A multiple motives approach to tobacco dependence:

The Wisconsin Inventory of Smoking Dependence Motives (WISDM-68)

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Abstract

The dependence construct fills an important explanatory role in motivational accounts of smoking and relapse. Frequently used measures of dependence are either atheoretical or grounded in a unidimensional model of physical dependence. This research creates a multidimensional measure of dependence, that is based on theoretically-grounded motives for drug use, and is intended to reflect mechanisms underlying dependence. Data collected from a large sample of smokers (N=775) indicated that all 13 subscales of the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68) have acceptable internal consistency, are differentially present across levels of smoking heaviness, and have a multidimensional structure. Validity analyses indicated the WISDM-68 subscales are significantly related to dependence criteria such as smoking heaviness, and DSM-IV symptoms of dependence and relapse.

Despite the well-publicized dangers of smoking, some 46.5 million American adults currently smoke cigarettes (CDC, 2002). Smoking prevalence rates remain fairly high because once an individual smokes regularly it is unlikely that he or she will be able to quit easily. In 2000, 15.7 million adult smokers tried to quit smoking but only 4.7% of smokers who reported daily smoking during the previous year were abstinent for 3-12 months in 2000 (CDC, 2002). It is estimated that, on average, adolescent boys who start smoking now will smoke for approximately 16 years and adolescent girls who start smoking now will smoke for at least 20 years before being able to quit (Pierce & Gilpin, 1996). What is it that makes smoking so refractory despite the high personal costs that are eventually exacted by smoking?

Since the 1980s, broad scientific consensus has developed around the idea that smokers become dependent upon nicotine, and that tobacco dependence is in fact the primary factor maintaining smoking behavior among adult smokers (USDHHS, 1988). Consequently, tobacco dependence has been assigned a heavy explanatory and clinical burden – it is invoked to account for smoking withdrawal symptoms and relapse, individual differences in the nature of tobacco motivation, and as a guide to treatment assignment (e.g., Breslau & Johnson, 2000; Fagerström & Schneider, 1989; Killen, Fortmann, Kraemer, Varady & Newman, 1992; Niaura, Godlstein & Abrams, 1994). While dependence is certainly a crucial construct, there is little agreement as to its nature (Kenford, et al., 2002; Fagerström, 1978; Robinson & Berridge, 1993). Perhaps, if we could develop a clearer understanding of its nature and motivational mechanisms, we might be better-positioned to prevent its development in novice smokers and weaken its grip on dependent smokers. Achieving these

goals requires a systematic bootstrapping approach to establishing the construct validity of tobacco dependence measures (Cronbach & Meehl, 1955).

Such a research enterprise requires clear theoretical formulations of tobacco dependence, generation of a theoretically congruent measure(s), and systematic, iterative tests that determine whether the measured construct is related to other variables in a theoretically ordained manner. The results of such tests would guide the future refinement of the measure. Where theory-congruent relations are detected empirically, they corroborate both the construct and the measurement tool simultaneously. When these relations are not found, they must inspire re-examination of the dependence construct definition and/or the measurement tools developed to tap dependence.

To date, research in tobacco dependence has not followed this sort of orderly, iterative, bootstrapping approach to construct explication and measure refinement. To a large extent, the field has invoked the dependence construct without a clear specification of its nature or structure. Perhaps owing to this, investigators have, for decades, relied on a handful of relatively blunt dependence measures, even while bemoaning their validity and psychometric properties (e.g., Breslau & Johnson, 2000; Lichtenstein & Mermelstein, 1986). The slow progress of smoking cessation research (e.g., Piasecki & Baker, 2001; Shiffman, 1993a) may, in part, be attributable to the lack of a clear definition of dependence and an inability to measure it sensitively.

Two Traditions in Dependence Assessment

A meaningful measure should arise from careful consideration of the nature of the construct that it is intended to tap and the uses to which the measure is to be put. Disagreement about the meaning of the term "dependence" has plagued tobacco research,

and this has almost certainly slowed measurement innovation. There are two broad traditions in tobacco dependence measurement – one of which is based on a medico-psychiatric diagnostic tradition (e.g., APA, 1994) and one that is inspired by physical dependence models (e.g., Fagerström, 1978; see Colby, Tiffany, Shiffman & Niaura, 2000). These traditions differ in their assumptions about the structure of dependence and the explanatory burden they shoulder.

The medico-psychiatric tradition in tobacco dependence is exemplified by diagnostic criteria for tobacco dependence employed in recent editions of the Diagnostic and Statistical Manuals (DSMs; APA, 1980; 1987; 1994). In this tradition, dependence is essentially a binary variable – one is either dependent on nicotine or not. The presence of dependence is inferred (measured) by the display of various diagnostic criteria or features of the prototypic dependence syndrome, as determined by expert consensus (e.g., compulsive use of tobacco, craving or withdrawal symptoms contingent on abstinence). A tobacco dependence diagnosis is essentially a classification, not an explanatory construct. It is designed to identify persons in unselected populations who smoke heavily and persistently. For instance, a dependence diagnosis may be useful in epidemiological research to identify rates of dependence, comorbidity of dependence with other disorders, and so on. Tobacco dependence diagnoses tell us whether someone is or is not addicted to nicotine, but may offer little explanation as to why this is the case, and may be insensitive to differences among those labeled dependent.

A second approach has been to generate dependence measures based upon particular models of dependence. The widely used Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, and Fagerström, 1991) and the Fagerström Tolerance

Questionnaire (FTQ; Fagerström, 1978) represent examples of such measures. In this approach, dependence is construed as a continuously-scaled variable – persons are assumed to vary in the degree of their dependence. In contrast to the diagnostic tradition, the Fagerström scales <u>do</u> arise from a particular explanatory model of dependence; they development of these scales was guided by the belief that signs and symptoms of dependence (such as those codified in the DSM) arise from a physical dependence/tolerance process (which is thought to motivate compulsive use of tobacco; Fagerström & Schneider, 1989). Thus, the Fagerström scales are designed to assess gradations in dependence, and these gradations are assumed to reflect magnitude of physical dependence/tolerance processes.

However, there are limitations to the Fagerström scales: (a) their assumption that a single tolerance dimension is adequate to capture meaningful individual differences in dependence severity, and, (b) their psychometric properties. These scales are based on the assumption that the most important and predictive component of dependence is physical dependence (and resulting withdrawal severity). The FTQ and FTND do not attempt to assess directly more specific motivational factors that may affect the dependence construct: e.g., reinforcement value of smoking, magnitude of abstinence-induced urges. Thus, these instruments do not sample the universe of processes that addiction researchers have postulated give rise to dependence outputs. In addition, the Fagerström questionnaires directly assess smoking heaviness (e.g., How many cigarettes do you smoke each day?). When scores from these measures are used to predict common validation criteria that are proxies for smoking heaviness, e.g., breath carbon monoxide, criterion contamination may inflate the obtained correlations. This criterion contamination may create unfounded beliefs regarding what the Fagerström tests measure and how well they measure it.

Second, two psychometric concerns have dogged the Fagerström scales: poor internal consistency (e.g., α = .51-.55; Lichtenstein & Mermelstein, 1986) and questions about their structures (Lichtenstein & Mermelstein, 1986). Even when Heatherton, Kozlowski, Frecker, and Fagerström (1991) modified the FTQ and created the 6-item FTND, the internal consistency was only marginally improved to α = .61. While the FTND is more reliable than the FTQ (Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994; Payne, Smith, McCracken, McSherry, & Antony, 1994), the reliability coefficients are still below traditionally accepted standards for clinical use (Nunnally & Bernstein, 1994). Consistent with the low internal consistency, factor analyses suggest that the Fagerström scales may be multifactorial (e.g., Lichtenstein & Mermelstein, 1986; Payne, Smith, McCracken, McSherry, & Antony, 1994).

Despite the psychometric problems with the FTQ and FTND, they are both frequently used measures of tobacco dependence, perhaps because they are brief and because they measure smoking heaviness and predict efficacy of different doses of nicotine replacement (e.g., Fagerström & Schneider, 1989). However, a recent study by Garvey et al. (2000) showed that 4-mg gum did not significantly improve quit rates for high vs. low scorers on the FTND. In addition, while the FTND predicts smoking heaviness quite well, it is unclear that it predicts important dependence criteria such as withdrawal severity and blood cotinine level better than do measures such number of cigarettes smoked per day (Breslau & Johnson, 2000; Gilbert, Crauthers, Mooney, McClernon, & Jensen, 1999; Hughes & Hatsukami, 1986). This inability to predict important outcomes consistently, above and beyond those predicted by smoking heaviness per se, suggests that the Fagerström measures tap only a narrow aspect of dependence.[1]

Dependence as a Multifactorial, Continuous, Explanatory Variable.

The current paper describes the development of the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68), a measure intended to redress the shortcomings of previous tobacco dependence measures. The validation enterprise begins with theoretically-derived dependence subscales, and the implicit assumption that dependence is multidimensional. The current approach attempts to define and measure dependence based on *motivations*, derived from a broad sampling of theoretical domains, which might lead to compulsive or problematic drug (nicotine) use. Thus, the WISDM-68 measures the degree of different motivational forces present, which are intended to illuminate mechanisms underlying compulsive drug use. Motives are not equivalent to dependence, but in this measure, they are serving as indicators of the underlying latent variable of tobacco dependence.

We assessed *motives* for dependent or addictive tobacco use for several reasons. First, we believe that considerable research shows that dependence (as opposed to *physical* dependence) is, at heart, a motivational phenomenon. Dependence is not captured by the presence of internal states, behaviors or external situations alone, but instead by the organism's disposition to respond to such states or phenomena with drug use. This view of dependence accords with numerous observations such as the fact that medical patients may become physically dependent upon opiates, but unless the withdrawal syndrome spurs drug-seeking, other manifestations of dependence are not observed (Mansky, 1978). Similarly, states or events such as negative affects or exposure to smoking cues should not index dependence unless they spur drug (tobacco)-seeking. Therefore, we posited that the accurate

assessment of the level and type of dependence requires inferences about the strength of drug-seeking in the context of the motivational prod.

We also believed that the assessment of dependence motives would be more likely to reveal the multidimensional nature of tobacco dependence, especially across the ontogeny of dependence. This is because we believe that while motives for tobacco-seeking may differ both across ontogeny and across individuals, chronic tobacco use will inevitably produce a core set of manifestations that do not sensitively reflect these differences. Thus, chronic smoking will likely produce tolerance and personal costs (e.g., ill health) regardless of the motives that instigate use. These residues of dependence motivational processes may reflect the existence of dependence, but not important information about its nature.[2] These residues may be thought of as end-states of disease (e.g., dementia) that do not reflect important etiologic information (e.g., normal pressure hydrocephalus, lacunar states).

Previous scales have attempted to assess motives or "reasons" for smoking. Indeed, smoking motivations have been studied for more than 30 years (e.g., Ikard, Green & Horn, 1969; McKennell, A. C., 1970; Russell, Peto & Patel, 1974). However, it is important to note that the WISDM-68 differs from those earlier scales in some important respects. First, the subscales of the WISDM-68 were not based on smokers' commonly volunteered "reasons for smoking." Rather, subscales were based on current research and theories of drug motivation. This strategy resulted in assessment of constructs that are distinct from those targeted by earlier "reasons" scales. For instance, the Behavioral Choice/Melioration and Affiliative Attachment subscales are ones that have no counterparts in earlier measures. Thus, the distinct origins of the WISDM-68 subscales result in a broader, more far-ranging measure.

Second, earlier scales were not constructed or validated in order to optimize discriminant validity with respect to dependence criteria (e.g., withdrawal dimensions, relapse). Therefore, items were not selected, and subscales were not constructed, so as to promote the assessment of dependence. As has been observed previously (e.g., Clark & Watson, 1995), validity does not inhere in instruments. Rather, one validates the *inferences* that one can make based upon responses to them. Therefore, one difference between the WISDM-68 and earlier measures is that only the WISDM-68 was constructed and validated to permit inferences about dependence (e.g., its items were generated by theories of dependence, and gauged with respect to their relations with dependence criteria).

In addition to conceptual differences, the current measure of dependence is intended to demonstrate psychometric attributes that are superior to those of extant measures, including that the subscales have adequate internal consistency in diverse populations (e.g., ethnic minorities).

A Multiple-Motive Measurement Strategy

Through a careful review of the literature, and after polling experts in the field, we identified 13 separate motives for drug use. These motives arise from research and theory regarding the motivational bases of compulsive or heavy drug use. The motives, and the developmental processes that led to their assessment, are discussed below. See Appendix A for a more complete description of the 13 domains.

The model guiding the current effort is based on the notion that multiple domains, or different motives for drug use, can be used to infer or assess the construct of tobacco dependence. In other words, smokers may have many different motives for smoking, and each motive may contribute to compulsive drug use, withdrawal and relapse – the three key

criteria of dependence. In theory, dependence may be a function not only of strength of motivation, but also number and types of motivational processes involved. These different aspects of dependence may differ not only with respect to their relations with the various dependence criteria, but also with respect to course over ontogeny. Eventually, dependence scales will be validated against a broad range of validation criteria (e.g., behavioral economic measures, withdrawal severity). The present report presents data on scale content, internal consistency and structure, concurrent validity and modest information on predictive validity.

<div align="center">Methods</div>

Questionnaire Development

The first step in the development of the WISDM-68 was to identify and define the relevant candidate motive domains and write sample items to assess the proposed domains. Subsequently, various experts in the field were invited to evaluate the identified motives. After receiving the feedback from the expert panel, the motive domains were revised but no new domains were added. Once the domains were finalized, numerous items were generated to assess each domain.

Items were written to ensure adequate sampling of the entirety of each motive; e.g., its frequency, breadth, intensity, and variability. For example, cravings may vary in frequency, intensity, and controllability. Some smokers may have frequent mild cravings while others may have infrequent, but very intense cravings. In addition, smokers may differ in the number of smoking cues they encounter, the frequency with which they encounter cues, and the salience of the cues. The total item set used to generate the questionnaire comprised 285 questions assessing the 13 motivational domains. (See Appendix A for a description of the thirteen domains).

The WISDM-68 is based on the supposition that dependence should be related to the following 13 motives for drug use:

1. Affiliative Attachment – characterized by a strong emotional attachment to smoking and cigarettes;

2. Automaticity – characterized by smoking without awareness or intention;

3. Behavioral Choice/Melioration/Alternative Reinforcement – characterized by smoking despite constraints on smoking or negative consequences and/or the lack of other options or reinforcers;

4. Cognitive Enhancement – characterized by smoking to improve cognitive functioning (e.g., attention);

5. Craving – characterized by smoking in response to craving or experiencing intense and/or frequent urges to smoke;

6. Cue Exposure/Associative Processes – characterized by frequent encounters with nonsocial smoking cues or a strong perceived link between cue exposure and the desire or tendency to smoke;

7. Loss of Control – based on the notion that once dependence becomes ingrained, the dependent person believes that he or she has lost volitional control over drug use due to any of a variety of factors (e.g., urges, loss of other reinforcers, automaticity);

8. Negative Reinforcement – characterized by the tendency or desire to smoke in order to ameliorate a variety of negative internal states (e.g., dysphoria, stress, withdrawal);

9. Positive Reinforcement – characterized by the desire to smoke in order to experience a "buzz" or a "high," or to enhance an already positive feeling or experience;

10. Social and Environmental Goads – characterized by social stimuli or contexts that either model or invite smoking;

11. Taste and Sensory Properties – characterized by the desire or tendency to smoke in order to experience the orosensory/gustatory effects of smoking;

12. Tolerance – characterized by the principal need of individuals to smoke increasing amounts over time in order to experience the desired effects, or the ability to smoke large amounts without acute toxicity;

13. Weight Control – characterized by the use of cigarettes to control body weight or appetite.

Participants

775 participants (303 men, 454 women, and 18 not identified) from Madison and Milwaukee, WI were recruited through solicitation of participants from previous smoking cessation experiments, through newspaper and radio advertisements, and from students taking psychology classes at the University of Wisconsin-Madison. Participants were at least 18 years old and they had to have smoked at least one cigarette within the last 14 days. 638 participants (82%) identified themselves as white, 83 identified as African-American (11%), 5 as American Indian (1%), 13 as Asian/Pacific Islander (2%), 18 participants (2%) responded with "Other", and 18 participants (2%) did not supply information on race. Hispanics constituted 2.9% of the sample. See Table 1 for demographic information by smoking status and research site.

Procedure

Participants were invited to attend a large group survey session to complete the questionnaires and provide a breath sample for carbon monoxide measurement. During the

survey session, an overview of the study was provided and participants read and signed the consent form. Participants then completed the research questionnaires. After completing the forms, the participants were given a carbon monoxide breath test and excused. Participants from the Madison and Milwaukee community received $30 in exchange for their participation. Students taking psychology classes at the University of Wisconsin-Madison received class credit in exchange for participation.

Measures

Wisconsin Index of Smoking Dependence Motives. The preliminary Wisconsin Index of Smoking Dependence Motives (WISDM-P) comprised 285 items designed to assess the 13 different theoretically-derived motivational domains listed above. Each item is answered on a 7-point Likert scale ranging from 1 – "Not true of me at all" to 7 – "Extremely true of me."

Fagerström Test of Nicotine Dependence. The Fagerström Test of Nicotine Dependence (FTND) is a 6-item scale designed to measure tobacco dependence. Each item has its own individual response scale that varies by item. The FTND is a revision of the original Fagerström Tolerance Questionnaire and previous research indicates that it has fair internal consistency (α = .61; Heatherton, et al., 1991).

Kawakami Tobacco Dependence Screener. The Kawakami Tobacco Dependence Screener (TDS; Kawakami, et al., 1999) is a self-report measure designed to assess 10 of the DSM-IV criteria for tobacco dependence, each on a dichotomous scale with 0 indicating lack of the symptom and 1 indicating endorsement of the criterion. The sum of symptoms, from 0-10, allows for a more continuous measure of dependence that is based on both physical aspects of dependence, such as withdrawal and tolerance, as well as on social and behavioral

aspects, such as continuing tobacco use despite problems in life or despite other consequences. It has been validated only on Japanese smokers, mainly men. In that research it showed good internal consistency (α ranging from .76 to .81 across three studies). It was also significantly correlated with number of cigarettes smoked per day, years smoking, and carbon monoxide (CO) levels.

Demographics and Smoking History. A demographics questionnaire assessed characteristics such as gender, ethnicity, age, marital status, education level, and employment. The smoking history questionnaire included items such as the number of cigarettes smoked per day, age of smoking initiation, smoking status (e.g., daily smoker, occasional smoker, etc.), number of quit attempts, longest time abstinent, and other smokers in the household.

Carbon Monoxide Assessment. Participants provided a breath sample to permit alveolar carbon monoxide analysis to verify their smoking status and estimate their smoking heaviness. A Bedfont Smokerlyzer was used to measure the CO in the breath samples. Results were recorded as parts per million of carbon monoxide.

Preliminary Evaluation of Clinical Validity

We also collected preliminary predictive validity information from a smoking cessation study. In this randomized double-blind placebo controlled cessation study, conducted in Milwaukee, WI, smokers were randomly assigned to receive active bupropion SR and active nicotine gum (N = 91), active bupropion SR and placebo gum (N = 86), or placebo bupropion SR and placebo gum (N = 61). Gum was provided for 8 weeks and bupropion for 9 weeks. Participants also received three 10-minute counseling sessions to aid in their quit attempt. The WISDM-68, FTND, and TDS were administered at a baseline

assessment session. Based on the study design, 2-week point prevalence abstinence data were collected at the end of treatment (8 weeks after the quit date) and verified using CO readings of less than 10. The data presented are based on a sample of 238 participants (60.1 % women). Of the 238 participants, 78.4% of the participants were white, 20.7% were African-American and the remaining 0.8% were Native American and Asian/Pacific Islander. Only one participant reported being Hispanic. On average, the participants smoked 22.18 cigarettes per day ($\underline{SD}$ = 10.07).

<div align="center">Results</div>

Overview of Data Analysis

Data analysis was conducted in four phases: 1) item selection; 2) preliminary modeling; 3) evaluation of differential subscale performance; and 4) preliminary validation. In the item selection phase the participants were randomly divided into two groups, a Derivation Sample (N = 385) and a Validation Sample (N = 390). Sixty-eight items were selected using classical item selection criteria with the Derivation Sample and then verified using the Validation Sample. After selecting the 68 items of the WISDM-68 from the original pool of 285 items, the next phase of analysis was the assessment of different structural models of the WISDM-68. Using the Mplus software package (Muthén & Muthén, 1998), confirmatory factor analyses (CFAs) were conducted to evaluate the distinguishability of the motives tapped by each subscale. The third set of analyses examined the differential performance of the individual subscales. Using nonlinear regression, levels of smoking heaviness were used to predict scores on the WISDM-68 subscales. After deriving and modeling the internal structure of the WISDM-68 and examining the differential performance of the subscales, concurrent validation analyses were conducted to compare the

WISDM-68 with other putative markers of dependence, such as smoking heaviness and DSM-IV criteria, and to examine the discriminant validity of the various subscales. Finally, preliminary data from the Validation smoking cessation study were analyzed to determine the ability of the WISDM-68 to predict end-of-treatment relapse.

<u>Item Selection</u>

Using data from the Derivation Sample only, subscale items were selected based on two criteria: 1) item-whole correlation in the Derivation Sample; and 2) representativeness of the targeted domain.[3] Ideally, each subscale should have a reliability coefficient greater than or equal to .90 to make it an effective clinical tool. Therefore, the initial goal was to create subscales with internal consistencies of approximately .93 or greater in the Derivation Sample to adjust for the shrinkage expected to occur when the internal consistencies were calculated in the Validation Sample. We attempted to retain the smallest number of items possible, with the highest item-whole correlations, such that each subscale had an alpha of .93 in the Derivation Sample. We also surveyed the item content to ensure that there were items to tap the breadth of each domain.

The original subscales ranged from 10 to 38 items. The thirteen revised subscales of the WISDM-68 comprised 4 to 7 items each. See Appendix B and C for the WISDM-68 questionnaire and scoring key. Each of the revised 13 subscales was analyzed for internal consistency, using the Derivation sample. The results revealed that every original subscale had a Cronbach's alpha > 0.90, with the exception of the Social/Environmental Goads sub-scale, which had an alpha of .87. These results indicate that each of the individual subscales exceeded the cut-off of $\underline{\alpha}$ = .80, which has been deemed appropriate for clinical diagnosis (Nunnally & Bernstein, 1994). Then, using the Validation Sample, the internal consistency

of each revised subscale was re-examined and found to have a reliability coefficient greater than .90, with the exception of the Cue Exposure/ Associative Processes subscale, which had an internal consistency coefficient of .88.

To ensure that the WISDM-68 subscales are appropriate for various populations, the final step in the item selection analyses was to determine the reliability of the 68 items across six different populations: men, women, daily smokers, non-daily smokers, white smokers, and non-white smokers (83 African-American, 5 American Indian, 13 Asian, and 18 other). The results revealed that the WISDM-68 subscales have fair-to-excellent internal consistency (range = .73 - .95) for all six of the groups examined: men, women, daily, non-daily, white, and non-white smokers. The lowest internal consistencies were for non-daily smokers on the Tolerance subscale (α = .73), the Cravings subscale (α = .82), and the Automaticity subscale (α = .82). The internal consistency of the total WISDM-68 in these populations ranges from .97 to .99.[4]

CFA Models

Our hypothesis was that the WISDM-68 would be multidimensional. Therefore, once the subscale items were selected, we examined the dimensional structure of our measure by fitting confirmatory factor analysis (CFA) models. These models addressed the issue of whether dependence, as assessed via the WISDM-68, should be construed as multidimensional. We did not attempt to identify a best-fitting structure of the WISDM-68 at this early point in its development. Nor did we attempt to prune or merge subscales. We believed such steps to be premature given the modest validity data available and the relatively small number of subject samples available for analysis.

The preliminary modeling was done using a second random split of the sample into Sample 1 and Sample 2. Using Sample 1, two different theoretically derived models were tested. These models were then replicated in Sample 2. The first model tested, a single-factor model, was based on the work of theorists who have suggested that dependence is a unidimensional latent construct, i.e., that either a single factor accounts for the great proportion of variance in indices of addictive drug use, or that if distinct factors are involved they become so entrained and coherent that they may be effectively modeled as a single factor (e.g., Edwards & Gross, 1976; Shiffman, 1993). The single-factor CFA model was created to assess whether or not the data fit a model in which all of the items reflect a common tobacco dependence factor. The second model tested the implicit model that guided the generation of the 13 separate subscales; that variance in dependence phenomena can be accounted for by multiple, relatively discrete motives, in this case the 13 distinct motives tapped by the WISDM-68. Model evaluation involved an examination of the Comparative Fit Index (CFI) and the root mean square error of approximation (RMSEA). We considered a model to have adequate fit if the CFI was greater than or equal to .90 and the RMSEA was .08 or less (Browne & Cudeck, 1993; Newcomb, 1994). The chi-square/degree of freedom ratio is also presented. Although there are no agreed-upon criteria for interpreting this ratio, it is nevertheless a useful criterion for model comparison purposes, with the better model being the one that minimizes the index (e.g., Widaman & Reise, 1997).

Using Sample 1, the single factor model of dependence had a CFI of .60 and a RMSEA of .113. Neither of these indices indicates a good fit for this model. The model also failed to fit the data from Sample 2. Using Sample 1, the 13-factor model had a CFI of .86 and a RMSEA of .068. These results also fall slightly below common standards for a well-

fitting model. However, inspection of modification indices failed to suggest any simple correction that would significantly improve fit, and thus the model was not modified. When fit to Sample 2, the 13-factor model produced a CFI of .90 and a RMSEA of .059, indicating an acceptable fit. In addition, the change in the chi-square:degrees of freedom ratio indicates that the 13-factor model is an improvement on the single-factor model. Thus, despite its more modest fit in Sample 1, the 13-factor model was deemed a reasonably well-fitting model, and clearly an improvement over the single-factor model. See Table 2 for a summary of the model fit indices.

These results indicate that dependence, as measured by the WISDM-68, is not a unitary construct, but rather a diverse collection of distinct motives for drug use. While these models do not address the potential presence of other latent variables (e.g., a latent variable related to physical dependence which might include tolerance, craving, and loss of control), or an overarching second order factor, they do suggest that there may be value in parsing dependence (as reflected in the scales used here) rather than attempting to model the latent construct of dependence as homogeneous.[5] These results do not mean that the 13-factor model is the best-fitting model possible. Indeed, the strong intercorrelations among some of the WISDM-68 subscales, suggest that not all 13 motives are distinct (see Table 3 for the zero-order correlations among the WISDM-68 subscales in daily smokers). However, some subscales (e.g., Social/Environmental Goads, Weight Control) appear to be fairly distinct. It is also clear from the correlations (Table 3) that while many subscales appear to be strongly related to the FTND, there are certain subscales (e.g., Social/Environmental Goads, Taste/Sensory Properties, Weight Control) that appear to have relatively little overlap.

Differential Subscale Performance

The third set of analyses focused on the relation of the different subscales to different levels of smoking heaviness and lifetime smoking or cigarette exposure. The variable cigarettes-smoked-per-month was calculated based on number of cigarettes smoked per day times number of days smoked (daily smokers were assumed to smoke 30 days per month). Lifetime cigarette exposure was calculated for daily smokers using the following equation: (cigarettes smoked per month) x (12) x (years of daily smoking), and for non-daily smokers using the following equation: (cigarettes per month) x (12) x (years since the participant had smoked his/her first cigarette). Due to over-sampling of non-daily smokers, we had positively skewed distributions for both cigarettes smoked per month and lifetime nicotine exposure. Therefore, for each variable we transformed the scores by taking the log of the score plus one.

The relations between these smoking variables and scores on the 13 subscales was studied by fitting nonlinear regression curves to the data. Initially, logistic curve fitting was used to examine the ability of either smoking heaviness or lifetime cigarette exposure to predict the scale scores on the 13 subscales. This analysis allowed us to examine how smoking heaviness predicts different motives. A logistic model was thought to be more appropriate than a linear model due to the presence of floor and ceiling effects in the subscale scores; consistent with this hypothesis, for all 13 subscales the logistic curves produced a higher R^2 in predicting subscale variance than a linear regression. For these analyses, the results for both cigarettes smoked per month and lifetime cigarette exposure were similar and so only the results using cigarettes smoked per month will be presented and discussed.

Visual inspection of the logistic curves suggested that there may be two different groups of subscales, one with steady growth across all levels of smoking heaviness and one with accelerated growth at higher levels of smoking heaviness (see Figure 1 for examples). To examine this hypothesis further and to characterize better the differences between the 13 curves, we fit a quadratic regression model to each subscale. The results indicated that almost all of the subscales had a significant linear trend and many had a significant quadratic trend, with the exceptions being Social/Environmental Goads, Cue Exposure/Associative Processes, Taste/Sensory Properties and Weight Control subscales (see Table 4).

In order to determine the significance of the linear and quadratic terms, F-tests were performed using full versus reduced model comparisons. To determine the significance of the linear term, the linear model (full model) was compared against a model with no predictors (reduced model). To determine the significance of the quadratic term, a model with both a linear and quadratic term (full model) was compared against a model with only a linear term (reduced model). Results indicate two distinct groups of motives, those with only a linear component and those with both a linear and a quadratic component (data not shown). The subscales found to lack a significant quadratic component were the same as those identified using the logistic curve fitting analysis.

There appears to be one group of motives that is influential for both novice and inveterate smokers that might be labeled "early emergent smoking motives." The early emergent motives are present for all smokers, regardless of their experience, and appear to include: Social/Environmental Goads, Cue Exposure/Associative Processes, and Taste/Sensory Properties. These three motives have significant linear components, but no

statistically significant quadratic components, implying a consistent rate of increase in relation to smoking heaviness.

Another group of motives appears to be influential only for individuals who are heavier smokers or who have had a considerable lifetime exposure to nicotine. This group of motives might be labeled as "late emergent smoking motives." These late emergent motives, which are present only in individuals who smoke at a moderate daily rate or have at least moderate smoking experience, include: Craving, Automaticity, Behavioral Choice/Melioration, Cognitive Enhancement, Affiliative Attachment, Tolerance. In the quadratic regression, these subscales have negative linear but positive quadratic components, implying a slower rate of change at low levels of smoking heaviness, but a sharper increase at higher levels (see Figure 1).

Loss of Control, Negative Reinforcement and Positive Reinforcement motives also show strong and significant quadratic components. However, these motives are characterized by non-significant linear coefficients. Thus, these motive are more similar to late emergent motives in that they show steep accelerations at high levels of smoking heaviness. It is interesting to note that while the linear components of the Negative and Positive Reinforcement motives are not statistically significant, they are positive whereas the linear components for all other late emergent motives are negative.

Validation

Ultimately, the WISDM-68 will be validated against four major criteria: heaviness of smoking/nicotine self-administration, DSM-IV criteria for tobacco dependence (e.g., consequences of smoking), severity and duration of withdrawal symptoms, and likelihood or latency to relapse. In this paper we present data on smoking heaviness, which was assessed

via self-report of smoking rate and via alveolar carbon monoxide, DSM-IV criteria of

tobacco dependence, which was assessed using the TDS, and relapse assessed using 2-week

point prevalence data at the end of treatment.

    Concurrent Validation. The results from the multiple regression analyses in which

the 13 WISDM-68 subscales were entered as predictors indicate that, in the overall

population, the 13 WISDM-68 subscales accounted for approximately 58% of the variance in

number of cigarettes smoked per day, 53% of the variance in carbon monoxide level, and

60% of the variance in DSM-IV dependence. Comparatively, the FTND accounted for 62%

of the variance in cigarettes smoked per day, 55% of the variance in carbon monoxide level,

and 37% of the variance in DSM-IV dependence.

    Regression analyses were also conducted to examine which of the various subscales

of the WISDM-68 predict the most variance in the different dependence indicators.   In the

Derivation sample, the Tolerance subscale best predicted carbon monoxide level ($\underline{r}$ = .69, $\underline{p}$ <

.001), but the Craving, Cue Exposure/Associative Processes, and Tolerance subscales were

the best predictors of DSM-IV dependence when entered together into a multiple regression

equation ($\underline{R}$ = .79, $\underline{p}$ < .001). These results were replicated in the Validation sample such that

Tolerance was correlated at .72 ($\underline{p}$ < .001) with carbon monoxide level and Craving, Cue

Exposure/Associative Processes, and Tolerance accounted for almost 55% of the variance in

DSM-IV criteria ($\underline{R}$ = .74, $\underline{p}$ < .001). See Table 5 for the zero-order correlations among the

WISDM-68 subscales and dependence criteria.

    We also utilized path analysis, conducted using LISREL software, to test the

discriminant validity of the different subscales. An omnibus test was performed to determine

whether the predictive relationships between the thirteen subscales and these outcomes

differed. When the paths for each of the three concurrent validity variables (DSM-IV dependence criteria, cotinine level, and cigarettes smoked per month) were constrained to be equal across the 13 subscales, the model did not fit the data (CFI = 0.96; RMSEA = 0.12; χ^2 (36, $\underline{N}$ = 775) = 432.97, $\underline{p}$ < .001). Based on the modification indices we attempted to improve the model by freeing certain paths and allowing them to vary in their relation with the 3 outcome measures. When the paths from Loss of Control, Craving, Cue Exposure, and Positive Reinforcement were allowed to vary for DSM-IV dependence (i.e., the TDS), and Loss of Control and Tolerance were allowed to vary for both carbon monoxide level and cigarettes smoked per month, the model provided a much better fit (CFI = 1.00; RMSEA = .032; χ^2 (28, $\underline{N}$ = 775) = 49.84, $\underline{p}$ < .007). This suggests reliable heterogeneity among subscales in terms of their relations with dependence criteria.

Due to the heterogeneity of the smoking population, we examined the predictive power of these questionnaires in different smoker sub-populations. We examined whether or not the correlations between subscales and the validation criteria (i.e., cigarettes per day, carbon monoxide level, and DSM-IV dependence) differed between men and women, between daily and non-daily smokers, and between white and non-white smokers. To this end, the LISREL software was used to fit multigroup path models that allowed for a comparison of the path coefficients from individual subscales to the validation criteria across the targeted populations. The results revealed that the models of the WISDM-68 in which the paths were constrained to be equal across groups provided an adequate fit for both men and women (CFI = 1.00; RMSEA = 0.033), daily and non-daily smokers (CFI = .98, RMSEA = 0.084) and for white and non-white smokers (CFI = 1.00, RMSEA = 0.030). This suggests

that the assumption of equivalent concurrent validity of the subscales across groups may be reasonable.

Preliminary Predictive Validity. Using data from the cessation study, we examined predictors of end-of-treatment relapse using heirarchical logistic regression. Results revealed that, after controlling for treatment group in the first step, the total WISDM-68 score was not statistically significant in its prediction of end-of-treatment relapse (B = -.02, Wald = 2.15, $\underline{p}$ = .14). However, when each of the individual subscales was examined separately in the second step, after controlling for treatment group, Automaticity (B = -.22, Wald = 5.71, $\underline{p}$ = .02), Cognitive Enhancement (B = -.21, Wald = 5.08, $\underline{p}$ = .02), Negative Reinforcement (B = -.20, Wald = 3.68, $\underline{p}$ = .055) and Social/Environmental Goads (B = -.20, Wald = 6.69, $\underline{p}$ = .01) all significantly predicted relapse at the end of treatment. Using the model building strategy suggested by Hosmer and Lemeshow (2000), a best-fitting model was created (χ2 (6, N = 238) = 33.87, p < .001) that included Automaticity (B = -.27, Wald = 6.06, $\underline{p}$ = .01), Behavioral Choice/Melioration (B = .72, Wald = 16.63, $\underline{p}$ < .001), Cognitive Enhancement (B = -.31, Wald = 5.32, $\underline{p}$ = .02), and Negative Reinforcement (B = -.34, Wald = 4.12, $\underline{p}$ = .04). The FTND did not significantly predict relapse at the end of treatment after controlling for treatment condition (B = -.08, Wald = 1.49, $\underline{p}$ = .22).

Discussion

The primary goal of this research was to use construct validation to enhance understanding and measurement of tobacco dependence. The dependence model guiding the development of the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68) is that dependence is an emergent property of motivational processes that influence compulsive drug use and an inability to quit. Using various theory-based motives, we created the

WISDM-68 to assess dependence as a multivariate construct. The assessed motives are intended to reflect both the diversity and strength of drug-use motives. The final common pathways yielded by these motives can be labeled as tobacco dependence, which is associated with outcomes such as heavy smoking, severe withdrawal, and relapse.

Internal Consistency and Structure. The thirteen WISDM-68 subscales were found to have acceptable levels of internal consistency in the overall population and in various subpopulations of smokers, such as men, women, daily smokers, non-daily smokers, White, and Non-White smokers. While the internal consistencies of the subscales are very good, it is clear that some subscales are highly intercorrelated and do not represent wholly distinct constructs. However, the correlation matrix in Table 3 also shows that despite a positive manifold, some intercorrelations are modest (e.g., Loss of Control and Social/Environmental Goads $\underline{r}$ = .06).

Another important finding is that self-reported motives for smoking appear to be multidimensional. And, to the extent that these motives reflect dependence, dependence is best modeled as a multidimensional construct. By assessing dependence as a multidimensional construct, researchers will be able to examine the heterogeneity among smokers. In other words, rather than assessing the end-states of dependence per se (e.g., chronic use, relapse), this measure allows researchers to examine the different motivational processes in terms of their relations with important criteria.

What is the evidence that dependence motives are multidimensional? First, an analysis of their covariance structures suggests that their interrelations cannot be well modeled as unidimensional.[6] In addition, their relations with the available criteria suggest nonequivalence among the motives. For instance, the criterion of smoking heaviness (as

reflected by CO scores) was predicted consistently by two scales: Tolerance and Loss of Control. These two scales are not only highly intercorrelated ($r = .71$), but they also have the highest correlations of all scales with cigarettes smoked per day ($r = .76$ & $.68$, respectively; see Table 5). The more multifaceted criterion of DSM symptoms (as measured here by the TDS) was predicted across different samples, by a range of scales, including Craving, Cue Exposure/Associative Processes, Negative Reinforcement, Tolerance, Behavioral Choice/Melioration, and Affiliative Attachment. Relapse was best predicted by Automaticity, Cognitive Enhancement, Negative Reinforcement and Social/Environmental Goads. In short, neither the more complex, multifaceted DSM criteria nor the distal criteria of relapse could be well predicted by measures that primarily reflect heaviness of smoking. This suggests that criteria such as relapse vulnerability and continuing to smoke despite problems – problems assessed with the DSM-IV – are best predicted when measures address affective, interpersonal factors and broad behavioral domains.

Further evidence of the multidimensionality of smoking motives arises from analyses in which measures of smoking heaviness or lifetime exposure to nicotine were used to predict subjects' mean subscale scores (see Table 4). These analyses revealed that different subscales bore very different relations with these smoking exposure variables. Some subscales such as Social/Environmental Goads, Taste/Sensory Properties, and Cue Exposure/Associative Processes were linearly related to exposure. Other subscales, such as Tolerance, Cravings, Cognitive Enhancement, Behavioral Choice/Melioration, Automaticity, Negative Reinforcement, Positive Reinforcement, and Affiliative Attachment, all shared significant quadratic relations with exposure. Most of these scales, but not all (i.e., Positive Reinforcement & Negative Reinforcement), had negative linear coefficients. Thus, these

scales showed very little increase at low levels of smoking exposure, but rapid acceleration as exposure became heavy.

The above findings *suggest* that different motives are differentially influential across the ontogeny of smoking. Early-emergent motives, or those that increase in a linear manner across the range of exposure, may be prepotent for lighter/neophyte smokers. However, as nicotine exposure increases, the rate of growth of late-emergent motives overshadows the early motives in terms of smokers' levels of endorsement (see Figure 1). This pattern suggests that the smoking of light or neophyte smokers is influenced primarily by social and nonsocial environmental cues, and by sensory/gustatory properties of cigarettes. While these factors do increase with greater exposure to tobacco, other factors appear to become relatively more important.

One might assume that it is the late-emergent motives that reflect "true dependence." That is, the step-like increase in these motives across exposure levels suggests the passage of individuals into a more discrete taxon that separates mere exposure from addictive use. While this hypothesis is plausible, dependence may not, in fact, be taxonic. For example, factors that are linearly related with exposure may be more reflective of the graded onset of dependence. Furthermore, it is the case that early-emergent factors such as Cue Exposure/Associative Processes do possess predictive validity with respect to DSM criteria. Also, it may be that such factors are more predictive of dependence criteria among those with relatively little tobacco exposure.

Finally, it is important to examine the nature of the late-emergent scales. The Tolerance subscale comprises questions that address the need of individuals to smoke more to experience tobacco effects. The Loss of Control subscale assesses the subject's sense that

s/he has lost control over smoking.   Therefore, some of these scales may merely reflect the fact that individuals smoke a lot, and may not provide insight into motives that influence smoking (i.e., these are "residues" of other dependence motives). However, some of the late-emerging scales may provide insights into mechanisms and vulnerabilities. For instance, those who have histories of especially heavy tobacco exposures are likely to endorse strongly notions that they have formed emotional attachments to smoking/tobacco use, that tobacco use has displaced other sources of reinforcement, that tobacco use allows them to think more clearly and effectively, and that tobacco use reduces cravings/urges. It will be important to continue to explore the relation between the different late onset motives and outcomes such as withdrawal severity and relapse latency to determine whether or not the quadratic pattern seen is truly informative or merely a reflection of increased use.

Validation. At this time the validation of the WISDM-68 is a work "in progress." Until we relate the WISDM-68 to additional validation criteria such as inability to stop smoking or relapse vulnerability at 12 months, and to withdrawal severity and persistence (e.g., Piasecki, Jorenby, Smith, Fiore & Baker, 2003a, 2003b), the construct validity of the instrument must be considered unsubstantiated.

Examination of the available validity criteria, however, is promising. For instance, one of the subscales (i.e., Tolerance) is essentially equivalent to the FTND in terms of its relation with cigarettes smoked per day and CO level. Moreover, the Tolerance subscale has a considerably stronger relation with these criteria than does the DSM-IV criteria (data not shown). This pattern of findings is encouraging in that the FTND directly queries cigarettes smoked per day. In addition, several of the WISDM-68 subscales show correlations with DSM symptoms that are as high, or higher, than is the correlation between the FTND and

these symptoms. Finally, the preliminary predictive validity analyses revealed that four of
the WISDM-68 subscales, Automaticity, Cognitive Enhancement, Negative Reinforcement,
and Social/Environmental Goads predicted relapse at the end of treatment while the FTND
did not.

The best-fitting model for predicting relapse, the model that included Automaticity,
Behavioral Choice/Melioration, Cognitive Enhancement, and Negative Reinforcement
suggests that four different mechanisms may be related to relapse by the end of treatment.
Smokers reporting automatic smoking motives (e.g., smoking without thinking about it) were
more likely to relapse as were individuals who reported smoking to enhance their cognitive
abilities. In addition, smokers reporting high levels of smoking to alleviate negative states
were also more likely to relapse. However, if an individual endorsed high levels of
behavioral choice/melioration motives (e.g., it would take a pretty serious medical problem
to get me to quit, or smoking is the best thing I do all day) but was motivated enough to
participate in the cessation study, then they were less likely to relapse. One possible
interpretation for the strong negative relation between the Behavioral Choice/Melioration
subscale and relapse is that it is a measure of overall motivation to quit. If an individual is
motivated enough to participate in a smoking cessation program, despite believing that
smoking is the best thing s/he does all day, then the scale becomes a proxy for strong motives
to quit. Further research must be done to characterize further how the Behavioral
Choice/Melioration subscale relates to cessation/relapse – especially among general smoker
populations not self-selected for high levels of motivation to quit.

Future research must address not only the relations among WIDSM-68 subscales and
dependence criteria, but carefully assess its validity relative to alternative instruments such as

the Cigarette Dependence Scale (Etter, Le Houezec & Perneger, 2002) and the Nicotine

Dependence Syndrome Scale (Shiffman, Hickcox, Gnys, Paty, & Kassel, 1995). Its future

use depends, of course, on its ability to predict a range of dependence criteria across the

broad population of smokers. Thus far, however, our results support the use of the WISDM-

68 subscales for research purposes: the subscales are internally consistent, and different

subsets of subscales predict major dependence criteria providing an opportunity to examine

heterogeneous processes among smokers.

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　　　treatment of addiction. <u>Journal of Abnormal Psychology, 97</u>, 118-132.

Endnotes

1.   It should be noted that there are new measures of dependence entering the field, such as the Nicotine Dependence Syndrome Scale (NDSS; Shiffman, Hickcox, Gnys, Paty, & Kassel, 1995; Shiffman & Sayette, 2002) and the Cigarette Dependence Scale (Etter, Le Houezec, & Perneger, 2002). These measures are based heavily on the DSM diagnostic criteria. However, we are not aware of articles in peer-reviewed journals on these instruments that demonstrate their predictive validity with regards to relapse latency and withdrawal severity. For example, the Etter et al. paper (2002) assessed relapse likelihood and found that none of the dependence scores yielded by the Etter measures was significantly related to relapse occurrence.

2. It is important to note that most researchers studying dependence to other drugs directly assess dependence criteria; i.e., the residues of dependence (e.g., in the case of alcohol; Edwards, 1986). Currently, we do not know whether a motivational approach would be effective in assessing these other drug dependencies.

3.   We retained items that would tap different dimensions of a motive, such as frequency, timing, and intensity of the motive.

4. It is possible for a multidimensional scale to have a high Cronbach's alpha if it reflects correlated latent variables (see Clark & Watson, 1995).

5. We did examine the fit of other multifactorial models comprising merged subscales, and they did show adequate fit. However, because we are interested in the predictive validity of all of the theoretically-derived subscales, we are disinclined to merge the subscales before assessing their discriminative validities.

6. We were not interested so much as identifying a best-fitting model at this point in the scale development process, as in determining whether a unidimensional model seemed appropriate. We wish to relate each theoretically derived subscale to the full set of dependence criteria (e.g., smoking heaviness, withdrawal severity, relapse latency) prior to achieving a best-fitting model via scale integration, deletion, or restructuring.

Table 1. Demographic data

	Daily Smokers (n=443)	Non-daily Smokers (n=330)	All Smokers (n=775)
Women (%)	56.3	64.8	60.0
White (%)	78.3	92.0	84.3
African-American (%)	17	2.6	10.7
Graduated from high school/GED or greater education (%)	89.5	98.8	92.7
Married (%)	18.0	4.0	11.9
Students (%)	27.3	77.9	48.8
Mean cigarettes per day (SD)	16.34 (11.13)	2.96 (2.76)	10.51 (10.81)
CO in ppm, Mean (SD)	15.97 (10.60)	3.97 (3.31)	10.76 (10.17)

.

Table 2. Summary of Model Fits

Model	Group	N	χ^2	df	χ^2: df ratio	CFI	RMSEA
Single factor model	Sample 1	317	11223.50	2210	5.08	.60	.113
	Sample 2	393	12363.85	2210	5.59	.63	.108
13-factor model	Sample 1	317	5231.94	2132	2.45	.86	.068
	Sample 2	393	5012.64	2132	2.35	.90	.059

Note. df = degrees of freedom; CFI = Comparative Fit Index; RMSEA = root mean square error of approximation.

Table 3. Zero-order correlations of the WISDM-68 Subscales in Daily Smokers

	Affiliative Affachment	Automaticity	Behavioral Choice/ Melioration	Cognitive Enhancement	Loss of Control	Craving	Cue Exposure/ Associative Processes	Negative Reinforcement	Positive Reinforcement	Social/ Environmental Goads	Taste/Sensory Properties	Tolerance	Weight Control
Affiliative Attachment	1.0												
Automaticity	.53*	1.0											
Behavioral Choice/ Melioration	.82*	.53*	1.0										
Cognitive Enhancement	.65*	.42*	.70*	1.0									
Loss of Control	.63*	.58*	.66*	.49*	1.0								
Craving	.62*	.59*	.71*	.54*	.72*	1.0							
Cue Exposure/ Associative Processes	.51*	.52*	.59*	.51*	.55*	.65*	1.0						
Negative Reinforcement	.63*	.48*	.71*	.70*	.55*	.70*	.65*	1.0					
Positive Reinforcement	.70*	.44*	.73*	.68*	.47*	.63*	.59*	.79*	1.0				
Social/Environmental Goads	.08	.17	.13*	.12*	.06	.24*	.30*	.25*	.17*	1.0			
Taste/Sensory Properties	.50*	.34*	.50*	.43*	.24*	.43*	.49*	.50*	.69*	.24*	1.0		
Tolerance	.54*	.61*	.62*	.48*	.71*	.66*	.45*	.50*	.45*	.13*	.34*	1.0	
Weight Control	.36*	.24*	.37*	.33*	.24*	.23*	.32*	.38*	.33*	.06	.16*	.18*	1.0
FTND	.47*	.48*	.52*	.36*	.58*	.53*	.22*	.33*	.28*	.01	.18*	.78*	.11*

* p < .05

Table 4. Linear and quadratic coefficients describing the relation between the WISDM-68 subscales and smoking heaviness

Outcome	Linear	t	p-value	Quadratic	t	p-value
Affiliative Attachment	-.588	-4.303	.000	1.155	8.456	.000
Automaticity	-.510	-4.091	.000	1.168	9.360	.000
Behavioral Choice/Melioration	-.773	-7.180	.000	1.510	14.020	.000
Cognitive Enhancement	-.470	-3.817	.000	1.140	9.259	.000
Control	-.212	-1.522	.128	.777	5.576	.000
Cravings	-.375	-3.232	.001	1.092	9.422	.000
Cue Exposure/ Associative Processes	.619	4.684	.000	.008	.063	.950
Negative Reinforcement	.185	1.346	.179	.403	2.930	.003
Positive Reinforcement	.172	1.190	.234	.359	2.490	.013
Social/Environmental Goads	.565	3.588	.000	-.198	-1.258	.209
Taste/Sensory Properties	.663	4.469	.000	-.182	-1.230	.219
Tolerance	-.971	-10.698	.000	1.768	19.467	.000
Weight Control	.201	1.310	.190	.229	1.489	.137

Table 5. Zero-Order Correlations Between Validation Criteria, the WISDM-68 Subscales and the FTND for All Smokers

	TDS	CO (ppm)	Cigarettes Per Day
Affiliative Attachment	.59	.46	.54
Automaticity	.61	.56	.60
Behavioral Choice/Melioration	.66	.55	.59
Cognitive Enhancement	.56	.42	.49
Control	.70	.64	.68
Cravings	.73	.57	.60
Cue Exposure/ Associative Processes	.66	.39	.45
Negative Reinforcement	.63	.39	.45
Positive Reinforcement	.53	.34	.42
Social/Environmental Goads	.31	.15	.23
Taste/Sensory Properties	.43	.26	.33
Tolerance	.65	.70	.76
Weight Control	.44	.32	.30
Total WISDM-68	.72	.55	.63
FTND	.61	.74	.79
TDS	--	.49	.54
CO (ppm)	.49	--	.70

Figure 1. Logistic Regression Curves Predicting Scores on the WISDM-68 Subscales from Cigarettes Smoked Per Month – Examples of an Early-Emergent Motive (Social/Environmental Goads) and a Late-Emergent Motive (Tolerance)
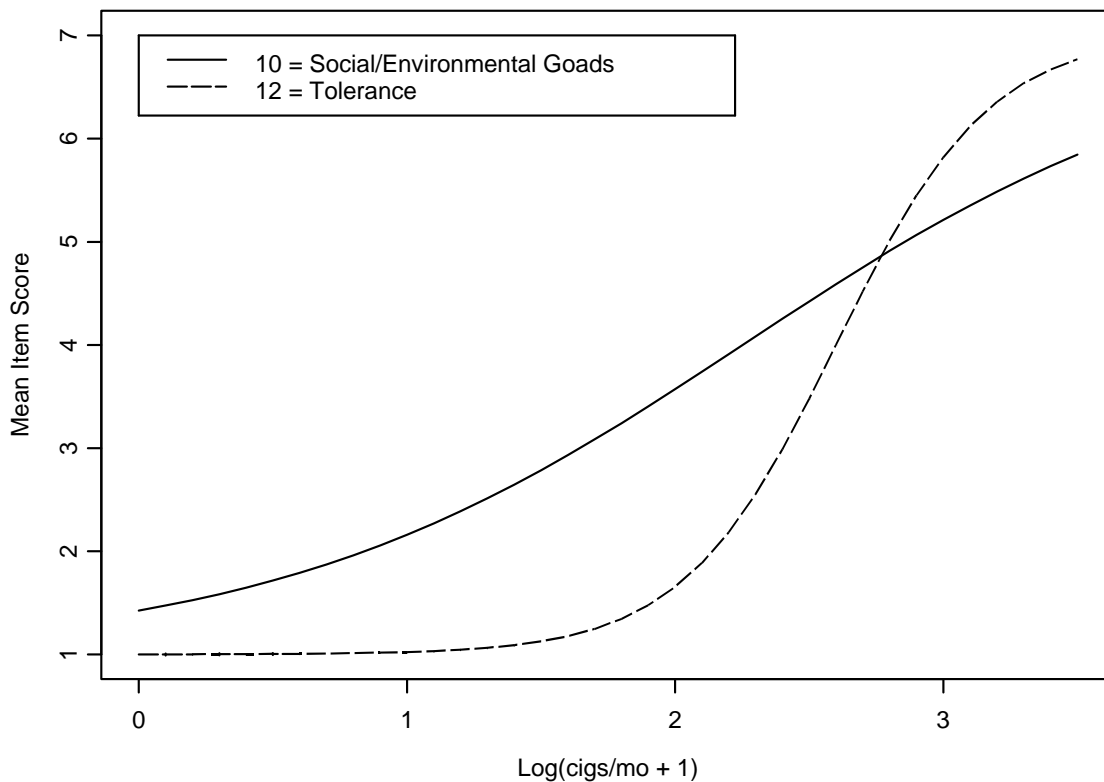

Figure 1. This figure illustrates the different curves of the early emergent motives and late emergent motives, using Social/Environmental Goads and Tolerance as prototypes of each motive, respectively. The early emergent motive has a higher intercept at low rates of smoking than the late emergent motive and has consistent linear growth as smoking rates increase. The late emergent motive is not endorsed by light smokers but as smoking rates increase, there is an exponential increase in the rate of endorsement.

Appendix A.

Affiliative Attachment.

This motive arises from evidence that psychomotor stimulants like nicotine activate neural systems involved in the motivational impact of social cues (e.g., Panksepp, Siviy, & Normansell, 1985; Wise, 1988). These neuropharmacologic data are supported by self-report data from addicted smokers that cigarettes come to share many of the same affective and motivational properties as attractive social stimuli (i.e., "friends") and that withdrawal from tobacco is tantamount to social loss/mourning (Baker, Morse, & Sherman, 1987). The more attached a smoker is to his or her cigarettes, the harder cessation will be, suggesting stronger dependence. Some examples of questionnaire items are: 1)"Cigarettes keep me company, like a good friend."; or 2)"Sometimes I feel like cigarettes are my best friends."

Automaticity.

Tiffany (1990) suggested that there is insufficient evidence that self-reports of urges are strongly linked to either physiological measures or drug consumption, indicating that, "Urges may not be necessary for the initiation or maintenance of drug-use behavior." (p. 151). The automaticity theory proposed by Tiffany posits that, like any activity an individual practices, smoking eventually becomes automatic and is controlled by automatic processes. Subsequently, urges, or subjective awareness of wanting to smoke, will result when the automatic ritual of smoking is blocked, resulting in non-automatic cognitive processes. For example, if a smoker automatically reaches for a pack of cigarettes, only to find that there are none left, the smoker will experience a craving or an urge to smoke. Smokers with highly automatic smoking processes will find it harder

to quit, either due to a stronger dependence or an inability to counter their automatic behavior. Examples of questionnaire items tapping automaticity are: 1) "I often smoke without thinking about it."; and 2) "I smoke without deciding to."

Behavioral Choice/Melioration/Alternate Reinforcement.

Behavioral theories of choice (Vuchinich & Tucker, 1988) suggest that drug use is inversely proportional both to constraints on the access to drug and the availability of other reinforcers. It has been suggested that the latter may play a more important role in drug behavior (Vuchinich & Tucker, 1988). According to this theory, smokers who are more dependent will be more likely to smoke even in the presence of constraints on cigarettes, and when other reinforcers are available. In addition, more dependent smokers may also have fewer reinforcers available to them.

Melioration theory (Heyman, 1996), based on Herrnstein's matching law, refers to the use of a "local bookkeeping strategy" for deciding among competing reinforcers that emphasizes the current value of each. Therefore, rather than maximizing the long-term reinforcement by construing the choice problem in terms of competing groups of reinforcers, combining rather than comparing options, the person focuses only on the immediate value of the different options. This results in a discounting of future reinforcers. Therefore, smokers who are more dependent will report being unwilling to give up cigarettes even when confronted with negative consequences such as cigarette taxes or illness. Two sample items that tap the behavioral choice/melioration motive are: 1) "Very few things give me pleasure each day like cigarettes."; and 2) "Few things would be able to replace smoking in my life."

Cognitive Enhancement.

Studies have shown that nicotine can improve attention and vigilance (Bell, Taylor, Singleton, Henningfield, & Heishman, 1999). Therefore, smokers may be smoking to increase their cognitive abilities either above their baseline ability or to restore their cognitive abilities after nicotine deprivation. Questions that address this motive ask about the perceived cognitive impact of smoking. Smokers were asked to rate how much they agree or disagree with sentences such as: 1) "I smoke when I really need to concentrate."; and 2) "I frequently smoke to keep my mind focussed."

Craving.

This is a very traditional theoretical motive for drug use. Craving is an aversive state that motivates relapse and self-administration of drug. While this motive reflects negative reinforcement, it is such a crucial motive for drug use, that we will attempt to assess it separately from the negative reinforcement motive. The stronger the dependence, the stronger the cravings may be. An item that would assess craving frequency is, "I frequently crave cigarettes." An item such as, "When I haven't been able to smoke for a few hours, the craving gets intolerable," assess craving intensity. Finally, craving controllability was assessed using items such as, "It's hard to ignore an urge to smoke."

Cue exposure/associative processes.

This motive reflects basic associative learning processes. The smoker learns to associate certain cues with smoking or withdrawal and these cues gain the capacity to elicit smoking behavior either by increasing the perceived motivation for a cigarette or through automatized self-administration. Smokers who are more dependent will be exposed to more salient cues more frequently than less dependent smokers. Some sample

items from this domain include: "My life is full of reminders to smoke."; "There are particular sights and smells that trigger strong urges to smoke."

Loss of Control.

Loss of control is not a motive to smoke per se, however it does provide an important measure of how addicted a smoker feels; how compulsive the smoker feels his or her drug use is. The assessment of control may provide important information regarding the smoker's ability to quit smoking. If a smoker endorses significant loss of control, it is hypothesized that he or she will be less likely to quit smoking than will the smoker who feels that they still have some control over his or her drug use. Sample items to assess level of control include: "Cigarettes control me."; "Sometimes I feel like cigarettes rule my life."

Negative reinforcement.

This motive for drug use is based on the operant conditioning learning theory that operant behaviors that alleviate an aversive physical or psychological state are reinforcing and increase the probability that those behaviors will be repeated. Within this domain the aversive state may be due to life events such as stress or may be due to withdrawal symptoms. Smokers may differ in the severity or frequency of their aversive states, such that more dependent smokers will have more severe and/or more frequent aversive states either due to withdrawal symptoms or negative life events and stress, causing them to utilize cigarettes more frequently to alleviate these states. Smokers have also been shown to differ on their expectancies that smoking will alleviate their distress (e.g., Brandon & Baker, 1991). This suggests that the operant conditioning model may be paralleled by subjective awareness. Therefore, questionnaire items attempted to assess

these individual differences within the negative reinforcement domain. Some sample items include: "Smoking a cigarette improves my mood." and "Smoking helps me deal with stress."

<u>Positive Reinforcement.</u>

This motive is based on Thorndike's law of effect, which states that behaviors followed by positive outcomes are strengthened and more likely to reoccur. Therefore, behaviors that result in positive experiences, such as a high or a buzz, are reinforcing and are more likely to be repeated. Items address the following: the perceived intensity of appetitive effects, the reliability between smoking and appetitive effects, and the nature of appetitive effects. It is important to note that items were written so as to preserve the distinction between the appetitive positive reinforcement and negative reinforcement models. It is predicted that more dependent smokers will report more positive reinforcement motives for smoking than less dependent smokers. An example of sample items designed to tap positive reinforcement motivation would be: 1) "Smoking makes a good mood better."; and 2) "Smoking makes me feel content."

<u>Social and Environmental Goads.</u>

This motive also plays an important role in motivating drug use and it may be especially important in the initiation as well as the maintenance of drug behavior. Social learning theory, proposed by Bandura, posits that individuals can learn by observing the behavior of others. Modeled smoking behavior may not only influence initiation, but if there is a lack of abstinence behavior modeled; it may be very difficult for smokers to quit. Additionally, social or occupational environments may promote smoking, making cessation difficult. Therefore, smokers with more smokers in their environment or

smokers who interact with other smokers who don't value cessation will have a harder time quitting. Examples of questions to assess social and environmental goads include: 1) "I'm around smokers much of the time."; and 2) "Most of the people I spend time with are smokers."

Taste and Sensory Properties.

The taste and sensory properties of smoking are being considered as separate motives from positive reinforcement, although the law of effect and operant conditioning principles are relevant to these motives as well. The more positive the experience of smoking a cigarette is, the more that behavior will be strengthened. Therefore, even if the taste and sensory properties weren't reinforcing initially, every time a smoker has a cigarette and enjoys the taste, smell, etc., these positive sensations will increase the likelihood that the smoking will be repeated. Smokers who are more dependent will have a stronger appreciation for the taste and sensory properties of smoking. Some examples of questions to assess this domain are: 1) "I enjoy the taste of cigarettes most of the time."; and 2) "I love the feel of inhaling the smoke into my mouth."

Tolerance.

This motive is a necessary component of dependence and is frequently considered to be one of the defining characteristics of dependence. Tolerance theory is based upon the idea that homeostatic adaptations to the presence of drug in the body oppose the drug effect, rendering the tissues less sensitive to the drug. This enables the individual to tolerate higher doses of drug without suffering its toxic effects and individuals require higher doses of the drug in order to achieve the same subjective high. Tolerance is a very physiological construct and is probably best measured using some sort of physiological

assay. However, this questionnaire can tap into some aspects of tolerance that are available through self-report. Smokers who are dependent will no longer experience the toxic effects of nicotine, such as nausea, that novice smokers experience. Additionally, more dependent smokers will report smoking more now than they used to. Some sample items include: 1) "I usually want to smoke right after I wake up."; and 2) "I can only go a couple hours between cigarettes."

Weight control.

Finally, smokers may be motivated to continue using drug for the purposes of controlling their weight. Cigarettes do appear to increase metabolism and serve as an appetite suppressant. This weight control motive may occur in response to weight loss that occurred after smoking was initiated or it may be driven by a fear of gaining weight once the smoker quits. People who are concerned about their weight or concerned about controlling and/or suppressing their hunger may have more trouble quitting smoking. Items that tap into the weight control motive include: 1) "Smoking keeps me from gaining weight."; 2) "I rely upon smoking to control my hunger and eating."

It is important to acknowledge the limitations of this assessment strategy. First, there are many general limitations to using a self-report measure to assess motives (Baker & Brandon, 1990). It is possible that the items written to tap specific constructs may activate different or altered constructs in participants.   Item wording may present problems in the consistency of interpretation across participants. There is a certain amount of response reactivity inherent in self-report measures. Self-report measures are likely to increase attentional focus on the construct being measured, which, in turn, influences that construct. Specifically for smoking, answering questions regarding

smoking motivations may activate certain motivations and make those motivations more salient than they would be if the participant were not answering questions regarding their smoking. Individual differences, such as personality variables or social desirability will also influence participants' responses to self-report measures. In addition to these more global limitations to self-report assessment, there is one additional caveat specific to this proposed questionnaire. It is possible that the constructs we are asking participants to report on may not be accessible to self-awareness (e.g., Automaticity), however we have done our best to ask questions that tap conscious processes but that also assess the latent motive of interest. Despite these limitations, given the necessities of clinical research and the past research indicating that self-report measures can produce valid and reliable results, we believe that a self-report measure is appropriate (Baker & Brandon, 1990).

In each domain the presence of the motive was assessed, as were characteristics of the motive. For example, cravings may vary along a variety of dimensions, such as frequency, intensity, and controllability of cravings. Some smokers may have frequent mild cravings while others may have very intense cravings less often. It is important to examine each of these dimensions in relation to drug motivation and dependence. In addition, smokers may differ in the number of cues they encounter, the frequency with which they encounter smoking cues, and the salience of these cues. Therefore, individual characteristics of each motive were assessed along with the presence of the motive itself.

Appendix B. The Wisconsin Inventory of Smoking Dependence Motives (WISDM-68)

Below are a series of statements about cigarette smoking. Please rate your level of agreement for each using the following scale:

1	2	3	4	5	6	7
Not True of Me At All						Extremely True of Me

1.	I enjoy the taste of cigarettes most of the time.	1	2	3	4	5	6	7
2.	Smoking keeps me from gaining weight.	1	2	3	4	5	6	7
3.	Smoking makes a good mood better.	1	2	3	4	5	6	7
4.	If I always smoke in a certain place it is hard to be there and not smoke.	1	2	3	4	5	6	7
5.	I often smoke without thinking about it.	1	2	3	4	5	6	7
6.	Cigarettes control me.	1	2	3	4	5	6	7
7.	Smoking a cigarette improves my mood.	1	2	3	4	5	6	7
8.	Smoking makes me feel content.	1	2	3	4	5	6	7
9.	I usually want to smoke right after I wake up.	1	2	3	4	5	6	7
10.	Very few things give me pleasure each day like cigarettes.	1	2	3	4	5	6	7
11.	It's hard to ignore an urge to smoke.	1	2	3	4	5	6	7
12.	The flavor of a cigarette is pleasing.	1	2	3	4	5	6	7
13.	I smoke when I really need to concentrate.	1	2	3	4	5	6	7
14.	I can only go a couple hours between cigarettes.	1	2	3	4	5	6	7
15.	I frequently smoke to keep my mind focussed.	1	2	3	4	5	6	7
16.	I rely upon smoking to control my hunger and eating.	1	2	3	4	5	6	7
17.	My life is full of reminders to smoke.	1	2	3	4	5	6	7
18.	Smoking helps me feel better in seconds.	1	2	3	4	5	6	7
19.	I smoke without deciding to.	1	2	3	4	5	6	7
20.	Cigarettes keep me company, like a close friend.	1	2	3	4	5	6	7
21.	Few things would be able to replace smoking in my life.	1	2	3	4	5	6	7
22.	I'm around smokers much of the time.	1	2	3	4	5	6	7
23.	There are particular sights and smells that trigger strong urges to smoke.	1	2	3	4	5	6	7
24.	Smoking helps me stay focussed.	1	2	3	4	5	6	7
25.	Smoking helps me deal with stress.	1	2	3	4	5	6	7
26.	I frequently light cigarettes without thinking about it.	1	2	3	4	5	6	7
27.	Most of my daily cigarettes taste good.	1	2	3	4	5	6	7
28.	Sometimes I feel like cigarettes rule my life.	1	2	3	4	5	6	7
29.	I frequently crave cigarettes.	1	2	3	4	5	6	7
30.	Most of the people I spend time with are smokers.	1	2	3	4	5	6	7
31.	Weight control is a major reason that I smoke.	1	2	3	4	5	6	7
32.	I usually feel much better after a cigarette.	1	2	3	4	5	6	7
33.	Some of the cigarettes I smoke taste great.	1	2	3	4	5	6	7
34.	I'm really hooked on cigarettes.	1	2	3	4	5	6	7
35.	Smoking is the fastest way to reward myself.	1	2	3	4	5	6	7
36.	Sometimes I feel like cigarettes are my best friends.	1	2	3	4	5	6	7

37. My urges to smoke keep getting stronger if I don't smoke.   1   2   3   4   5   6   7
38. I would continue smoking, even if it meant I could spend   1   2   3   4   5   6   7
    less time on my hobbies and other interests.
39. My concentration is improved after smoking a cigarette.   1   2   3   4   5   6   7
40. Seeing someone smoke makes me really want a cigarette.   1   2   3   4   5   6   7

41. I find myself reaching for cigarettes without thinking about it.   1   2   3   4   5   6   7
42. I crave cigarettes at certain times of day.   1   2   3   4   5   6   7
43. I would feel alone without my cigarettes.   1   2   3   4   5   6   7
44. A lot of my friends or family smoke.   1   2   3   4   5   6   7
45. Smoking brings me a lot of pleasure.   1   2   3   4   5   6   7

46. Cigarettes are about the only things that can give me a lift   1   2   3   4   5   6   7
    when I need it.
47. Other smokers would consider me a heavy smoker.   1   2   3   4   5   6   7
48. I feel a strong bond with my cigarettes.   1   2   3   4   5   6   7
49. It would take a pretty serious medical problem to make me   1   2   3   4   5   6   7
    quit smoking.
50. When I haven't been able to smoke for a few hours,   1   2   3   4   5   6   7
    the craving gets intolerable.

51. When I do certain things I know I'm going to smoke.   1   2   3   4   5   6   7
52. Most of my friends and acquaintances smoke.   1   2   3   4   5   6   7
53. I love the feel of inhaling the smoke into my mouth.   1   2   3   4   5   6   7
54. I smoke within the first 30 minutes of awakening in the morning.   1   2   3   4   5   6   7
55. Sometimes I'm not aware that I'm smoking.   1   2   3   4   5   6   7

56. I'm worried that if I quit smoking I'll gain weight.   1   2   3   4   5   6   7
57. Smoking helps me think better.   1   2   3   4   5   6   7
58. Smoking really helps me feel better if I've been feeling down.   1   2   3   4   5   6   7
59. Some things are very hard to do without smoking.   1   2   3   4   5   6   7
60. Smoking makes me feel good.   1   2   3   4   5   6   7

61. Smoking keeps me from overeating.   1   2   3   4   5   6   7
62. My smoking is out of control.   1   2   3   4   5   6   7
63. I consider myself a heavy smoker.   1   2   3   4   5   6   7
64. Even when I feel good, smoking helps me feel better.   1   2   3   4   5   6   7
65. I reach for cigarettes when I feel irritable.   1   2   3   4   5   6   7

66. I enjoy the sensations of a long, slow exhalation of smoke.   1   2   3   4   5   6   7
67. Giving up cigarettes would be like losing a good friend.   1   2   3   4   5   6   7
68. Smoking is the easiest way to give myself a lift.   1   2   3   4   5   6   7

Appendix C. WISDM-68 Scoring Key

Item Numbers	Motive Assessed
20, 36, 43, 48, 67	Affiliative Attachment
5, 19, 26, 41, 55	Automaticity
6, 28, 34, 62	Loss of Control
10, 21, 35, 38, 46, 49, 68	Behavioral Choice/Melioration
13, 15, 24, 39, 57	Cognitive Enhancement
11, 29, 37, 50	Craving
4, 17, 23, 40, 42, 51, 59	Cue Exposure/Associative Processes
7, 18, 25, 32, 58, 65	Negative Reinforcement
3, 8, 45, 60, 64	Positive Reinforcement
22, 30, 44, 52	Social/Environmental Goads
1, 12, 27, 33, 53, 66	Taste/Sensory Processes
9, 14, 47, 54, 63	Tolerance
2, 16, 31, 56, 61	Weight Control

To calculate the scores of the subscales, take the mean of the items that load onto each subscale. The total scale score is the sum of all of the subscale scores, or a sum of the means for each subscale.