Cognitive and social learning models of drug dependence: implications for the assessment of tobacco dependence in adolescents

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ABSTRACT

This paper is part of a series that has the goal of identifying potential approaches toward developing new instruments for assessing tobacco dependence among adolescents. The fundamental assumption underlying the series is that contemporary theories of drug dependence offer a rich source of opportunities for the development of theoretically based assessment tools. The present paper focuses on cognitive and social-learning models of drug dependence and the implications of these models for novel assessment instruments. In particular, the paper focuses on Mark Goldman's model of drug expectancies, Albert Bandura's model of self-efficacy, Thomas Wills's model of stress and coping and Stephen Tiffany's cognitive-processing model of drug urges and cravings. In addition to traditional self-report measures, naturalistic and laboratory-based assessments are identified that may yield information relevant to multi-dimensional measurement of tobacco dependence.

KEYWORDS Adolescence, cognition, coping, nicotine dependence, self-efficacy, social learning theory, tobacco.

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INTRODUCTION

Given that long-term tobacco use typically begins and accelerates during adolescence (UHDHHS 1994; DiFranza *et al*. 2000), it is vital for both theoretical and applied reasons that researchers strive to understand the processes underlying the development of adolescent tobacco use and dependence. At a minimum, this requires the availability of reliable and valid measures of tobacco dependence. Recent reviews of existing conceptualizations and measures of tobacco dependence have concluded that the field lacks such a theoretically derived, psychometrically sound research tool (Colby *et al.* 2000; Kassel 2000).

The first challenge to developing such a tool is to delineate the construct domains of tobacco dependence. Well-accepted descriptions of a nicotine dependence syndrome exist, such as the diagnostic criteria included in DSM-IV (APA 1994). Although these criteria are generic across substances, they are to a degree arbitrary and are descriptive rather than explanatory. Thus, their utility for furthering our understanding of the addiction process is limited. Fortunately, there also exists a range of theoretical explanations for tobacco dependence. One of many ways of broadly categorizing these explanations is as neurobiological models, classic learning models, cognitive social learning models, and models of social and cultural influence (Shadel *et al.* 2000).

The present paper is one of a series of three papers in this issue with the shared mission of identifying theoretically based approaches to measuring tobacco dependence. For the sake of this mission, models of dependence were divided (again very broadly) into models that emphasize (1) positive reinforcement mechanisms (see Glautier 2004; Tiffany *et al*. 2004); (2) negative reinforcement mechanisms (see Eissenberg 2004); and (3) social learning and cognitive constructs—which is the subject of this paper.

There are many cognitive and social learning models of substance use, and we briefly describe a select few of these below. However, these models tend to share a limited number of key constructs. We will describe these con-

Table 1 Summary of potential assessment strategies, in rough order of estimated near-term utility.

Expectancy
Develop tests of expectancy *accessibility*: reaction time tasks and self-generated expectancy statements
Quantify expectancy differentiation (i.e. scatter) on multi-dimensional scale
Determine whether light versus heavier smokers show different patterns of activation of expectancy network
Develop measure of implicit memory to assess expectancies not available to conscious awareness
Develop standardized laboratory tests of placebo responding
Self-efficacy
Develop context-specific measure of abstinence self-efficacy that is appropriate for adolescent smokers
Develop other self-efficacy assessments (e.g. resistance self-efficacy) for adolescents
Assess changes in the latent structure of ASE assessments across stages of tobacco dependence
Develop implicit memory tasks that assess automatic self-efficacy processes
Coping
Smoking Motive Questionnaire (Wills *et al*. 1999) reworded to emphasize motivation rather than expectancies
Also assess Smoking for Coping and Coping by Smoking via additional questionnaires or new, integrated questionnaires
Develop parallel instrument to assess use of cigarettes for positive reinforcement
Developed structured interview for assessing the above
Assess real-time, naturalistic coping using ecological momentary assessment
Assess coping in response to stress in controlled laboratory setting
Develop measure of implicit memory to assess cognitive accessibility of smoking as a coping mechanism
Develop measures of self-control, if research demonstrates that self-control is affected by dependence
Craving
Self-reported smoking automaticity.
Assess real-time, naturalistic smoking automaticity using ecological momentary assessment
Adapt laboratory-based tests of attentional bias, such as the Stroop or suppression task (Zwaan & Truitt 2000)
Assess variability in smoking topography (either naturalistically or in laboratory)
Laboratory tasks: dual processing and controlled processing
Psychophysiological measures

structs as they pertain to tobacco dependence and other substance use, and we will then select one contemporary theory that highlights each construct. Within the framework of each theory, we will consider the relevance to tobacco dependence (with a particular focus on their relevance to the development of dependence in adolescents), and identify potential implications for developing new measures of tobacco dependence. We stop short, in the present paper, of specifying exactly how these new measures should be constructed. However, we do offer our opinions about the potential utility of the various assessment strategies, and we summarize the strategies in Table 1. In the spirit of exploration that underlies this special series, we have assumed a broad, multi-dimensional conceptualization of dependence as well as a broad range of potential assessment approaches that is not limited to the typical short self-report measures.

SOCIAL LEARNING AND COGNITIVE MODELS

The social learning and cognitive models of addiction represent a loose collection of models, conceptualizations and constructs influenced primarily by social learning theory (Bandura 1977) and cognitive-behavioral principles of learning. Concise overviews of the social learning perspective on addiction can be found in the Social Learning Theory chapters by Abrams & Niaura 1987) and Maisto, Carey & Bradizza (1999) from the two editions of *Psychological Theories of Drinking and Alcoholism*. The key social learning concepts featured in these chapters include situational factors (environmental stimuli), social modeling, coping skills, self-efficacy and outcome expectancies.

There have also been attempts at more focused, integrative models of addictive behavior that draw heavily from social learning theory and cognitive psychology. We will provide three examples of such models. The first example is Marlatt's (1985) model of the relapse process. In this influential model, the distal cause of drug relapse is the presence of a 'high risk situation', which—due perhaps to prior conditioning—threatens an individual's sense of control and increases the risk of relapse. To avoid relapse, the individual must execute a cognitive or behavioral coping response, which in turn produces an increase in self-efficacy. If a coping response is not used, the individual experiences a decrease in self-efficacy and an increase in positive outcome expectancies for the initial use of the substance. These positive outcome expectancies are subjectively experienced as 'cravings' for the substance, and they lead to the initial use of the sub-

stance, referred to as a 'lapse'. The lapse, in turn, leads to cognitive dissonance ('I quit smoking, and yet I smoked'), guilt and the self-attribution of failure and weakness. This combination of reactions then increases the likelihood of additional substance use, or full 'relapse'.

A second example of an integrated model is provided by Niaura *et al.* (1988). As with the previous model, the initial precipitant of drug relapse is a contextual cue associated with drug use. This cue, moderated by affect state, produces a series of responses, including urges to consume the drug, positive drug outcome expectancies and physiological activation. This trio of responses threatens the person's self-efficacy both directly and via diminished cognitive and behavioral coping. Low self-efficacy then increases the risk of lapse and relapse.

These first two examples were both models of substance relapse. The third example, Cooper, Russell & George (1988), is a model of alcohol abuse and dependence. In this model, the proximal predictor of heavy drinking, and ultimately abuse and dependence, is drinking as a means to cope with stress and negative affect. The predictors of drinking to cope are both poor general coping skills and positive expectancies about the mood-enhancing effects of alcohol, as well as the interaction between general coping skills and positive expectancies.

These three examples are by no means exhaustive of the models of addiction derived from social learning theory. However, they illustrate how general social learning constructs have been adopted into more specific, integrative models. The particular postulated roles of the constructs may differ across models. For example, Marlatt & Gordon (1985) and Niaura *et al.* (1988) both view expectancies as a proximal cause of substance use, whereas Cooper *et al.* (1988) conceptualize expectancies as a distal, trait-like causal variable. Moreover, Niaura *et al.* posit a causal relationship between expectancies and self-efficacy, whereas Marlatt & Gordon do not.

Given the range and diversity of these integrative social learning models, we chose in this paper to focus not on these models, but instead on a select number of social learning constructs that appear across models. These constructs are coping, expectancies, self-efficacy and craving. Other elements of the social learning models borrowed from learning theory, such as situational factors (conditioned stimuli) are covered in the accompanying papers in this series.

The conceptualization of many of these social learning constructs continues to be influenced by contemporary cognitive science. That is, theories and methodologies from current cognitive research (such as implicit memory, cognitive capacity and controlled versus automatic processing) have been applied to the study of constructs such as craving (Tiffany 1990) and expectancies (Goldman 1999a). For this paper, we have chosen to emphasize these more contemporary theories whenever possible. Thus, for each of the cross-cutting constructs, we select one key contemporary theory and discuss its implications for the assessment of tobacco dependence.

The models and constructs discussed in this paper differ from many of those that are the foci of the accompanying papers in that, by and large, they have not been proposed as models of substance dependence *per se*. Instead, they tend to be described by their proponents as *contributors*, *predictors* or *markers* of substance use initiation, maintenance, cessation or relapse. However, within a broad, muilti-dimensional definition of dependence, such constructs can be viewed as at least indices of level of dependence. Indeed, from the perspective of these models, there may not be a clear threshold that demarcates dependence from heavy use. Rather, tobacco and other substance use may be viewed as occurring on a continuum of intensity, ranging from infrequent, casual use all the way through highly frequent, compulsive use, which others may label as dependence. Accordingly, this perspective of dependence occurring on a continuum has been adopted throughout this paper. Another challenge associated with the use of these constructs is that they have rarely been applied to the development of dependence. Instead, the bulk of the work on these constructs has focused on their role in cessation and relapse. However, we attempt to extrapolate, where necessary, to developmental trajectories.

KEY CONSTRUCTS

Expectancy

The notion of expectancy has great intuitive appeal. The formation of if-then hypotheses about our world can be seen easily as a vital aspect of the learning process and of our everyday functioning. Because of this appeal, the concept of expectancy has a relatively long history in psychology, beginning with Tolman (1932), and it has emerged in virtually every area of the field (Zuroff & Rotter 1985).

Within the study of addiction, conceptualizations of addictive behaviors, and alcohol abuse in particular, were influenced heavily by the cognitive and social learning theories of Rotter (1954), MacCorquodale & Meehl (1954), Bolles (1972) and Bandura (1977). Bandura's distinction between 'self-efficacy expectations' and 'outcome expectancies' has been especially influential to many in the field. According to this theory, an outcome expectancy is an individual's estimate that a particular behavior will lead to certain positive outcomes. An efficacy expectation is the belief that one can successfully execute that behavior (Bandura 1977).

When both self-efficacy and outcome expectancies are high, the individual should be motivated to perform the behavior. This expectancy dichotomy has generated an immense quantity of research in social, personality and clinical psychology—including addictive behaviors. However, several theorists have argued that the distinction is not as clear-cut as Bandura suggested (cf. Kirsch 1995; Maddux 1995). In this section we focus on outcome expectancies.

Expectancies have received a great deal of attention from alcohol researchers, who used the balanced placebo design to infer expectancies by partitioning the influences of pharmacology (alcohol or placebo administration) and instructional set (subjects told they were receiving alcohol or placebo) on observed responses to drinking (Marlatt & Rohsenow 1980). They also examined whether measured expectancies about the effects of drinking were related to indices of drinking motivation, such as onset of drinking, quantity and frequency of drinking, and success of alcoholism treatments (Goldman *et al.* 1987; Jones & McMahon 1998). More recently, tobacco researchers have also adopted these research approaches, often following the path forged by alcohol research (see Brandon *et al.* 1999). It is important to note that expectancies do not have to be accurate in order for them to motivate behavior. For example, individuals may consume alcohol in part because they hold expectancies that alcohol increases sexual arousal, when in fact it has just the opposite physiological effect (Crowe & George 1989). Similarly, a smoker's expectancies regarding tobacco's ability to reduce stress and negative affect, to facilitate social interaction, to relieve nicotine craving, to control appetite and weight gain, and so on, may motivate smoking behavior regardless of whether or not these expectancies hold true for the given smoker. It is sufficient that the smoker *believes* that they are true. Complicating the matter is that the expectancies themselves may in fact lead to some expected responses (Kirsch 1985; Juliano & Brandon 2002). Additionally, expectancies about the benefits of quitting smoking may influence quitting behavior in smokers (Sutton *et al.* 1987).

However, the expectancy construct can also be conceptualized more broadly than it has typically been by addiction researchers. Mark Goldman and colleagues consider 'expectancy' to refer to a fundamental process that influences all behavior. That is, they view expectancy as a label for memory in its most basic sense (Goldman 1999a). Thus expectancies, in their conceptualization, refer to information templates stored in the nervous system, as well as to the processing of this information to produce behavioral output (Goldman, DelBoca & Darkes 1999). These templates, or memories, prepare the organism for future circumstances based on their degree of similarity to circumstances already encountered. In this way, expectancies serve to organize and interpret input, and they also guide the organism's responses to that input. That is, this contemporary perspective considers expectancies to be an example of 'hot cognition', linked inextricably to affective and motivational processes. Because Goldman's model of drug expectancies includes and extends the conceptualizations used by many others in the field, we have chosen to work with his model in our discussion of expectancies and their implications for the assessment of nicotine dependence.

Self-efficacy

Self-efficacy refers to 'beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments' (Bandura 1997, p. 3). Although the term 'self-efficacy' originated in the work of Albert Bandura (1977, 1982, 1997), expectancies regarding whether or not one will succeed at a task have long been recognized as potentially important determinants of behavior (reviewed in Kirsch 1986).

According to self-efficacy theory (e.g. Cervone & Scott 1995; Bandura 1997), human behavior is not solely the result of previous learning (e.g. operant conditioning) and biological factors (e.g. genetics). Volitional thought processes, particularly self-efficacy beliefs, also play an important role in determining human action. (However, the causal role of self-efficacy has been challenged; Lee 1996; Wolpe 1978.) Indeed, self-efficacy is hypothesized to influence the goals people pursue, the effort they expend to achieve them, how long they will persevere when confronted with obstacles and the likelihood that specified goals will be achieved (Bandura 1997, 1999). Although self-efficacy to perform a task may be based partially on the success or failure of previous attempts to perform that task, it should not be redundant with this experience. Thus, self-efficacy should be predicted by previous behavior *and* retain unique variance that predicts future behavior.

Self-efficacy is not proposed as a global trait (e.g. self-esteem), but rather is hypothesized to vary across behavioral domains. Due to this, identifying appropriate domain-specific 'targets' (i.e. the actions or tasks to be completed) is required for the measurement of self-efficacy. These targets may vary both in content and specificity according to the phenomenon under study. (In fact, determining the appropriate level of specificity for self-efficacy targets is a source of confusion and controversy; Devins 1992; Haaga & Stewart 1992; Maddux 1999.) For example, in the domain of smoking cessation, self-efficacy for abstaining from smoking in a variety of high-risk situations and self-efficacy for completing the tasks necessary for maintaining abstinence (e.g. refusing an offer of cigarettes, avoiding situations where others are

smoking) could both be measured. Bandura (1997) and others (Cervone & Scott 1995) suggest that multiple targets within any domain of behavior may be appropriate for assessment. However, predictive power is maximized when the targets closely match the behavior or goal of interest (Cervone & Scott 1995; Bandura 1997).

Bandura's conceptualization of self-efficacy has been directly adapted for addictive behaviors, with little revision. Although integrative models (e.g. Marlatt & Gordon 1985; Niaura *et al.* 1988) provide different accounts of how self-efficacy should interact with other variables to predict behavior, the fundamental aspects of Bandura's theory remain intact. Therefore, Bandura's general model will be used to organize our discussion of self-efficacy. However, we will also draw heavily on influential reviews and integrative models addressing the association between self-efficacy and addictive behaviors (DiClemente 1986; Abrams & Niaura 1987; DiClemente *et al.* 1995; Marlatt *et al.* 1995).

Coping

Coping models of substance use all postulate that people use substances to cope with stress in their lives. This approach differs from behavioral models, which consider substance use a learned response to social cues and pressures (Biglan & Lichtenstein 1984) and deviancy models, which view substance use as a rejection of conventional values and behaviors (Jessor & Jessor 1977). Across the various coping models, substance use is hypothesized to fulfill three major categories of coping functions. First, substances are used to regulate affect through both positive affect enhancement and negative affect reduction (Wills & Shiffman 1985; Brandon *et al.* 1996). Secondly, substances are used for distraction. For example, alcohol can be used to escape from self-awareness (Hull & Bond 1986; Steele & Josephs 1990) and cigarettes can be used to reduce boredom (Brandon & Baker 1991). A third coping function is performance enhancement, which for nicotine has taken the form of increased attentional focus and enhanced performance of well-learned behaviors (e.g. Heishman 1999). These coping functions (and expected coping functions) are also central to expectancy models of both alcohol (Goldman *et al.* 1999) and nicotine (Brandon & Baker 1991).

Most coping models of substance use have built upon the transactional model of Lazarus & Folkman (1984). The transactional model distinguishes between problem-focused coping and emotion-focused coping, and both types of coping are hypothesized to protect against substance use. Problem-focused coping mitigates stress by reducing the amount and severity of problems that cause stress, whereas emotion-based coping reduces the amount of experienced stress.

Subsequent models of coping shifted focus toward the distinction between active coping and avoidant coping (e.g. Roth & Cohen 1986; Moos & Schaefer 1993). Active coping is conceptualized as any form of coping that requires an investment of effort aimed at dealing with a problem, whereas avoidant coping is defined by disengagement and lack of effort. In general, coping models predict that active coping will lead to desirable outcomes whereas avoidant coping will lead to undesirable outcomes (e.g. Blechman & Wills 1992). One paradox of these models is that substance use is both an avoidant coping mechanism and a negative outcome resulting from other forms of avoidant (i.e. ineffective) coping.

The stress–coping model of Wills (e.g. Wills & Hirky 1996) was selected as the focal model of this section for several reasons. First, the Wills model builds upon previous models of coping and integrates the important elements of these models. Secondly, the Wills model addresses explicitly the topic of substance use, whereas other coping models tend to be more general in scope. Thirdly, the model is instructive with regard to defining and assessing nicotine dependence and the development of nicotine dependence.

Craving

The notion that postcessation drug cravings contribute to the problem of relapse has considerable theoretical support (Fletcher & Doll 1969; Wikler 1977; Siegel 1999). In line with this, the construct of craving has played an important explanatory role in historical and contemporary conceptualizations of drug addiction. Theories of craving generally presume that urges vary widely among individuals, are associated with the activation of a hedonic emotional state and serve to motivate actual drug-seeking behavior (Tiffany 1990). Models of drug craving can be divided loosely into withdrawal-based models (Wikler 1948; Siegel 1999) and appetitive models (Stewart *et al.* 1984; Wise 1988; Robinson & Berridge 1993). These models all draw heavily upon classical conditioning processes.

That individuals continue to experience drug cravings sometimes long after the acute withdrawal period has ended highlights a potentially important role for the contribution of basic learning processes. The cue-reactivity paradigm assumes that stimuli paired reliably with the administration of a drug (e.g. drug paraphernalia, temporal cues, environmental cues) become conditioned stimuli and therefore are able to elicit conditioned responses in the absence of administration of the actual drug (i.e. the unconditioned stimulus) (see Carter & Tiffany 1999). Conditioned stimuli are therefore thought to play an important role in the emergence and maintenance of drug use and dependence (Tiffany 1995).

In contrast to conditioning-based models of craving, Tiffany's (1990) cognitive processing theory of drug use and craving proposes that the processes subserving actual drug use behavior often operate independently of those that govern urges or cravings to use a drug. Rather, cravings and actual drug use are thought to be controlled by automatic and non-automatic cognitive processes (Tiffany 1990, 1995). Assessment implications of the conditioning-based models of craving are addressed in other papers in this series. We have selected Tiffany's model to represent the craving-based approach to assessing nicotine dependence because it provides an alternative, cognitive focus on craving.

THE MODELS AND THEIR IMPLICATIONS FOR ASSESSMENT

Goldman's expectancy model

As noted above, Goldman views expectancies more broadly than has been typical of most other addiction researchers. In his view, expectancies are fundamental elements of memory that organize input to the central nervous system and guide behavior. According to Goldman's conceptualization, expectancies serve as both moderators (e.g. moderating the role of stress on alcohol use) and mediators of other variables that play a causal role in drug use. In fact, expectancies can be viewed as one 'final common pathway' by which genetic predisposition, social and cultural information, affective state, personality and so on, influence drug use and abuse (Goldman *et al.* 1999).

Although expectancies have been measured typically (especially in the substance abuse field) via self-report—and thus assumed to be accessible to conscious awareness, or to require focused attention—there is nothing about the model that requires this. In fact, given the quantity of information that must be processed, and the speed required for much of this processing, it may be argued that expectancy-based control systems are 'automatic', functioning via parallel processes, and operating largely outside conscious awareness (cf. Roehrich & Goldman 1995; Stein *et al.* 2000). The degree to which this occurs limits the potential validity of self-report measures.

Moreover, Goldman and colleagues have found that a contemporary mathematical information processing model of affect can be applied equally well to expectancies (Rather & Goldman 1994). That is, affect (or expectancy) can be mapped within a two-dimensional model (e.g. arousal and valance) that represents patterns of expectancy activation. In fact, using multi-dimensional scaling techniques to map patterns of expectancy activation, they have found that heavy and light drinkers demonstrate different activation patterns. Specifically, heavy drinkers appear to associate alcohol with expectancies of positive arousal, whereas light drinkers associate it with expectancies of positive sedation.

Relevance to nicotine dependence and its development

Drug-related expectancies are traditionally described as risk factors for the use and abuse of drugs, rather than representing dependence *per se*. For example, expectancies develop before an individual's initial experience with a drug (Christiansen *et al.* 1982). Holding positive expectancies related to drug use increases the probability that an individual will initiate drug use (Christiansen *et al.* 1982) and that they will have poor cessation outcomes (Brown 1985, 1993; Rather & Sherman 1989). These relationships hold for tobacco as well as alcohol and other drugs (see Brandon *et al.* 1999), and they are reciprocal. That is, not only do expectancies influence drug use, but drug use enhances expectancies (Bauman & Chenoweth 1984; Smith *et al.* 1995). Because the magnitude of drug-related expectancies is correlated with traditional measures of dependence and use, expectancy can easily be conceptualized as a correlate, or marker, of dependence among current drug users, even if it not a direct measure of dependence.

However, if expectancy-based control systems are unconscious and automatized, as Goldman suggests, this automatization may in fact be the essence of drug dependence, accounting for such symptoms as loss of control, craving (cf. Tiffany *et al.*'s (2004) model of craving described in this paper), behavioral tolerance, difficulty quitting, and so on. In theory, development of such an automatized network of expectancy activation should correspond with the development of these common symptoms of drug dependence.

Based on Goldman's model of drug expectancies, as well as research on alcohol, tobacco and other expectancies, the following two general changes should occur as a smoker develops dependence on nicotine. First, positive smoking-related expectancies should increase in magnitude. This is consistent with research showing a correlation between level of smoking and strength of expectancies (Brandon & Baker 1991; Copeland *et al.* 1995) and showing that expectancy magnitude is associated with severity of withdrawal symptoms and poor cessation outcome (Wetter *et al.* 1994). In fact, based on these findings, Wetter *et al.* conjectured that expectancies may be a more sensitive index of dependence than traditional self-report or biochemical assays.

The other general change with the development of dependence is with the structure of the expectancy network itself. This might happen in several ways. Using factor analyses, Copeland *et al.* (1995) found that heavy smokers held more specific expectancies than did lighter,

Table 2 Hypothesized changes in expectancies associated with greater level of dependence.

Dependence-related changes in expectancies	Associated assessment approach
Magnitude of expectancies	
Positive expectancies become stronger	Magnitude of scores on self-report measures
	Magnitude of placebo responses
Structure of expectancy network	
More specific expectancy content	Variability (scatter) analyses of self-report scales
Different pattern of expectancy activation	Implicit memory tasks
Greater degree of automaticity	Measures of accessibility
	Implicit memory tasks

younger smokers. Whereas college students who smoked an average of 11 cigarettes per day yielded a factor structure of only four rather general expectancies (positive reinforcement, negative reinforcement, negative consequences and appetite/weight control), the heavier smokers who averaged over 25 cigarettes per day produced 10 different expectancy factors of greater specificity and homogeneity. For example, rather than the single positive reinforcement factor produced by the light smokers, the heavier smokers produced three more specific factors that included stimulation/state enhancement, taste/sensorimotor stimulation and social facilitation. This finding is consistent with alcohol research that also found that greater drinking was associated with the development of more specific and refined alcohol-related expectancies (Brown *et al.* 1980; Christiansen *et al.* 1982).

Another way in which the structure of the expectancy network itself might change as dependence develops is that patterns of expectancy activation may change, as suggested by the different patterns of expectancy activation that Rather & Goldman (1994) found between light and heavy drinkers. However, the basic cognitive mapping studies that set the groundwork for such comparisons have not yet been conducted with tobacco smokers.

Finally, as dependence develops, smoking behavior may be guided progressively less by conscious expectancies involving controlled processes (and assessable through self-report) and more by largely unconscious expectancies involving automatic processes. This conceptualization is consistent with recent models of Tiffany (1990), Oei & Baldwin (1994) and Brandon, Juliano & Copeland (1999), and it suggests a need to look beyond self-report measures of dependence, as we describe below. Table 2 summarizes the hypothesized changes in expectancies as dependence develops, along with associated assessment strategies.

Dependence assessments that follow from the model

Self-report. Expectancies have been measured traditionally via self-report instruments that gauge the strength of individuals' expectancies across a number of drinking outcomes. Several instruments exist for measuring alcohol expectancies (see Goldman *et al.* 1999), and the field has debated the utility of measuring negative expectancies along with positive expectancies, including a valence dimension and other psychometric issues beyond the scope of this paper (e.g. Leigh 1989). There has been less research on measurement of tobacco-related expectancies. However, two instruments that have been adopted by several researchers include the Smoking Consequences Questionnaire (SCQ; Brandon & Baker, 1991) developed for college-aged smokers, and the Smoking Consequences Questionnaire-Adult (SCQ-A; Copeland *et al.* 1995) developed for older, heavier smokers. These measures have shown adequate reliability as well as concurrent and predictive validity (Brandon & Baker 1991; Wetter *et al.* 1994; Copeland *et al.* 1995). However, neither of these instruments was developed to assess expectancies in very early stage adolescent smokers, although a recent brief version of the SCQ was developed and validated recently with adolescents (Myers *et al.* 2003). Bauman and colleagues have conducted expectancy research with this population, finding that a measure of subjective expected utility (SEU; an expectancy-value index) predicted smoking in adolescents (Bauman & Chenoweth 1984; Bauman *et al.* 1984; Bauman *et al.* 1989). Although the correlations were modest, the assessment instrument may have been handicapped by being unidimensional (i.e. positive and negative expectancies for a range of outcomes were included in a single scale) and by including the calculation of SEU rather than simply using the subjective probability ratings alone (cf. Brandon & Baker 1991; Copeland *et al.* 1995).

Brandon *et al.* (1999) made the distinction between relatively stable, 'generalized expectancies' and more phasic 'situational expectancies' that reflect current motivation to smoke. This distinction demonstrates the importance of choosing an assessment instrument that corresponds with the time-frame of the construct of interest. That is, if we are interested in using smoking expectancies as indices of dependence, and if we conceptualize

dependence as a relatively stable attribute, than we must be sure to measure generalized, rather than situational expectancies.

Another distinction in the measurement of expectancies may be useful. Structured self-report instruments, such as those described above, tend to measure the *availability* of expectancies as participants respond to items generated by researchers. Stacy and colleagues have argued that, in contrast to availability, expectancy *accessibility* should be more related to substance use, and that it can be assessed by allowing participants to generate their own drug use outcomes prior to rating the subjective probabilities of these outcomes (Stacy *et al.* 1996). Another approach to measuring expectancy accessibility is to time smokers' judgements about the expected consequences of smoking. Palfai (2002) had smokers respond as quickly as possible to a computerized presentation of expectancy-related phrases (e.g. 'Smoking makes me relaxed'), indicating whether or not the phrase was true for them. He found that speed of responding to the smoking-related phrases (relative to control phrases) was associated with number of cigarettes smoked per day, and it predicted urge to smoke following exposure to a smoking-related cue. Moreover, this reaction time measure predicted variance in smoking behavior above and beyond that explained by the self-report SCQ-A.

As a related issue, alcohol research has generally found that expectancies for positive outcomes have been more predictive of drinking behavior than have expectancies for negative outcomes (Stacy *et al.* 1990), perhaps because positive outcomes, which usually occur more immediately after substance use, are more accessible in memory. Copeland *et al.* (1995) concluded that positive smoking expectancies showed more construct validity than did negative expectancies and Brandon *et al.* (1999) suggested that positive expectancies may be prepotent in the daily, automatized maintenance of smoking, whereas negative expectancies may be more important for motivating a conscious decision to quit smoking. Therefore, when assessing expectancies as an index of dependence, it may be most effective to focus on positive expectancies.

Expectancy network. In addition to the assessment of conscious expectancies via self-report measures, contemporary expectancy theory suggests it would be worthwhile to assess the cognitive structure underlying expectancies, which is likely to change with the development of nicotine dependence. As discussed above, one change that is predicted is that smokers' expectancies become more discrete and specific as they gain experience with tobacco. At the group level, factor analytical studies have found that experienced smokers (Copeland *et al.* 1995) and drinkers (Brown *et al.* 1980; Christiansen *et al.* 1982) have a more differentiated expectancy network than less experienced users. In theory, the level of expectancy differentiation (ranging from only global expectancies, such as 'cigarettes are good', to fine-grained expectancies focused on specific consequences of smoking) may serve as an index of dependence. The degree of variability, or scatter, across an individual's scores on subscales of an expectancy questionnaire (e.g. the SCQ-A; Copeland *et al.* 1995) might provide an index of expectancy differentiation.

The other approach to assessing dependence level via the expectancy network first requires the type of cognitive-mapping studies conducted by Goldman and colleagues (Rather *et al.* 1992; Rather & Goldman 1994). Rather & Goldman (1994) found that heavy and light drinkers showed different patterns of expectancy activation. Heavy drinkers, when exposed to an alcohol stimulus, tend to associate rapidly many positive and arousing outcomes of drinking, whereas light drinkers associate more slowly sedating and adverse outcomes. If some similar differentiation were found with smokers, the nature of an individual's pattern of expectancy activation might serve as an indirect index of nicotine dependence.

Implicit memory. Techniques developed to assess implicit memory (Roediger 1990) provide an alternative approach to assessing expectancies that is consistent with the notion that the full cognitive expectancy network is not subject to conscious awareness (Goldman 1999a). Implicit memory tasks are those that indirectly reveal prior learning via performance that does not require conscious recollection. Reaction time and Stroop tasks are two common examples. These contrast with explicit memory tasks, such as self-report measures, that rely upon the subject's conscious awareness of memory. Rather than measure the magnitude of expectancies, as with self-report, implicit memory tasks allow an assessment of the accessibility and structure of the expectancy network. There is evidence that alcohol expectancy networks can be assessed through implicit memory techniques (Stacy *et al.* 1994; Weingardt *et al.* 1996; Palfai *et al.* 2000). However, the results from such studies to date have not shown effect sizes robust enough to be considered useful for individually based assessment.

Placebo responding. An indirect measure of expectancy content and strength is the magnitude of a smoker's responses to smoking a placebo (denicotinized) cigarette. Research has demonstrated that denicotinized cigarettes are capable of producing reductions in craving and/or withdrawal comparable to nicotine-containing cigarettes (Gross *et al.* 1997; Pickworth *et al.* 1999; Rose, Westman & Johnson 2000). Further evidence of placebo-responding can be found using balanced placebo design, a 2×2

factorial design in which the dosage of a drug (active versus placebo) is crossed with the instructions that subjects receive about the drug (that it is active versus placebo). The design allows the partitioning of a given drug effect between pharmacological and expectancy-related causes. It has long been a productive experimental design in the alcohol field (Hull & Bond 1986), although it is not without its limitations and controversy (Sayette *et al.* 1994). The lack, until recently, of a credible placebo cigarette has limited the use of the balanced-placebo design for tobacco research. Recently, however, the first such study was published, examining the influences of nicotine pharmacology versus expectancies on both the urge-reducing and anxiolytic effects of smoking (Juliano & Brandon 2002). Although strong nicotine effects were found for both responses, urge reduction was also significantly influenced by instructional set and, by implication, smoking-related expectancies. Instructional set also influenced anxiety reduction, but only when moderated by generalized expectancies assessed by the SCQ. That is, if smokers reported at baseline that they expected cigarettes to reduce anxiety, then they tended to report greater anxiety reduction when they believed that they had just smoked nicotine cigarettes, regardless of whether they had actually smoked nicotine or placebo cigarettes. There remain methodological challenges to overcome in adapting the balanced-placebo design from use with alcohol to tobacco, and it is far from certain that the design will have the necessary utility for assessing individual difference variables. Nevertheless, it is worth exploiting the design to test the pharmacological and expectancy-based effects of smoking on a range of tobacco-related outcomes. Aside from the theoretical insight afforded by this line of research, it at least has the potential to yield measures of smoking-related expectancies (and hence, indices of dependence) that are less dependent on face-valid questionnaires.

When assessing smoking-related expectancies, it may be important to distinguish between expectancies for nicotine *per se* versus expectancies for the full act of tobacco smoking. For most smokers, nicotine ingestion is linked closely to smoking behavior. (Alcoholics regularly drink liquids other than alcohol, whereas smokers rarely smoke non-nicotine products.) Therefore, most smokers may not hold well-developed expectancies for nicotine itself, but rather expectancies that blur the effects the pharmacological effects of nicotine with other social, perceptual and behavioral effects of smoking. This distinction was shown in a survey of smokers' expectancies about cigarettes versus nicotine replacement treatments (e.g. nicotine patch, nicotine gum) (Juliano & Brandon 2004). With the exception of urge reduction, smokers did not hold the expectancies for the nicotine replacement products that they held for cigarettes (e.g. negative affect reduction, appetite control). This distinction between nicotine expectancies and smoking expectancies needs to be kept in mind when translating previous research and instruments for alcohol into those for nicotine.

Bandura's self-efficacy model

As mentioned previously, Bandura's self-efficacy theory has been directly adapted to the domain of addictive behaviors. Therefore, his model will be used to guide this discussion. However, integrative models applying social-learning constructs to addictive behaviors (e.g. Marlatt & Gordon 1985; Abrams & Niaura 1987; Niaura *et al.* 1988) and reviews of the association between self-efficacy and addictive behaviors (DiClemente 1986; DiClemente *et al.* 1995; Marlatt *et al.* 1995) have been instrumental in this adaptation and will also be relied upon here. In Bandura's theory, self-efficacy is believed to mediate all behavior *change.* Accordingly, self-efficacy should be particularly important during the initiation, modification, and cessation of substance use; occasions when behavior is changing. The role of self-efficacy, if any, during behavior maintenance (e.g. regular substance use) is less clear.

Bandura's original work (1977) closely tied self-efficacy to changes in clinical functioning achieved as a result of psychological treatment. Thus, although it is presumed important for all behavior change, much of the research and theorizing regarding self-efficacy and substance dependence focuses on modification and cessation of use, rather than initiation (cf. Abrams & Niaura 1987). Furthermore, some authors (e.g. DiClemente *et al.* 1985; DiClemente *et al.* 1995; Dijkstra *et al.* 1996; Kraft, Sutton & Reynolds (1999) have linked self-efficacy and the 'stages of change' approach to modification of addictive behaviors (although this linkage has been criticized; Abrams *et al.* 2000). Because the stages begin typically with entrenched substance use and continue through extended abstinence from use, this research emphasizes cessation over initiation. Bandura's model indicates clearly that stronger self-efficacy beliefs should be associated with a greater probability of achieving and maintaining abstinence from smoking.

Bandura's conceptualization of self-efficacy acknowledges that the targets of a self-efficacy assessment can vary: different targets may be assessed (e.g. abstaining from substance use completely versus controlled use) and/or the same target may be assessed in a variety of challenging contexts (e.g. ability to abstain from substance use when with others who are using, when sad, or following a meal). In the addiction literature, self-efficacy measures tend to assess abstinence self-efficacy—confidence in one's ability to abstain from substance use. It has been suggested that the latent structure of ASE judge-

ments may vary, according to whether or not an individual is actively trying to change his or her behavior. For example, individuals who are engaged in changing their substance use may distinguish between contexts when making ASE judgements, whereas those who are not thinking about changing their behavior and those who have achieved long-term change may not (Velicer *et al.* 1990).

Relevance to tobacco dependence and its development

According to theory, self-efficacy plays a critical role in determining personal control: over thoughts, feelings, behaviors and the environment (Bandura 1997). This is important, as definitions of nicotine dependence refer to previous loss of control over smoking and/or difficulty refraining from smoking (DSM-IV; Fagerstrom 1978; APA, 1994; Colby *et al.* 2000). This suggests that self-efficacy may have an important relationship with tobacco dependence (DiClemente *et al.* 1995). In fact, if self-efficacy is a causal determinant of loss of control, it may be a core component of tobacco dependence.

Empirical studies suggest that self-efficacy is related to aspects of tobacco dependence. Among adults, abstinence self-efficacy is correlated significantly with smoking rate, such that those who smoke more frequently have less confidence in their ability to abstain from smoking (e.g. DiClemente *et al.* 1985; Baer *et al.* 1986). ASE is also associated inversely with cigarette craving (Niaura 2000). ASE reliably predicts the outcome of a smoking cessation attempt, even when concurrent smoking rate is controlled (e.g. Condiotte & Lichtenstein 1981; Baer *et al.* 1986; Stuart *et al.* 1994; Mudde *et al.* 1995; Shiffman *et al.* 2000; Gwaltney *et al.* 2001); stronger ASE is associated with a reduced probability of relapse. (However, no study in the smoking cessation literature has demonstrated a causal relationship between ASE and relapse.) Among adolescents, self-efficacy (for a variety of behavioral targets, see below) predicts the onset of smoking and progression from experimental to regular use (Lawrance 1989; Ellickson & Hays 1991, 1992; Conrad *et al.* 1992; Flay *et al.* 1998).

Although these studies are compelling, they do not address how self-efficacy changes over time in concert with the development of tobacco dependence. To answer this question, self-efficacy and other dimensions of dependence must be measured at multiple time points and their trajectories compared. However, before proceeding to this step, it will first be necessary to identify the appropriate targets for self-efficacy assessment. Several authors (DiClemente *et al.* 1995; Marlatt *et al.* 1995; Dijkstra & de Vries 2000) suggest that multiple targets may be relevant to smoking behavior; it will be important to (a) determine which are critical in the development of dependence and (b) if the different targets exhibit differential temporal changes as dependence develops.

Table 3 provides a listing of self-efficacy assessment targets and their potential relevance to the development of tobacco dependence. Abstinence self-efficacy is proposed as the most likely candidate for assessment, as (a) it is closely linked to the concept of control over smoking, a commonly used feature of dependence, (b) it may be an appropriate target at different frequencies of use, from early onset to regular use and (c) it may encompass other, more specific targets of assessment. (For example, it may capture both ability to refuse cigarette offers and ability to use coping strategies other than smoking to manage aversive situations.) Other self-efficacy assessment targets may be appropriate at different times as tobacco dependence develops. For example, resistance self-efficacy and acquisition self-efficacy may be important factors in determining onset of tobacco use (e.g. Conrad *et al.* 1992), but may be less relevant at higher levels of dependence. Of course, this is an empirical question; studies are needed to compare the trajectories of each self-efficacy assessment across different levels of tobacco dependence.

According to self-efficacy theory, ASE should demonstrate an inverse relationship with tobacco dependence: as dependence increases, confidence in one's ability to abstain from smoking (i.e. perceived control over smoking) should decrease. Based on studies of adult smokers (Velicer *et al.* 1990) it also seems likely that as dependence develops, ASE may become less variable. This can be determined only if ASE is measured across a variety of challenging situations. This type of assessment is endorsed by self-efficacy theory (Bandura 1997). At low levels of tobacco dependence, smoking may be confined to a few, specific contexts (Flay *et al.* 1998). Thus, ASE may be low in situations associated with smoking, but high for other situations. As dependence develops, however, smoking may occur in more situations and low ASE may generalize across these contexts.

Dependence assessments that follow from the model

Self-report: abstinence self-efficacy. Self-efficacy is measured exclusively by self-report, typically via ratings on a questionnaire (cf. Haaga 1989). A variety of ASE questionnaires exist in the literature on adult smokers. Although these measures may serve as a guide for the development of ASE measures among adolescents, it may be inappropriate to adapt them directly for use with this population. For example, among adult smokers, ASE is usually measured by asking individuals to rate their confidence in their ability to 'resist the urge to smoke' (e.g. Baer *et al.* 1986; Gwaltney *et al.* 2001) or 'avoid smoking' (e.g. Velicer *et al.* 1990) in a variety of affect states and

Table 3 Targets of self-efficacy (SE) assessments.

SE measure	Definition (confidence in ability to …)	Item example	Relevance
Abstinence SE (DiClemente *et al.* 1995; Gwaltney *et al.* 2001)	Abstain from smoking in various high-risk situations	Rate your confidence in your ability to abstain from smoking when feeling sad	High
Resistance SE (Marlatt *et al.* 1995)	Resist social pressure to smoke	Rate your confidence in your ability to refuse a friend's offer to smoke	Moderate
Coping SE (DiClemente *et al.* 1995; Dijkstra & de Vries 2000)	Cope with specific situations instead of smoking	Rate your confidence in your ability to be assertive with friends without smoking	Moderate
Acquisition SE (Marlatt *et al.* 1995)	Complete the various acts needed to smoke a cigarette	Rate your confidence in your ability to light a cigarette	Moderate
Control SE (DiClemente *et al.* 1995)	Control smoking rate in a variety of situations	Rate your confidence in your ability to not smoke heavily when with others who are smoking	Moderate
Action SE (Marlatt *et al.* 1995; Dijkstra & de Vries 2000)	Achieve goal of initial abstinence from smoking or reduction in smoking rate	Rate your confidence in your ability to decrease your smoking rate	Moderate
Treatment behavior SE (DiClemente *et al.* 1995)	Perform treatment-relevant behaviors	Rate your confidence in your ability to self-monitor your smoking	Low
Recovery SE (Haaga & Stewart 1992; DiClemente *et al.* 1995; Marlatt *et al.* 1995)	Recover from a lapse to smoking following a quit attempt	Rate your confidence in your ability to recover from a slip to smoking	Low

environmental contexts. Confidence in ability to avoid or abstain from smoking may be more appropriate for adolescent smokers, as the relationship between urges to smoke (i.e. craving) and smoking is largely unknown among this population.

Additionally, all the affect and environmental states used in adult ASE assessments may not be appropriate for use with adolescent smokers, especially contexts associated with alcohol use (Velicer *et al.* 1990; Gwaltney *et al.* 2001). Furthermore, contexts that are not assessed in adult measures may be important for adolescents, such as school contexts and leisure activities (e.g. playing video games). Lawrance (Lawrance & Rubinson 1986; Lawrance 1989) developed a multi-context self-efficacy assessment for adolescent smokers that may inform the selection of contexts for future ASE assessments.

When designing novel ASE assessments, researchers should be sure to avoid the limitations of previous measures. First, ASE assessments should distinguish clearly self-efficacy from other related constructs, such as intention to smoke. For example, Lawrance's (1989) assessment assesses the likelihood that one *would* or *would not* abstain from smoking in particular situations—a measure of intention. However, ASE measures should instead assess the degree to which one believes that he or she *can* abstain from smoking (Bandura 1997). This semantic distinction is subtle, but important: according to social-cognitive theories (e.g. Ajzen 1991), intention results from the synthesis of self-efficacy and other factors (attitudes and social norms) and, thus, is not redundant with self-efficacy. Also, difficulty abstaining from smoking (e.g. Unger *et al.* 2000) should be differentiated from ASE. Although the degree of difficulty involved in completing a task is certainly associated with self-efficacy, they are not redundant. For example, an individual may find it very difficult to fly on a plane, but may still be confident in their ability to do so because not flying would be associated with negative consequences (e.g. loss of job, not being able to see family).

According to theory (e.g. Bandura 1997), self-efficacy is not static; it may vary over time as an individual encounters changing situational demands. Integrative models of smoking initiation and relapse emphasize the situational nature of self-efficacy judgements (Marlatt & Gordon 1985; Abrams & Niaura 1987; Niaura *et al.* 1988). As mentioned previously, ASE questionnaires are designed typically to address self-efficacy across multiple contexts to identify this situational specificity. However, ASE has also been measured using an 'ecological momentary assessment' approach, where individuals rate their ASE in real-time, as they encounter situations in their natural environment (Shiffman *et al.* 2000). This assessment strategy may improve the accuracy of self-

efficacy assessments, as individuals are not required to envision future situations in making efficacy judgements; they need only report their ASE at the moment of assessment. Given similar situational demands, an individual with greater dependence may report weaker ASE than an individual with less tobacco dependence.

Self-report: other self-efficacy targets. Although we propose that ASE may be related most closely to the development of tobacco dependence, this association awaits empirical verification. In order to do this, it may be informative to compare the trajectories of different self-efficacy assessments (Table 3) during the development of dependence. As mentioned previously, some targets may be applicable at different levels of dependence. Acquisition self-efficacy and resistance self-efficacy may be particularly important in the early development of dependence, but then may plateau as dependence increases in magnitude. Conversely, action self-efficacy and control self-efficacy may be applicable only at higher levels of dependence, after an individual begins to smoke frequently. Coping self-efficacy may be applicable across all levels of dependence, but may be largely reflected and mediated by ASE. Treatment behavior self-efficacy and recovery self-efficacy may be applicable only among adult smokers, who are more likely to seek treatment and make serious quit attempts.

The development of these self-efficacy measures will benefit from following the guidelines for self-efficacy assessment development outlined by DiClemente *et al.* (1995). These guidelines encourage researchers to identify carefully the target of assessment and to examine the literature for similar assessments and use these as a model for new measures. New measures should also avoid the limitations described above in the description of ASE measures.

Latent structure of ASE assessments. ASE measures should assess an individual's belief that he or she can abstain from smoking across a variety of challenging situations. According to self-efficacy theory (Bandura 1997) and theories of relapse (Marlatt & Gordon 1985), ASE may vary across contexts. For example, an adolescent may feel confident that she can abstain from smoking when at home, but less confident when with friends who are smoking. Among adults, situation-specific ASE factors have been identified, measuring ASE in affect states and environmental contexts (e.g. Velicer *et al.* 1990; Mudde *et al.* 1995; Gwaltney *et al.* 2001). However, Velicer *et al.* (1990) note that this structure may vary according to whether or not behavior change is in progress: individuals who are not considering behavior change may rate most, if not all, contexts with extremely high or low self-efficacy (extremity response style).

This finding may have important implications for the development of tobacco dependence. As mentioned previously, the experimentation phase of smoking (Flay *et al.* 1998) may involve irregular smoking that is linked closely to certain stimuli. During this time, ASE judgements may vary significantly across contexts, resulting perhaps in a multi-factorial structure. However, as smoking becomes more diffuse and more frequent with dependence escalation, ASE strength and variability may decrease. This may result in a single, general ASE factor. Among adults trying to change their smoking actively a hierarchical structure has been identified, including both general and context-specific factors (Velicer *et al.* 1990; Gwaltney *et al.* 2001). To assess this possibility among adolescents it may be necessary to utilize confirmatory factor analysis techniques, as exploratory analyses are unlikely to identify this response pattern.

Are adolescent self-efficacy judgements meaningful? The cognitive processes underlying self-efficacy judgements are not well understood (Bandura 1997). However, efficacy judgements may result, at least in part, from explicit (i.e. conscious) identification, weighting and integration of relevant information (e.g. past experience, anticipated difficulty of the task, available skills; Bandura 1997). These 'higher-order' cognitive processes may be less well developed among pre-teens and younger adolescents, leading potentially to more error-prone self-efficacy judgements. If self-efficacy judgements are more error-prone they may be less likely to index tobacco dependence. For example, ASE ratings for negative affect contexts may be inappropriately strong if an adolescent fails to anticipate the desire to smoke in those contexts and to consider what alternate affect-regulation skills would be at his/her disposal.

While the potential for error in self-efficacy judgements is a concern, studies of pre-teens and young adolescents suggest that self-efficacy judgements meaningfully predict subsequent behavior. As mentioned previously, self-efficacy measures predict the onset and progression of adolescent smoking (Lawrance 1989; Ellickson & Hays 1991, 1992; Flay *et al.* 1998). However, these studies tended to utilize participants who were aged 12 years or older. While this may be an important time in the onset of smoking, some children may experience their first episodes of smoking prior to this age. Therefore, it is necessary to consider the validity of self-efficacy assessments in younger children. Interestingly, a meta-analysis of the relationship between self-efficacy and academic performance suggests that the efficacy judgements of elementary school children are less predictive of future academic performance than the judgements of high-school and college students (Multon *et al.* 1991). However, self-

efficacy was still associated significantly with academic performance among the elementary school students, suggesting the predictive validity of self-efficacy in this age group. The utility of smoking self-efficacy assessments in younger children is an important question for future research.

Implicit memory. Self-efficacy is measured typically via questionnaire, reflecting the conceptualization of self-efficacy as the result of effortful, non-automatic cognitive processes (explicit decision-making). Although this conceptualization and measurement strategy has demonstrable value, it is also possible that self-efficacy 'judgements' can be made in a much faster, automatic fashion (Cervone & Scott 1995). As challenging situations are encountered in everyday life, there is often no time for deliberate reflection and decision-making prior to action. Thus, behavioral choices may be based on heuristics that allow for rapid responses to emergent situations. Furthermore, explicit self-efficacy beliefs are hypothesized to be largely related to past mastery (or failure) experiences, vicarious modeling and verbal persuasion (Bandura 1997). Presumably, this information is stored in memory and accessed when a person makes a deliberate self-efficacy judgement. These memories may also guide more automatic self-efficacy processes.

These factors suggest that self-efficacy may be measurable via implicit memory tasks. To our knowledge, no study in the field of addictive behaviors has addressed this question. However, these measures may prove valuable in understanding rapid smoking-related decision making and the development of dependence. As dependence develops and self-regulatory failures increase, information regarding these failures may become more easily accessible, promoting further self-regulatory failures. We believe that this is a potentially fruitful area deserving of more attention.

Wills's stress–coping model

The classical model of Wills

The classical Wills model states that tobacco use (and other substance use) is affected and predicted by two major categories of influences: stress and coping. Stress occurs when 'the demands from the environment exceed the resources a person has available to meet those demands' (Wills & Filer 1996, p. 93). Stress is often associated with negative life events. Coping is divided into two broad classes: active and avoidant coping (defined above). Active coping serves as a buffer against substance use, whereas avoidant coping is frequently associated with increased substance use. There are, in addition, two other types of coping that do not fit neatly into these two categories: social support and religious coping.

The classical stress-coping model employs three basic propositions. First, stress is a risk factor at all phases of substance use: onset, escalation, maintenance and relapse (Wills 1990; Wills & Hirky 1996). The stress–substance use relationship obtains regardless of how stress is measured, although the relationship is strongest for major negative life events, intermediate for measures of subjective life stress and weakest for measures of daily hassles (Wills 1986). There is a number of potential explanations for the stress–substance use relationship, although all these explanations should be considered partial. One link between stress and substance use has been mentioned already: substance use can be used to regulate affect, both by increasing positive affect and mitigating negative affect (see Eissenberg 2004 for a fuller review of negative reinforcement and 'self-medication' models of dependence). Another possibility is that negative life events (which are stressful) lead to feelings of loss of control and perceived meaninglessness of life, which may in turn lead to substance use (Newcomb & Harlow 1986; Wills 1994). Negative life events may also decrease self-efficacy, which could lessen the ability to resist temptations to use substances. Future research is needed to more fully explicate these and other hypotheses. Although stress is a risk factor for substance use, it is neither a necessary nor a sufficient cause of substance use. Substance can occur in the absence of stress, and other factors other than stress are needed for substance use to occur. For example, the availability of a substance is a necessary condition for substance use.

The second major proposition of the Wills model is that how one copes with stress affects the likelihood that one will use substances. Active coping (problem solving, behavioral coping) decreases the likelihood of substance use and abuse, whereas avoidant coping (anger, disengagement, distraction) is a risk factor for substance use and abuse (Wills & Hirky 1996).

The third proposition states that people differ in the extent to which they believe that tobacco and other substances will help them alleviate life stress (see the expectancy section of this paper). People who believe that tobacco will be useful for dealing with stress are more likely to use tobacco and will be more likely to become dependent. According to this proposition, it is not necessary that smoking actually reduces stress, but only that smokers expect smoking to reduce stress. Coping functions for tobacco include: calming down when tense, cheering up when sad, helping to relax, helping to forget worries, improving self-confidence and relieving boredom. Evidence of these coping motives has been found for both adolescents (Wills & Cleary 1995; Wills *et al.* 1999) and adults (Cooper *et al.* 1995).

Revisions to the classical model

Recent years have seen revisions to Wills' classical stress–coping model. One revision is an increased emphasis on the role of dispositional factors in the stress and coping relationship. This revision was brought about by data revealing substantial correlations among measures of certain dispositional dimensions, life stress, coping processes and peer affiliations (Wills *et al.* 1995; Wills *et al.* 1998; Wills & Cleary 1999; Wills *et al.* 2000). According to the revised stress–coping model, early dispositional characteristics influence the development of self-control, which in turn affects the likelihood of negative life events and affiliations with deviant peers. Poor self-control is also associated with coping motives to use substances (Wills *et al.* 1999). Thus, an early dispositional proclivity toward poor self-control shapes a tendency to develop avoidant coping strategies, which in turn are predictive of substance use in later childhood and adolescence. Early dispositional self-control (or lack thereof) interacts with the socio-cultural environment. A favorable environment fosters the development of better self-control, which deters substance use (Wills *et al.* 1998). Unfavorable environments undermine the development of self-control, increasing the likelihood of coping motives for substance use (Sher & Trull 1994).

The revised Wills model also places greater emphasis on genetic and biological influences, which are hypothesized to contribute to an early temperamental predisposition towards poor self-control. This predisposition may lead to a greater willingness to initiate tobacco use, escalate tobacco use and associate with deviant peers. These early temperamental tendencies are mitigated by factors such as higher SES and a supportive family environment (Wills & Cleary 1996; Wills *et al.* 1996). However, when environmental conditions are unfavorable and an individual perceives tobacco use as a useful coping strategy, the likelihood of tobacco use and eventual nicotine dependence is increased.

Relevance to nicotine dependence and its development

The Wills model is relevant to initiation, maintenance and relapse of tobacco use (as well as other substance use). Dependence is not described or defined, but the model is informative with regard to dependence as conceptualized upon a continuum. The model posits that people use substances to cope, and that this leads to the development of dependence. That is, people become psychologically dependent on substances to cope with stress in their lives. Using substances to cope hinders the development of active (i.e. better) coping strategies, which leads to greater dependence on substances. The revised stress–coping model also emphasizes genetic and early dispositional factors as distal causes of dependence.

According to the Wills model, dependence develops as a person uses a substance to cope with life stress. Continued substance use forestalls the development of more healthy (active) coping strategies. Substance use begets further substance use and other forms of avoidant coping. Parental support is a buffer against life stress, and peer influences can have a variety of effects. If friends were substance users this could foster sustained or increased substance use, possibly resulting in dependence. The revised stress–coping model suggests that a predisposition for developing dependence can exist in early childhood in the form of poor self-control, and this predisposition may be partially attributable to genetics. The environment interacts with these genetic and dispositional factors, heightening or reducing risk according to the characteristics of a particular environment. A prediction that follows from the model is that, as dependence develops, the user progressively increases his or her reliance on the substance as a coping mechanism. Thus, in the case of smoking, level of dependence should be associated with the degree to which the individual uses cigarettes to cope with stress, to the exclusion of other more adaptive coping mechanisms. Consistent with the Wills theory, Kenford *et al.* (2002) recently found that smoking relapse was predicted by the interaction of (a) expectancies that smoking reduced negative affect and (b) ineffective coping mechanisms.

Dependence assessments that follow from the model

Smoking to cope. First, it should be reiterated that Wills' model is not a model of dependence, and does not describe or define dependence *per se*. The model does, however, describe processes and conditions leading towards and maintaining increasing levels of substance use. From these we can extrapolate indices of dependence. There are three related indices of dependence that follow from the model. The first index corresponds to Wills' construct of 'coping motives for smoking'. Wills and colleagues have developed the Coping Motive Inventory to measure this construct (see Wills *et al.* 1999). This instrument contains 15 Likert scale items divided into four categories. The four categories of coping motives are: self-enhancement (e.g. 'smoking helps you concentrate on things'), boredom relief (e.g. 'you smoke when there's nothing better to do'), affect regulation (e.g. 'smoking helps you calm down when you're feeling tense and nervous') and social (e.g. 'smoking makes it easier to be social with others'). High scores on at least the first three of these scales would be hypothesized to be associated with nicotine dependence. Note that these scales could equally well be derived from models of expectancies (see above) or negative reinforcement (see Eissenberg 2004).

In fact, the items are similar to the Negative Reinforcement scale of the Smoking Consequences Questionnaire (Brandon & Baker 1991). To move the instrument away from expectancies and toward a more direct measure of motivation, the items could be reworded in the format of, 'I smoke because . . .'.

Note that the Smoking Motive Inventory provides an index of the absolute magnitude of coping motives for smoking. It does not indicate the degree to which a smoker relies upon smoking as a way to cope with stress, or the degree to which coping is the dominant motivation for smoking. That is, in addition to the absolute magnitude of coping motives, it may be informative to know the *ratio* of coping motives for smoking to either (a) all coping mechanisms used by an individual or (b) all motives for smoking. The first of these represents the degree to which smokers use cigarettes, versus other more adaptive coping mechanisms, to cope with stress. We will call it the 'Coping by Smoking' index. A high value indicates an individual who has few available coping mechanisms other than tobacco use. It is easy to imagine that such an individual would be highly dependent on smoking, and that this ratio would be associated with level of dependence. The second ratio is the degree to which smokers' motives for smoking revolve primarily around coping with stress (versus other motives for smoking). We will call it the 'Smoking for Coping' index. A high score on this ratio indicates an individual who smokes primarily for coping reasons. A low value indicates that there are additional, non-coping motives for smoking (e.g. taste, weight control). Therefore, for any given values on the Smoking Motive Inventory and the Coping by Smoking index, a *low* value on the Smoking for Coping index may indicate a greater level of dependence.

The determination of these two ratio-based indices will require the measurement of general coping skills and general motives for smoking, in addition to their intersection as measured by Wills' Coping Motive Inventory. This could be accomplished by using new or existing measures of coping skills (e.g. Lazarus & Folkman 1984) or smoking motives (e.g. Ikard *et al.* 1969), or through the development of new open-ended or forced-choice self-report measures. For example, to measure Coping by Smoking, smokers could be asked to indicate how smoking ranks in comparison with other methods of dealing with life stress. Similarly, to measure Smoking for Coping, they could be asked to rank order their motives for smoking.

In addition to such self-report measures of coping by smoking, other assessment possibilities include the following. (1) Self-monitoring of smoking motives as they occur, perhaps using an ecological momentary assessment (Shiffman 2000); (2) semi-structured interviews, which allow for more ideographic assessment (see Coyne & Gottlieb 1996); (3) a laboratory-based behavioral assessment in which smokers' responses to a stressor (actual or imaginal) are measured with respect to self-reported urges and smoking topography (Payne *et al.* 1991; Brandon *et al.* 1996; Drobes & Tiffany 1997). As smokers become more dependent on nicotine to cope with stress, we would expect a laboratory stressor to produce greater craving, a shorter latency to smoke when cigarettes are made available, and more puffs of longer duration on the cigarette. (4) Implicit memory procedures might be used to assess the cognitive accessibility of smoking as a coping mechanism. For example, the procedure of Palfai *et al.* (2000) could be adopted. Participants would respond 'true' or 'false' as quickly as possible to computer-generated items from the Coping Motive Inventory (Wills *et al.* 1999). Cognitive accessibility scores would be calculated by subtracting the mean reaction time to the endorsed smoking items (i.e. items that were rated 'true') from the mean reaction time to control items (alternative coping techniques or unrelated items). The hypothesis would be that tobacco dependence would be associated with faster mean reaction times to the smoking-related coping items relative to control items.

Self-control. The Wills model suggests that poor self-control is a precursor for developing coping motives for using tobacco (Wills *et al.* 1999). Self-control is defined by concepts such as soothability, dependability, attentional focus and problem solving. Poor self-control consists of impatience, distractibility, impulsiveness and anger proneness. Instruments to measure these constructs have been employed in Wills' research (e.g. Wills *et al.* 1999). To the extent that self-control is a dispositional factor unaffected by smoking experience, it serves only as a risk factor for smoking in Wills' model and is not a useful index of current dependence. However, it is possible that smoking itself leads to further reductions in self-control. Indeed, Quinn, Brandon & Copeland (1996) draw upon Eisenberger's (1992) theory of learned industriousness to suggest that nicotine provides reinforcement for low effort behavior (smoking), leading to an increased resistance toward engaging in high-effort or frustrating behaviors. This, in turn, leads to a greater reliance on smoking and greater difficulty in quitting smoking. In an initial, cross-sectional test of this hypothesis Quinn *et al.* (1996) found that, as predicted, current smokers were less persistent than non-smokers on frustrating tasks. Additionally, it has been reported recently that task persistence among current smokers was associated with the success of their past smoking cessation histories (Brown *et al.* 2002). Smokers who had been unable to quit smoking in the past showed less persistence than those who had been able to abstain at some point for at least 3 months. Moreover, there is evidence that persistence measured prior to quitting smoking prospectively

predicted outcomes throughout 12 months of follow-up (Brandon *et al*. 2003), above and beyond a standard measure of tobacco dependence. Although this work is in its infancy, it is possible that self-reported and behavioral measures of self-control, such as task persistence, may reflect magnitude of tobacco dependence.

Positive reinforcement. Research on coping motives has indicated positive mood enhancement as one function of substance use (Wills & Shiffman 1985; see Glautier 2004). This raises the possibility that an index of dependence might be the degree to which individuals rely increasingly upon cigarettes (versus other activities) as a source of positive reinforcement, paralleling the measurement of the relative use of smoking for coping, or negative reinforcement, discussed above.

In conclusion, although the Wills model does not propose to define or assess tobacco dependence, it does have much to say about the development and maintenance of tobacco use. When considering the complexity of the construct of dependence, the Wills model provides insights not available from other sources. In particular, the Wills model places tobacco dependence within the larger context of how a person copes with stress. Extrapolations from the model suggest that assessment of a smoker's reliance on cigarettes as a coping mechanism might serve as a measure of developing dependence on tobacco, although such an approach has not yet been validated.

Tiffany's cognitive processing theory of drug use and craving

Overview

Tiffany's (1990) cognitive processing theory of drug use and craving holds that patterns of drug use are controlled largely by automatized action schemata in addicted users. These action plans are thought to vary in scope and coherence based on the addict's personal history with drug use. Over time and with repeated practice, they become increasingly integrated and efficient in contexts for which stimulus conditions are relatively fixed. As individuals engage repeatedly in the use of a drug over an increasing range of conditions, additional automatized action plans specific to these new conditions emerge. Drug use that is regulated by automatic processes tends to be bound to specific stimulus conditions, require little or no effort, are difficult to control in the presence of triggering stimuli and occur without conscious awareness or intention. Accordingly, the overall cognitive processing time required to perform the component behaviors that comprise drug use becomes markedly reduced.

The extent to which drug use becomes easily automatized depends largely on the extent to which a given drug is readily available and easily obtained by the addict. According to the theory, drug use that requires considerable planning or thought would be less likely to become controlled by automatic processes. Certain components of the behavior that are relatively routinized, however, may be controlled by automatic processes. For example, obtaining an illicit drug such as heroin may be relatively effortful and require careful planning and consideration, whereas the actual administration of the drug may be governed by a relatively automatic sequence of behaviors. Furthermore, characteristics of specific drugs are likely to influence the development of automaticity. A drug, such as tobacco, that is administered with a high frequency should become automatized simply as a function of repeated use.

As stated above, smoking or drug use that is under the control of automatized schemata is typically effortless and is performed without intention or conscious awareness. Theoretically, this phenomenon holds unless automatized smoking routines are interrupted or impeded. Once disrupted, non-automatic cognitive processing is usually required in order to resume the behavior. Non-automatic processing, in turn, gives rise to urges or cravings to use a drug. This point is key in that cognitive processes responsible for urges are theoretically independent of those subserving actual drug use. In other words, drug use would seem to occur under most conditions in the *absence* of urges or cravings. Rather, non-automatic processing is thought to give rise to urges under two primary types of conditions: (1) automaticity is blocked by some environmental condition for individuals not attempting to abstain from drug use or (2) individuals are attempting to intentionally obstruct an automatic action plan by abstaining from use. The first condition gives rise to 'abstinence–avoidance' urges and the second condition gives rise to 'abstinence–promotion' urges.

Abstinence-avoidance urges occur when individuals not attempting abstinence experience impediments to executing drug use action plans. Non-automatic cognitive processing ensues in an effort to solve the problem. Provided that these problems are relatively minor, they may actually become incorporated into the schema, thereby maintaining automaticity and suppressing urges. Relatively major obstacles that occur infrequently, however, are likely to require more cognitively effortful and deliberative processing of information.

Abstinence-promotion urges occur when non-automatic processing is intentionally employed in an effort to abstain from drug use. This renders attempts at avoiding drug use particularly difficult for the addict in that effortful cognitive processing required to disengage

automatized action plans inevitably gives rise to urges to use a drug. During attempts to abstain, addicts are required to inhibit well-practiced behavioral routines and are concurrently denied reinforcement previously contingent upon engaging in well-established action plans. Moreover, non-automatic processing that functions to block drug use theoretically impedes other cognitive activities that also require non-automatic processing of information.

Scope of the model

Tiffany's theoretical model is primarily a model of drug use maintenance and relapse rather than a model of dependence *per se*, although this distinction may be unimportant. Automatized drug use action plans develop over a repeated number of trials with a drug and are maintained as a function of continued use. Drug use under fixed stimulus conditions becomes fast and efficient and may be performed without effort, intention or conscious awareness. Therefore, use of a drug becomes an automatic and conditioned response in the presence of triggering stimuli. Automaticity is disrupted only in the presence of major obstacles to existing schemata. It is in this manner that automaticity functions to maintain drug use once action plans for drug use have been developed.

According to the model, relapse sometimes occurs when non-automatic cognitive processing required to maintain abstinence in the early stages of cessation is focused on some task other than avoiding drug use and environmental triggers to engage in drug use are present. That is, relapse may occur when individuals attempting abstinence are distracted and environmental conditions serve to activate a drug use action plan. Relapse may occur absentmindedly and without conscious awareness under these conditions (see Catley *et al.* 2000). Relapse may also occur when non-automatic processing is insufficient to suppress the operation of an existing drug use action plan.

Relevance to tobacco dependence and its development

Although Tiffany's model does not directly address the emergence of early drug dependence, certain theoretical mechanisms are relevant. The model predicts that automaticity should develop as the number of smoking trials increases, and therefore variability in smoking behavior should decrease with smoking experience. Variability between as well as *within* trials of cigarette smoking should decrease as the number of smoking episodes increases. Given that most of the trial-to-trial variability in smoking should occur relatively early on and that smoking-related behaviors should change little thereafter, automatized schemata for smoking should begin to develop over the course of an individual's relatively early experiences with smoking. It follows, then, that the cognitive structures underlying dependence should also begin to develop after an individual's experience with the first few cigarettes. Accordingly, most behavior change should occur here, suggesting that an important window of time for the assessment of early tobacco dependence may be during an individual's relatively early experiences with smoking. Clearly, the model conceptualizes dependence on a continuum that is linked closely to automaticity. That is, as dependence develops, automatized schemata specific to smoking should be richer, allow for greater flexibility and be better integrated overall.

Abstinence-avoidance urges are conceptualized to occur only when automatized drug use action plans are impeded. The relationship between urge responding and dependence is therefore expected to be curvilinear. That is, novice smokers with low dependence should experience relatively few urges to smoke early on in their smoking history, as automatized action plans have had little opportunity to develop. With advancing dependence, automaticity should be defined more broadly and become better integrated into smokers' daily behavior patterns. In turn, moderately dependent smokers should experience relatively more impediments to automatized smoking behavior, thereby increasing urge responding. Smokers should experience fewer urges to smoke as automatized schemata become even better developed and more richly defined because the schemata should be flexible and less vulnerable to abstinence avoidance urges. As such, urges should dominate moderate stage dependence, and should occur less frequently during very early stage and later stage dependence. It is important to note that, in contrast to abstinence-avoidance urges, abstinence-promotion urges should increase as a direct function of experience with smoking.

Dependence assessments that follow from the model

Self-report and self-monitoring. Self-report measures of urges and cravings to smoke would be important with both low and high levels of dependence. In the case of abstinence-avoidance urges, smokers with less experience should report fewer urges, smokers with a moderate level of experience should report greater urges, and smokers with extensive experience should perceive a reduction in urge responding. This pattern would be expected to map closely onto dependence, as smokers should become increasingly dependent on nicotine as they gain experience with smoking.

In addition to urge responding, self-report may be useful in assessing the automaticity of drug use. Experienced

smokers should report more features of automaticity than novice smokers. Therefore, report of automatized smoking behavior by relatively inexperienced smokers may serve as a marker for early onset tobacco dependence. Ikard, Green & Horn's (1969) measure of smoking motivation contains an automaticity factor that taps the absence of conscious awareness in automatized drug use. This factor is comprised of four items: (1) 'I've found a cigarette in my mouth and didn't remember putting it there'; (2) 'I light up a cigarette without realizing I still have one burning in the ashtray'; (3) 'I smoke cigarettes automatically without even being aware of it'; and (4) 'I smoke cigarettes just from habit, without even really wanting the one I'm smoking'. These items would appear to be useful in assessing one important facet of automatized drug use.

It is important to recognize, however, that urge and automaticity as they occur in the natural environment may be difficult to assess via traditional retrospective paper-and-pencil self-report measures. The use of *in vivo* self-monitoring via diaries or palm-top computers may be particularly relevant for this type of assessment (i.e. ecological momentary assessment; Shiffman, 2000). However, an important limitation of self-report approaches in general is that they are capable of capturing only those responses that are conscious. This becomes particularly problematic in attempting to measure automatized behavior in that a large proportion of the relevant responses are likely to occur outside conscious awareness (Tiffany 1990).

Laboratory paradigm. One possibility as a laboratory paradigm to assess dependence might be to measure time to complete a cognitively effortful task (e.g. solving difficult anagrams, solving complex mathematical problems) requiring controlled processing while smoking. Novice smokers with very low levels of dependence should, in theory, perform less efficiently, as cognitive processing required to smoke should attenuate the amount of cognitive resources available to devote to another simultaneous task. On the other hand, experienced smokers (who are highly dependent) should be capable of performing an effortful cognitive task with relative ease and without disruption, as relatively fewer non-automatic cognitive resources should be required of smoking behavior.

Smoking topography. Smoking topography (e.g. frequency, duration, strength and volume of puffs, duration of cigarette) should serve as a marker of automaticity in that smokers with more automatized routines should exhibit less variability in topography. Less dependent smokers should display more natural variability in smoking topography, as action patterns should be relatively less automatized and less flexible at this point. 'Stressing' the automatized action plans in the laboratory through the use of external stimuli and measuring disruption in topography may be a useful way to measure dependence. Relatively inexperienced smokers with little dependence would be expected to evidence greater disruption in topography compared to more experienced, more dependent smokers. Smoking topography can be measured by unobtrusive observation (counting and timing puffs; e.g. Payne *et al.* 1991) or by using cigarette holders containing pressure or flow transducers linked to computers (Kashinsky *et al.* 1995). An important limitation of this approach is that use of a smoking topography device is likely to disrupt automatized smoking patterns. It may therefore be necessary to allow for a period of adjustment to the device to ensure that individuals smoke naturally enough to allow the device to tap the proposed changes in topography. Fortunately, technological improvements are also leading to small, less intrusive and more portable topographic assessment devices (cf. Plowshare® Technologies, Baltimore, MD, USA).

Dual task processing. Tiffany (1990) suggested that smokers' performance on a probe reaction time (RT) task should reflect the extent that non-automatic processing is activated during an urge. Thus, probe reaction time in the face of an interruption to an automatized smoking action plan could be useful in assessing urge, and potentially dependence. Consistent with this, Baxter & Hinson (2001) found that experienced smokers displayed significantly slower RTs during tasks in which automatized smoking action plans were interrupted (i.e. pseudosmoking and holding) compared to a task in which smoking patterns were not interrupted (i.e. smoking condition) and a non-smoking task (baseline condition). Lending further support to the model, novice smokers' RTs were significantly faster during the non-smoking task (i.e. baseline condition) compared to two tasks that involved smoking (i.e. smoking and pseudosmoking conditions).

Automaticity should become more difficult to interrupt as smoking behavior becomes more and more automatized and action plans become increasingly complex and flexible. Thus, RT should correlate inversely with dependence. That is, heavier, more dependent smokers (versus lighter, less dependent smokers) should exhibit faster RTs because they may be able to allocate relatively less cognitive effort to the act of smoking, thereby allowing for the devotion of greater cognitive resources to reacting to a probe. Lighter, less dependent smokers should theoretically display slower RTs because the act of smoking requires a relatively greater amount of cognitive effort. On the other hand, if craving is correlated with dependence, heavier smokers may exhibit slower reaction times compared to lighter smokers following an imposed

period of abstinence (and the associated disruption of automaticity), as these individuals should experience stronger urges in the face of an interrupted action plan. In other words, RT should slow as urge magnitude increases.

In the case of interrupting successfully a very automatized action plan, the magnitude of the corresponding urge should be great, and the impact on RT should also be great. Consistent with Tiffany's model, several studies have found probe RT to be responsive to environmental manipulations intended to induce urge (Sayette & Hufford 1994; Sayette *et al*. 1994; Cepeda-Benito & Tiffany 1996; Juliano & Brandon 1998). However, associations between self-reported urge and RT measures have appeared only inconsistently within and across these studies. Thus, there is not as yet strong evidence that probe RT has utility as an index of urge, let alone dependence.

In assessing differences in urge responding (i.e. the amount and degree of urges occurring throughout the day) between experienced and inexperienced smokers, it would be important to equate for differences in urge-eliciting situations. Smokers' automatized smoking routines could be interrupted in the laboratory by delaying an expected smoking opportunity. Alternatively, degree of interruption could be manipulated through the use of audiotaped mental imagery scripts. That is, smokers could be asked to imagine scenarios in which smoking behavior is interrupted. Such imaginal procedures have been used successfully by Tiffany and colleagues (e.g. Drobes & Tiffany 1997; Conklin *et al.* 2000). The primary advantage of this method is that stimulus content and level of interruption reflected in the scripts can be modified easily (Tiffany 1990).

Psychophysiological responding. Tiffany (1990) proposed that certain psychophysiological indices such as heart rate reactivity (e.g. Carroll *et al.* 1986) should reflect the cognitive effort required of the non-automatic processes underlying urge responding. However, we do not view psychophysiological responding as a viable method for assessing degree of automaticity, given the multitude of factors known to influence such responding. In particular, besides reflecting cognitive effort, heart rate responses to a laboratory-based smoking challenge may primarily reflect conditioned responding consistent with the direct effects of nicotine (Niaura *et al*. 1988; Drobes & Tiffany 1997). Indeed, Tiffany (1990) ultimately reached a similar conclusion.

Attentional bias. Tiffany's (1990) model holds that automaticity develops through repeated exposure to smoking-related information, thereby creating a network of smoking-related concepts in memory. Heavier, more experienced smokers should therefore have more extensive networks of smoking-related knowledge in memory than do inexperienced smokers. It follows that experienced smokers who are more dependent on nicotine should have considerable difficulty inhibiting smoking-related information once these networks have been activated. On the other hand, inexperienced smokers with low dependence should have little difficulty inhibiting smoking-related information, as these memory networks should be relatively weak.

Employing a modified paradigm developed originally by Gernsbacher and colleagues (see Gernsbacher *et al.* 1990; Zwaan & Truitt 2000) investigated the hypothesis that smokers (versus non-smokers) might have more extensive smoking-related networks in long-term memory, thereby reducing the ability to inhibit smoking-related information once these networks were activated. They asked smokers and non-smokers to indicate whether probe words presented after computerized sentences were either related ('yes') or unrelated ('no') to the sentence presented immediately prior to the probe. Half the experimental sentences contained a final word that was smoking-related (e.g. tar, ashes), while the other half contained a final word that was unrelated to smoking. Results indicated that smokers, compared to non-smokers, exhibited relatively longer response latencies and fewer correct responses overall. No differences in performance emerged between smokers and non-smokers when the sentences and probes were unrelated to smoking. The authors concluded that smokers had greater difficulty than non-smokers in suppressing smoking-related information that was irrelevant to the task at hand, although they did not evidence greater difficulty suppressing irrelevant information overall.

The methodology of the Zwaan & Truitt (2000) study may be useful in assessing degree of tobacco dependence. Because one's personal history with smoking (e.g. duration and frequency of smoking) should impact the development of smoking-related networks in memory, more dependent smokers should have a relatively difficult time suppressing irrelevant smoking-related information, as networks in memory should be strong and easily activated. Smokers low in tobacco dependence, however, should have a relatively easy time inhibiting this information, as extensive smoking-related knowledge structures should not yet be present in memory.

Another potentially useful paradigm for assessing attentional bias in smokers is the emotional Stroop task. In this task smokers are presented with words written in different colors, but they are asked to ignore the meaning of the words and name only the color in which each word is written. The personal relevance of the words appears to affect the speed of subjects' color-naming. Smokers who

have temporarily abstained from nicotine have been found to be slower in naming the colors of smoking-related words compared to non-abstaining smokers (Gross *et al.* 1993; Waters & Feyerabend 2000). Moreover, color-naming interference was related inversely to time to first cigarette in the morning (often considered the best single-item index of physical dependence). That is, greater attentional bias was associated with smoking sooner after wakening. However, Stroop performance was unrelated to either daily or life-time consumption (Waters & Feyerabend 2000). A very recent study found that attentional bias indexed by the Stroop task predicted likelihood of smoking relapse (Waters *et al*. 2003). Thus, there is reason to believe that this task may assess an important element of tobacco dependence.

VALIDATION OF ASSESSMENT STRATEGIES

For the most part, the assessment methods suggested above have not yet been developed or validated. It will be important to establish the construct validity of these potential measures before they are adapted for widespread use. These measures are ideally suited for the use of the multi-trait–multi-method matrix in order to evaluate their convergent and discriminant validity (Campbell & Fiske 1959). To the degree that dependence is a unidimensional construct, or at least that there exists a common core essence of dependence that is captured by the various dependence measures proposed in this paper, convergent validity should be found across these measures, with the measures proposed in the two accompanying papers in this series (Eissenberg 2004; Glautier 2004) and with current measures of tobacco dependence (Colby *et al.* 2000). That is, the measures should covary, although their potential covariance is limited by the degree to which tobacco dependence is a multidimensional, rather than a unidimensional, construct. Ultimately, this is an empirical question best addressed by factor analytical-type techniques.

Special attention must be paid to the validity of these measures with respect to early smoking and low levels of tobacco dependence. Through cross-sectional studies the measures should be able to discriminate across smokers with varying degrees of smoking experience. More importantly, they should show predictive validity in prospective longitudinal studies. Thus, measure of tobacco dependence in relatively inexperienced smokers should predict the probability and speed of increased nicotine consumption, as well as the desire to quit smoking and the success at doing so.

It is quite possible that the validity of different dependence measures may vary with the level of tobacco dependence. Some measures (e.g. expectancies, automaticity) may be best able to discriminate among smokers with relatively low levels of dependence, whereas other measures (e.g. coping motives, tolerance, withdrawal symptoms) may be more useful with smokers having moderate or high levels of dependence.

PRACTICAL LIMITATIONS OF ASSESSMENT STRATEGIES

We have taken a liberal approach toward identifying the range of dependence assessment strategies that derive from the four selected models. For the most part, development and validation of the suggested strategies will be useful in the validation of the underlying theory, as well as providing potentially useful tools for assessing tobacco dependence. In fact, with the exception of the various self-report measures suggested above, many of the assessment strategies would be difficult to administer as a standard assessment tool in the field. Many are laboratory-based, involving specialized equipment or software. Thus, they would be cumbersome and relatively expensive to administer on a large-scale basis.

Because the models discussed in this paper are not explicitly models of drug dependence, we have had to extrapolate from the models to consider their relevance to dependence and to identify potential strategies for dependence-related assessment. Because these are, for the most part, indirect measures of dependence—at least as dependence is traditionally construed—they are likely to have limited utility for individual classification and diagnostic purposes. That is, any given assessment may account for a very small proportion of the variance of the dependence construct. As stand-alone measures, their utility may be greater as research instruments for theory-building and testing than as diagnostic tools. However, when combined with other dependence measures in a multi-modal, and perhaps multi-dimensional, assessment their inclusion may enhance the validity and utility of the assessment battery.

Finally, it is necessary to recognize that the hypothetical dependence-related processes discussed in this paper would not occur in a vacuum, but would be influenced by a host of other individual difference variables and contextual factors. Most relevant to the cognitive models are the cognitive capabilities of the individual. Given that initiation of tobacco use often occurs by early adolescence, the level or stage of the individual's cognitive development should influence the nature of the dependence-related cognitions. For example, both outcome expectancies and self-efficacy expectancies are based upon conditional (if–then) reasoning, which has been found to have developmental patterns—dependent upon factors such as the

capacity of working memory and the range of knowledge—although there is great variability across individuals (Markovits & Barrouillet 2002). Therefore, in younger children we would expect greater degrees of uncertainty and 'error variance' in the actual functioning of these cognitive processes, as well as in their measurement. Similarly, the limitations of children's prospective memory (memory for planned or anticipated events or actions) (Beal 1988) might interfere with planful stress coping as well as with actions motivated by self-efficacy or outcome expectancies. In particular, limited prospective memory may lead to decisions favoring immediate (rather than delayed) reinforcers, such as cigarettes. It is interesting that very little attention has been paid explicitly to level of cognitive development with regard to cognitive theories of addictive behaviors. This is an area that is ripe for additional research.

In addition to cognitive ability, probable moderator variables include demographic characteristics such as gender and socio-economic status (SES) and other contextual factors, such as the nature of one's peer group. This can be illustrated with three examples. First, females hold much stronger outcome expectancies than males regarding the appetite and weight-control benefits of smoking and these expectancies appear to be associated more with their motivation to smoke (Brandon & Baker 1991). Secondly, the range of stress-coping alternatives to smoking available to any adolescent is likely to depend, at least in part, on the adolescent's SES. Thus, a low-SES adolescent with fewer available coping options might be more likely to use tobacco smoking as a coping mechanism (cf. Vuchinich & Tucker 1988; Bickel *et al.* 1998) and thirdly, different peer groups in high school appear to differ in both their prevalence of smoking and their motivation for smoking (Mosbach & Leventhal 1988). These examples are by no means exhaustive, but they illustrate how the constructs discussed in this paper interact with other variables to influence tobacco dependence. A full assessment of adolescent tobacco dependence will need to consider such moderating variables.

SUMMARY AND CONCLUSIONS

This paper is part of a special series designed to identify potential measures of early tobacco dependence based upon existing theories of dependence. The implicit assumption underlying this endeavor is that dependence is a broader and more multi-dimensional construct than it has been typically defined, an assumption supported by recent research showing that standard measures of physical dependence to nicotine predict withdrawal symptoms and smoking relapse less well than do measures of negative affectivity, expectancies and coping (Gilbert *et al.* 2002; Kenford *et al.* 2002). Indeed, because the term 'nicotine dependence' tends to be associated exclusively with the pharmacological effects of nicotine itself, we have instead used the more inclusive 'tobacco dependence' throughout this paper. Thus, this series allows for both a re-examination of the parameters of dependence, as well as a theory-based exploration of new measurement options. Positive and negative reinforcement models of dependence were examined in accompanying papers (Eissenberg 2004; Glautier 2004). The present paper focused on cognitive and social learning models. Using major integrative models of substance use as a guide, we identified four constructs that were common to those models—expectancies, self-efficacy, coping and craving—and we examined each one from the perspective a currently influential theory. It is important to acknowledge the overlap between aspects of the constructs discussed in this paper. For example, elements of expectancy theory could be found in each of the other three constructs. Moreover, these constructs overlap a great deal with the positive and negative reinforcement constructs examined in the other two papers. In many cases it is the level of analysis that differentiates these constructs, although there may be disagreement over whether the cognitive, behavioral or physiological perspective is the most fundamental.

A special challenge of this particular paper was that none of the four theories considered herein have been explicitly offered as theories of dependence. Nevertheless, because they attempt to explain phenomena that are related theoretically to dependence—maintenance of substance use, ability to cease use, relapse to use, craving for the substance—we believe that the theoretical constructs are relevant to a broad, multi-dimensional model of dependence. Given the exploratory goal of this paper, we deemed it better to err on the side of inclusiveness of assessment ideas rather than to risk prematurely excluding potential strategies.

Our analyses of cognitive and social-learning models have revealed rich possibilities for developing multimodal assessments of adolescent tobacco dependence. In addition to the traditional approach of constructing or refining adolescent-specific self-report questionnaires, potential exists for novel measurement approaches. This includes implicit memory tasks, real-time assessment using ecological momentary assessment, analyses of inter- and intratrial smoking topography, responses to laboratory manipulations (e.g. use of placebo cigarettes; dual processing tasks) and assessments of memory structure in addition to content.

Table 1 provides a summary of the possibilities for assessing tobacco dependence that emerged from the four theoretical constructs examined: expectancy, self-efficacy, coping and craving. Within each construct, the

order of the assessment strategies represents our rough estimate of their potential near-term utility based on the integration of our estimates of (a) how close the field is to implementation of the assessment (based on existing research); (b) the magnitude of its potential construct validity; and (c) the pragmatics of the assessment (e.g. self-report versus complex laboratory paradigm). Of course, these are subjective judgements, and others might have ordered the assessments differently. Specifics regarding these potential assessment strategies can be found in the preceding sections of the paper. Although the table itself provides only a rough guide, it is our hope that the analyses presented in this paper will prove useful for stimulating the research and development of additional instruments for assessing tobacco dependence.

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