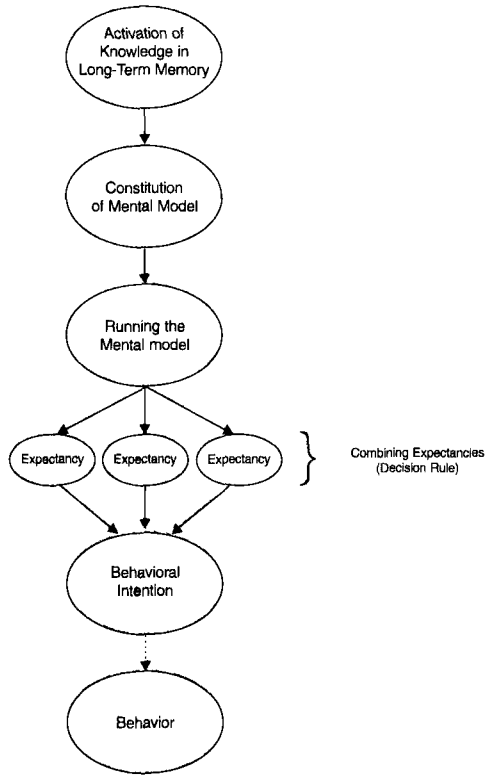

Fig. 1. A Mental models decision framework.

The knowledge activation step in the expectancy-generation process has several important implications for smoking decisions. First, in order to be activated, knowledge must first be present in memory. If an adolescent has no information related to lung cancer and heart disease, this information cannot be activated. Second, even if this information is present, there is no guarantee that it will be activated when a smoking decision is being made. Much depends on how health and smoking knowledge is organized in memory, and the strength of the associations between the nodes of these two knowledge domains. If the associations between nodes are strong, an appropriate stimulus should activate both types of knowledge. On the other hand, if the associations are weak or nonexistent, much of the decisionmaker's health knowledge will not be activated, and therefore have no impact on the decision.

Constitution of the mental model. The second step of the expectancy-generation process involves constituting a mental model from the knowledge activated in Step 1. As noted earlier, mental models describe the main concepts and rela-

tionships in a domain, and are used to generate inferences about possible future states within that domain. To construct a mental model, the decision maker must first retrieve elements and relations from the store of activated knowledge. In addition to simply retrieving relevant concepts and relations from memory, the model constitution process also may involve an element of constructive reasoning that enables the individual to move beyond the existing data. For example, even if a causal link between smoking and cancer is not present in memory, it is possible for this link to be created in the mental model through online processes such as those described by Kelley's (1967) covariation model of attribution.

It is presently not clear whether there are limits to the complexity of mental models. However, it seems reasonable that time constraints and motivational factors would restrict the number of concepts and relations included in a model for any given decision. This suggests that simply being active in memory is not sufficient to ensure a concept's inclusion in the mental model. A further winnowing process occurs in which only certain concepts and relations are selected. According to Jungermann and Thüring (1987), this winnowing process is accomplished primarily on the basis of salience. In general, knowledge that is novel, vivid, perceived to be relevant to the decision maker's goals, and that has been frequently activated in the past tends to be more salient and thus accessible (Fiske & Taylor, 1991). Tulving's (1983) encoding specificity principle suggests that compatibility between encoding-retrieval processes and contexts is also an important factor underlying accessibility.

Once again this has important implications for understanding adolescents' smoking decisions. Even if first-time smokers are knowledgeable about the negative health effects of smoking, and even if this knowledge is active in memory when they make their initial decision to smoke or not smoke, it still may not be included in their mental model if it is not sufficiently salient to displace other health-unrelated concepts (e.g., peer approval) that are also competing for inclusion.

Running the mental model. Once constituted, a mental model can be "run" to generate expectancies about possible outcomes. Jungermann and Thüring (1987) suggest that the running of a model involves several distinct steps, including: choosing a variable from which the simulation cycle can begin (i.e., the input variable); specifying the value of the input variable (e.g., starting to smoke versus not smoking, continuing to smoke versus trying to quit, etc.); searching for causally related variables (these searches can be either forward-directed to identify potential consequences of the input variable, or backward-directed to identify potential causes of the input variable); and specifying values for the simulated outcome variables on one or more dimensions (e.g., the probability and desirability of developing cancer later in life, of gaining peer approval now, etc.). Although decision theorists have identified probability, desirability, and time as the most relevant dimensions for evaluating possible outcomes, these dimensions, of course, are not used by all decision makers in all situations.

The number of simulations run for a given model will vary across contexts and individuals. If the decision is perceived to be important, there are few time constraints, and motivation is high, the decision maker may specify several different values for various input variables, repeatedly run the model, and systematically evaluate the resulting outcomes. However, given that adolescents' smoking decisions, especially those related to initial use, are often made in "high pressure" social situations in which there is little time to reflect upon one's choices, this type of systematic analysis is probably more the exception than the rule.

Combining expectancies using a decision rule. After running the model and simulating and evaluating one or more possible outcomes, the next task for the decision maker is to integrate the simulated information using a decision rule. Several examples of decision rules were outlined in the first half of this paper. For example, the combination rule for SEU involves multiplying probability and value ratings for each simulated outcome, and summing the products across all outcomes. On the other hand, the health-belief model is based on a rule in which probability and value assessments are summed rather than multiplied. Although decision researchers have relied almost exclusively on multiplicative and additive rules to predict behavioral intentions and behavior, as Furby and Beyth-Marom (1992) point out, other types of rules are, in fact, possible. For example, to minimize personal risk, they suggest a rule that would eliminate all actions that have a chance, no matter how small, of producing a large negative outcome. Given the absence of studies comparing the predictive utility of additive and multiplicative combination rules (Weinstein, 1993), and the possibility that decision rules often may be applied subconsciously (Furby & Beyth-Marom, 1992), it is presently not clear which rules might best account for adolescents' smoking decisions, and whether or not these rules generalize across individuals and contexts.

Behavioral intention and behavior. Once a decision is made and a behavioral intention is formed, the corresponding behavior may or may not follow, depending on a variety of factors. For example, after developing intentions to experiment with tobacco, a young adolescent may be denied access to cigarettes by peers, siblings, or parents. Similarly, an experienced smoker may decide to quit, only to have his resolve weakened by withdrawal symptoms. The tenuous link between decision making and behavior is reflected by the broken line connecting these two concepts in Figure 1.

Implications for Smoking Prevention and Cessation Interventions

Despite significant advances in our understanding of the factors underlying adolescents' smoking behavior, most community- and school-based prevention and cessation programs report only modest success rates (Flay, 1987). Programs designed to educate adolescents about the negative health effects of smoking have

fared especially poorly (Bruvold, 1993; McCaul & Glasgow, 1985), with one notable exception being Project TNT's physical consequences program (Sussman et al., 1995). These less-than-encouraging results have led many researchers to conclude that altering expectancies is not an effective means of influencing adolescents' smoking behavior, and that this perspective should be discarded in favor of more promising approaches based on social influence and social learning. We believe that this negative assessment is premature. The mental models decision framework outlined in the previous section (see Figure 1) suggests that the path between providing new knowledge and changing behavior is full of potential obstacles. Nevertheless, it is a path that can be successfully navigated, provided sufficient attention is given to the processes underlying knowledge accessibility, expectancy generation, and the correspondence between intentions and behavior. In this section of the paper, we employ our framework to help explain why many previous smoking interventions based on the decision-making perspective have failed, and make suggestions for improving future interventions.

Our proposed framework suggests that adolescents' smoking intentions and behavior are primarily a function of their smoking expectancies, that is, what they expect to happen to them if they begin smoking, continue smoking, or quit smoking. Expectancies are assumed to be generated from mental models, which, in turn, are assumed to be constituted primarily from knowledge in memory, although the possibility of on-line construction of new knowledge is not ruled out. According to the framework, a number of factors may contribute to the high prevalence of tobacco use among adolescents.

Knowledge of negative smoking consequences is not present in memory, or knowledge is present but inaccurate. Knowledge gaps and misconceptions can negatively influence adolescents' tobacco use decisions in at least two ways. First, because current knowledge influences how new information is processed and interpreted, it may cause adolescents to misinterpret, discount, or in some instances completely ignore new information that could help them make better or more informed smoking choices. Knowledge gaps and misconceptions may also lead to the generation of inaccurate smoking expectancies, leading adolescents to engage in behaviors that may not be in their best interests. For example, many first-time smokers may incorrectly believe that experimenting with tobacco will not significantly increase their risk of becoming a regular smoker, when in fact there is considerable evidence to the contrary (e.g., Chassin et al., 1990; Russell, 1990).

At present, it is difficult to draw any firm conclusions about how much adolescents know about smoking and its effects. Several studies suggest that adolescents know that smoking is addictive and is a contributing cause of cancer (e.g., Northrup & Pollard, 1995; Viscusi, 1992). However, it is less clear whether they are equally knowledgeable about other negative health effects such as heart disease and emphysema. Little also appears to be known about the prevalence of smoking myths and

misconceptions among adolescents. Several studies suggest that adolescent smokers have a tendency to overestimate the number of their peers who also smoke (e.g., Petraitus, Flay, & Miller, 1995; Sussman et al., 1995). There is also evidence that misconceptions about smoking and cancer may be more prevalent in some cultural groups than in others (Crowe, Torabi, & Nakornkhet, 1994), suggesting the need for specialized intervention programs.

Adolescents' current knowledge has important implications for the implementation of smoking prevention and cessation interventions. If their knowledge is inaccurate and/or incomplete, our framework suggests that an important first step would be to provide them with accurate information. On the other hand, if knowledge is already reasonably accurate and complete, attention should be directed at ensuring this knowledge is accessible when smoking decisions are made, an issue that we turn to next.

Knowledge of negative smoking consequences is present in memory, but is inaccessible. The presence of smoking knowledge in memory does not guarantee that it will be available when smoking decisions are made. According to the semantic network model of memory outlined earlier, the probability that knowledge will be activated in a given context is a function of the number and strength of connections to other active nodes in the network. Interventions that do not encourage deep processing and cognitive elaboration are more likely to produce "weak" networks in which the new information is not well-integrated into existing knowledge. In such instances, contexts and stimuli that activate existing smoking knowledge (i.e., knowledge that currently guides decisions and related tobacco use) may not activate the new knowledge gained during the intervention.

Even if accurate smoking knowledge is present and active in memory, it will not automatically be incorporated into the decision maker's mental model of smoking consequences. As noted previously, a further winnowing process takes place in which only the most salient active knowledge is selected for inclusion in the model. This represents a significant challenge for anti-smoking interventions because, due to their immediacy, the positive social, physiological, and psychological consequences of smoking will often be more salient than the negative health consequences emphasized by most prevention and cessation programs (Sussman et al., 1995).

What steps can be taken to increase the probability that adolescents will incorporate "negative-consequence" information into their mental models when making smoking decisions? If salience is the main factor underlying knowledge selection, as Jungermann and Thüring (1987) suggest, several possibilities present themselves. One strategy for increasing the salience (and, hence, availability) of "negative-consequence" information is to present it in a novel and vivid manner. Rather than relying on dry technical reports and health statistics, interventions should employ innovative new teaching techniques that are more likely to interest and engage students. Such techniques might include multi-media decision support

systems, student video projects, smoking-related art projects, mock funerals for smokers, and other role-playing exercises (e.g., see Sussman et al., 1995). A second possible strategy to increase the salience of negative smoking consequences is to emphasize the personal relevance of this information. Given adolescents' predisposition to discount consequences that occur far into the future, it may be more effective to emphasize the immediate negative effects of smoking (e.g., bad breath, smelly clothes, peer disapproval, etc.) than to focus exclusively on long-term negative health effects, although this has yet to be demonstrated empirically (McCaul & Glasgow, 1985). A third possible strategy to increase salience involves repetition and rehearsal. Most models of memory (e.g., Anderson, 1983; Wyer & Srull, 1989) suggest that the more frequently a piece of knowledge is accessed from memory, the easier it will be to retrieve in the future.

Adolescents may "rationally" decide that smoking is in their best interests. Even if adolescents incorporate "negative-consequence" knowledge into their smoking mental models, they may still conclude that beginning or continuing to smoke is in their best interests. This might occur, for example, if satisfying particular social and/or psychological motives is perceived to be more important than avoiding the long-term negative health effects of smoking. In such circumstances, interventions should address the instrumental function(s) of smoking, and provide adolescents with less health-compromising alternatives for achieving highly desired outcomes. For example, social skills programs could expose adolescents to new strategies for gaining peer acceptance. If stress-reduction is identified as an important motive for smoking, relaxation and meditation techniques could be presented as alternatives.

Adolescents may develop strong anti-smoking intentions, but may be unable to translate these intentions into behavior. Even if adolescents decide that smoking is not in their best interest, other factors may intervene to prevent these good intentions from manifesting themselves in behavior. As noted earlier, physiological addiction is one factor that likely weakens the link between quitting intentions and actual quitting. In terms of smoking initiation, intentions not to experiment with tobacco may be undermined by a myriad of social influences that operate during adolescence. For example, consider the dynamics of a romantic relationship where one partner, a committed nonsmoker, is being pressured by the other to begin. The tenuous link between intentions and behavior suggests that, in many instances, simply educating adolescents about the negative consequences of tobacco (even if this is done using innovative procedures that ensure accessibility) may not be sufficient to significantly affect smoking behavior. Additional supports such as peer counseling and refusal skills training will also be needed to help ensure that anti-smoking intentions, once developed, are translated into behavior.

Conclusions

In the previous sections we have made several suggestions for designing more effective smoking prevention and cessation interventions based on our mental models decision framework. Many of the intervention features that we recommend are neither revolutionary nor particularly novel. In fact, many existing anti-smoking programs already incorporate at least some of these features. This leads to the question "If existing interventions are already doing what we suggest, why aren't they more successful?" Our theoretical framework suggests that, by themselves, none of the recommended features is sufficient to produce consistent or substantial shifts in smoking behavior. Teaching adolescents about the negative consequences of smoking may have little effect if this knowledge is inaccessible when smoking decisions are being made. Similarly, increasing accessibility of "negative-smoking-consequence" knowledge would be expected to have only a limited impact on smoking behavior if supports are not in place to facilitate the translation of anti-smoking intentions into behavior. In short, our framework suggests that anti-smoking programs need to systematically address all of the obstacles outlined above to be effective, not just one or two, as has been the case with many past interventions.

Although space constraints prevent a detailed description of what a smoking prevention and cessation program based on our framework might look like, a brief overview of one possible incarnation is provided below. The program could consist of two main components: a multi-media knowledge-based decision support system (KB-DSS) and an in-school clinic. The KB-DSS would guide users through the process of identifying possible positive and negative consequences associated with smoking and not smoking, assessing the probability and desirability of each possible consequence, and combining this information using a decision rule that is consistent with the user's motives (e.g., maximizing subjective expected utility, minimizing risk, etc.). At each stage in the decision process, the KB-DSS would identify possible deficiencies in the way that adolescents structure their smoking decisions and make suggestions for improving them. For example, if users fail to consider important negative health, financial, or social consequences of smoking when structuring their decisions, the program would provide additional information about these factors and their relevance to the decision at hand. If the probability of certain negative consequences, such as cancer or heart disease, is underestimated, the program would provide more accurate estimates. If users' response patterns indicate that they smoke primarily to reduce stress or gain peer acceptance, the program would provide alternative strategies to achieve these ends. To help ensure that new knowledge provided by the KB-DSS will be accessible, the program could employ a multimedia interface designed to be attractive to adolescents and maximize cognitive engagement. To help ensure that anti-smoking intentions are translated into behavior, the KB-DSS could also provide personalized prevention and

cessation strategies based on users' responses. The in-school clinic could provide peer support and other resources to further strengthen the link between intentions and behavior. Testing would involve comparing the effectiveness of the proposed program with existing programs both in terms of the critical processes identified by the framework and smoking outcomes.

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