Original Investigation

Development of the Brief Wisconsin Inventory of Smoking Dependence Motives

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Abstract

Introduction: The 68-item Wisconsin Inventory of Smoking Dependence Motives (WISDM-68) is a theoretically derived measure of tobacco dependence consisting of 13 subscales measuring a variety of smoking motives. The WISDM-68 subscales have demonstrated good psychometric characteristics and have the potential to elucidate diverse nicotine dependence factors and mechanisms. The present research aimed to shorten the WISDM to reduce assessment burden while maintaining or enhancing its psychometric properties.

Methods: Data from three independent samples (one longitudinal observational study and two randomized clinical trials) were used to select subscales and reduced sets of items in order to develop and test a brief version of the WISDM-68. The full-item and reduced-item versions of the WISDM were then compared in terms of reliability, validity, and model fit (via confirmatory factor analysis) in the three independent samples.

Results: Thirty-one items were dropped from the WISDM, the Behavioral Choice–Melioration subscale was dropped, and the Negative and Positive Reinforcement subscales were consolidated. This resulted in a new WISDM short form (Brief WISDM) comprising 37 items that load onto 11 subscales. The psychometric properties of the reduced-item WISDM subscales were found to be comparable with the full-item subscales in terms of internal consistency, long-term stability, concurrent validity, predictive validity, and model fit.

Discussion: These analyses provide good evidence that the 37-item Brief WISDM can be used in place of the original 68-item WISDM if researchers desire to reduce participant assessment burden.

Introduction

Measures of nicotine dependence (ND) can be used to characterize both the smokers' motivation to use nicotine and the problems caused by such use. However, there is a notable lack of consensus about the nature and optimal measurement of ND (e.g., Etter, 2008; Hendricks, Prochaska, Humfleet, & Hall, 2008; Piper, McCarthy, & Baker, 2006). Many studies have used the Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) to assess ND; however, there are reasons to use additional dependence assessments. For instance, the FTND does not sample a broad range of dependence dimensions and has a mixed record of predicting some outcomes, such as withdrawal and cessation likelihood (Piper et al., 2006). In addition, recent genetic and psychometric studies suggest that ND is multidimensional (e.g., Baker, Conti, Moffitt, & Caspi, 2009; Baker, Weiss, et al., 2009; Broms et al., 2007; Hudmon et al., 2003; Piper et al., 2004; Shiffman & Sayette, 2005; Shiffman, Waters, & Hickcox, 2004).

The Wisconsin Inventory of Smoking Dependence Motives (WISDM-68; Piper, McCarthy, et al., 2008; Piper et al., 2004) is a 68-item multidimensional measure of ND consisting of 13 subscales that measure a variety of theoretically derived smoking motives. Piper et al. (2004) reported good internal consistency with Cronbach's α ≥.87 for all 13 subscales, and confirmatory factor analyses (CFAs) supported the multidimensionality of the WISDM-68. Piper et al. (2004) also presented results that supported concurrent validity (significant total score and subscale score correlations with the FTND, cigarettes per day [CPD], and breath carbon monoxide) and predictive validity (predicting relapse) for a subset of the subscales. A recent psychometric study of the WISDM-68 by Shenassa, Graham, Burdzovic, and Buka, (2009) also found good internal consistency for the 13 subscales and support for multidimensionality but

concurrent validity was somewhat weaker than the results reported by Piper et al. (2004).

The distinct theoretical bases of the WISDM-68 subscales and the scale's strong psychometric properties suggest that it may assess ND accurately and help elucidate its mechanisms. For example, a recent study by Cannon et al. (2005) demonstrated an association between phenylthiocarbamide gene polymorphisms that determine sensitivity to bitter taste and ratings on the WISDM-68 Taste and Sensory Properties subscale. Other research has identified a subset of four WISDM-68 subscales (Automaticity, Craving, Loss of Control, and Tolerance) that appears to constitute necessary and sufficient measures of dependence (Piper, Bolt, et al., 2008). In addition, this subset has been found to be especially highly associated with the CHRNA A_5-A_3-B_4 cluster haplotypes associated with severe dependence (Baker, Weiss, et al., 2009).

Although the WISDM-68 is a promising instrument, its length imposes a significant assessment burden. Prior research and methodologic work provide sound strategies for producing and evaluating shortened assessment instruments (cf., Coste, Guillemin, Pouchot, & Fermanian, 1997; Cox, Tiffany, & Christen, 2001; Heishman, Singleton, & Pickworth, 2008; Myers, McCarthy, MacPherson, & Brown, 2003; Smith, McCarthy, & Anderson, 2000). Also, prior research on the WISDM-68 (Piper et al., 2004; Shenassa et al., 2009) supports exploring the possibility of shortening the WISDM-68 by combining certain pairs of very highly correlated subscales: Negative Reinforcement (NR) and Positive Reinforcement (PR) subscales and Behavioral Choice (BC)-Melioration and Affiliative Attachment (AA).

The overarching goal of this study was to develop and validate a brief version of the WISDM-68 that (a) retains its multidimensional structure; (b) retains sufficient items to permit reliable and representative construct coverage; and (c) demonstrates reliability, validity, and factor structure comparable with the full-item WISDM-68 across independent datasets. To this end, we conducted psychometric and other analyses in three independent samples of smokers consistent with the methodological recommendations of Smith et al. (2000) and others (e.g., Coste et al., 1997) on short-form development.

Methods

Data from three independent samples of smokers who completed the WISDM-68 and other smoking-related measures were used in analyses.

Sample 1: The Wisconsin Behavioral Health Survey

The Wisconsin Behavioral Health Survey (WBHS) was a longitudinal observational study of a sample of 453 adult Wisconsin smokers who had participated in the 2003 *Wisconsin Tobacco Survey* (WTS; Ahrens, Bandi, Ullsvik, & Moberg, 2005; Smith, Beckley, & Fiore, 2005). The 2003 WTS was a population-based epidemiologic phone survey that collected data on tobacco use and other health-related behaviors in 8,111 representative Wisconsin adults including 1,544 current smokers. WBHS participants (N = 453; 86% White) were recruited from among the 1,544 current smokers and completed phone interviews and

the WISDM-68 (via mail) 1 and 2 years after their initial WTS interview (see Niederdeppe, Fiore, Baker, & Smith, 2008, for more details). The sample of 366 WBHS participants listed in Table 1 consists of those who were smoking at 12 months post-WTS and who returned mailed questionnaires.

Sample 2: The University of Wisconsin Center for Tobacco Research and Intervention Bupropion and Nicotine Gum Clinical Trial ("Bupropion–Gum Study")

This randomized clinical trial was conducted at the University of Wisconsin Center for Tobacco Research and Intervention. Adult smokers (N = 608; currently smoking >9 CPD; 76% White) were randomized to receive bupropion + placebo gum (n = 224), bupropion + active nicotine gum (n = 228), or placebo pill + placebo gum (n = 156). All study participants also received three 10-min counseling sessions and completed the WISDM-68, the FTND, and other questionnaires at a prequit baseline visit. Six-month smoking status was biochemically confirmed via carbon monoxide (CO). More detailed methods and results for this study can be found in Piper et al. (2007).

Sample 3: The M. D. Anderson Cancer Center Break-Free Clinical Trial ("Break-Free Study")

In this study, 399 adult Black smokers (≥5 CPD for the past year) were randomized to receive standard care consisting of 6 weeks of nicotine patch, the culturally sensitive self-help guide *Pathways to Freedom* and five individual counseling sessions, or standard care plus interactive, real-time computer-delivered (via handheld personal digital assistant) treatment (Businelle et al., 2008; Kendzor et al., 2008; Rowan et al., 2007). Six-month smoking status was biochemically confirmed via CO and saliva cotinine. The WISDM-68 was administered by computer approximately 19 days prequit and at 1 month and 26 weeks postquit. More detailed methods and results for this study can be found in Kendzor et al.

Measures

Wisconsin Inventory of Smoking Dependence Motives

The guiding premise in developing the WISDM-68 was that dependence reflects multiple motives to seek and use drug (nicotine; Piper et al., 2004). Thirteen motives were identified based primarily on theoretical considerations (see Piper et al., 2004, for details and scoring information); Table 1 lists the 13 subscales and provides brief descriptors of the subscales. 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*.

Two new synthetic WISDM scales, developed as a result of latent class analyses and factor mixture models (Piper, Bolt, et al., 2008), were also examined. The Primary Dependence Motives (PDM) scale consists of the mean of four WISDM subscales: Automaticity, Loss of Control, Craving, and Tolerance. The PDM scale indexes heavy smoking that is not discriminated on contextual cues, that occurs with little conscious control or mediation, and that is characterized by frequent, strong, and bothersome craving. The Secondary Dependence Motives (SDM) scale consists of the mean of the remaining nine WISDM-68 subscales that are not part of the PDM scale. These nine subscales assess diverse

Table 1. Descriptive statistics for the smoker samples

Measure	Wisconsin Behavioral Health Survey ($N = 366$)	Bupropion–Gum Clinical Trial ($N = 608$)	Break-Free Clinical Trial ($N = 393$)
% Female	63.7	57.9	50.9
% White/Caucasian	86.3	75.9	0
% Black	10.4	22.1	100
% High school (HS) or post-HS	93.4	90.7	82.2
% Married or member of a couple	50.8	56.1	41.4
	Mean (SD)		
Age	46.2 (12.9)	41.7 (11.3)	42.4 (9.7)
Cigarettes per day	17.1 (10.8)	22.4 (9.8)	20.6 (12.2)
FTND score[a]	3.6 (2.3)	5.6 (2.1)	–
WISDM *Affiliative Attachment* (strong emotional attachment to smoking)	3.1 (1.8)	3.0 (1.6)	3.8 (1.9)
WISDM *Automaticity* (smoking without awareness or intention)	4.2 (1.8)	4.7 (1.7)	4.6 (1.7)
WISDM *Loss of Control* (loss of volitional control over smoking)	4.3 (1.7)	5.2 (1.4)	4.7 (1.6)
WISDM *Behavioral Choice/Melioration* (smoking despite constraints on/negative consequences of smoking and/or lack of other reinforcers)	3.5 (1.5)	3.2 (1.3)	3.8 (1.7)
WISDM *Cognitive Enhancement* (smoking to improve cognitive functioning)	3.2 (1.7)	3.2 (1.6)	3.9 (1.8)
WISDM *Craving* (intense frequent urges to smoke)	4.4 (1.6)	4.9 (1.3)	5.0 (1.6)
WISDM *Cue Exposure/Associative Processes* (associative strength of cues to elicit smoking motivation)	4.4 (1.4)	4.6 (1.3)	4.7 (1.4)
WISDM *Negative Reinforcement* (smoking to ameliorate negative internal states)	4.1 (1.5)	4.1 (1.4)	4.7 (1.6)
WISDM *Positive Reinforcement* (smoking for pleasure or to enhance positive feelings or experience	3.8 (1.5)	3.6 (1.5)	4.2 (1.7)
WISDM *Social/Environmental Goads* (potency of social stimuli or contexts in increasing smoking motivation)	3.8 (2.0)	3.8 (1.9)	4.5 (2.0)
WISDM *Taste/Sensory Properties* (smoking for orosensory or gustatory effects)	4.3 (1.5)	4.2 (1.5)	4.7 (1.7)
WISDM *Tolerance* (need to smoke increasing amounts to get desired effect; ability to smoke heavily without toxicity)	4.2 (1.8)	5.1 (1.3)	5.2 (1.5)
WISDM *Weight Control*	3.0 (1.9)	2.9 (1.7)	3.3 (1.8)
WISDM *Primary Dependence Motives Scale*[b]	4.3 (1.5)	5.0 (1.2)	4.9 (1.4)
WISDM *Secondary Dependence Motives Scale*[c]	3.7 (1.1)	3.6 (1.1)	4.2 (1.4)
WISDM total score[d]	50.4 (15.1)	52.4 (13.0)	57.1 (17.2)

Note. [a]FTND = Fagerström Test for Nicotine Dependence (Heatherton et al., 1991).

[b]Primary Dependence Motives scale = mean of Automaticity, Loss of Control, Craving, and Tolerance.

[c]Secondary Dependence Motives scale = mean of Affiliative Attachment, Behavioral Choice/Melioration, Cognitive Enhancement, Cue Exposure/Associative Processes, Affective Enhancement, Social/Environmental Goads, Taste, and Weight Control.

[d]WISDM total score = mean of 13 WISDM subscale scores.

smoking motives that tend to reflect instrumental effects of smoking (e.g., Weight Control, NR) and contextually bound effects (e.g., Cue Exposure/Associative Processes; Social/Environmental Goads). Analyses showed that the PDM scale is more highly related than the SDM scale to traditional dependence.

Demographics and Smoking History
Each of the three studies assessed demographic characteristics, including gender, ethnicity, age, marital/partner status, employment status, and education level (see Table 1).

Concurrent Validity Measures
The FTND and CPD at baseline were selected as concurrent validity measures. The full 6-item FTND was administered in the WBHS and the Bupropion–Gum Study, whereas the

Break-Free study administered only Item 1 of the FTND (time to first cigarette after waking). In the Break-Free sample, CPD was categorized to construct FTND Item 4 (four categories of CPD scored 0–3) and combined with FTND Item 1 to form the Heaviness of Smoking Index (HSI; Heatherton, Kozlowski, Frecker, Rickert, & Robinson, 1989) that correlates highly with the total FTND score (e.g., Chabrol, Niezborala, Chastan, & de Leon, 2005; de Leon et al., 2003).

Predictive Validity Measures
Predictive validity was tested using 6-month abstinence outcome data from the Bupropion–Gum and Break-Free studies. The outcome variable consisted of biochemically validated 7-day point prevalence abstinence at 6 months coded as 0 = abstinent and 1 = smoking.

Table 2. Internal consistency and 1-year stability of WISDM-68 and Brief WISDM subscales

| WISDM subscale | Cronbach's alpha at baseline (internal consistency) | | | | | | One-year stability (correlations[a]) | |
| | WBHS (N = 366) | | Bupropion–Gum study (N = 608) | | Break-Free Study (N = 393) | | WBHS (N = 218) | |
	WISDM-68	Brief WISDM	WISDM-68	Brief WISDM	WISDM-68	Brief WISDM	WISDM-68	Brief WISDM
Affiliative Attachment	.93	.90	.88	.83	.91	.86	.78	.72
Automaticity	.91	.92	.90	.90	.86	.89	.69	.66
Loss of Control	.87	.87	.77	.77	.82	.82	.73	.73
Behavioral Choice/Melioration	.88	N/A	.83	–	.88	–	.78	–
Cognitive Enhancement	.94	.92	.92	.89	.91	.88	.70	.67
Craving	.85	.85	.80	.80	.86	.86	.73	.73
Cue Exposure/Associative Processes	.81	.69	.81	.68	.82	.72	.65	.63
Negative Reinforcement	.89	–	.86	–	.89	–	.72	–
Positive Reinforcement	.85	–	.85	–	.88	–	.72	–
Affective Enhancement	–	.76	–	.77	–	.78	–	.69
Social/Environmental Goads	.94	.93	.94	.94	.92	.91	.66	.66
Taste	.88	.88	.88	.87	.91	.91	.69	.61
Tolerance	.85	.85	.72	.73	.80	.79	.81	.81
Weight Control	.94	.90	.89	.88	.82	.84	.68	.64
WISDM total score[b]	.91	.87	.89	.84	.94	.91	.77	.76
Primary Dependence Motives scale[c]	.89	.88	.82	.81	.90	.89	.79	.79
Secondary Dependence Motives scale[d]	.86	.76	.86	.76	.92	.86	.75	.72

Note. N/A = not applicable.

[a]All stability correlations are statistically significant, $p < .001$.

[b]WISDM total score = mean of 13 WISDM subscale scores.

[c]Primary Dependence Motives scale = mean of Automaticity, Loss of Control, Craving, and Tolerance.

[d]Secondary Dependence Motives scale = mean of Affiliative Attachment, Behavioral Choice/Melioration, Cognitive Enhancement, Cue Exposure/Associative Processes, Affective Enhancement, Social/Environmental Goads, Taste, and Weight Control.

Statistical analyses

Dimensionality

Based on high WISDM-68 subscale intercorrelations, we examined the dimensionality of the 11 items comprised by the NR and PR subscales and the 12 items comprised by the BC and AA subscales. Two-factor structural equation model (SEM) exploratory factor analysis (EFA) computed in Mplus (Muthén & Muthén, 1998–2007; see Asparouhov & Muthén, 2008) was used to assess dimensionality of the targeted item sets. This analysis permitted examination of the pattern of loadings and cross-loadings to ascertain the extent to which, for example, NR items load on one factor with no significant cross-loadings on the other factor (i.e., a component of simple structure). In addition, dimensionality was assessed with parallel analysis (Horn, 1965; Humphreys & Montanelli, 1975) and scree test plots (Fabrigar, Wegener, MacCallum & Strahan, 1999). Parallel analysis compares the eigenvalues from a sample of data with eigenvalues computed on the basis of repeated sets of random data. Random data eigenvalues were computed via a SAS macro developed by Kabacoff (2003).

Item Selection Analyses

Item-to-total correlations were computed for each of the WISDM-68 subscales in each sample, and conventional maximum likelihood (ML) one-factor EFAs were computed separately for each subscale to obtain factor loadings. Three or four items per subscale were selected to achieve high item-to-total correlations and factor loadings while maintaining construct content coverage. Given the importance of the synthetic PDM scale, we chose four items for the four subscales contributing to the PDM scale.

Predictive Validity Analyses

Predictive validity was tested separately in the Bupropion–Gum and Break-Free studies by computing univariate logistic regression models (Hosmer & Lemeshow, 2000) in which biochemically confirmed 6-month abstinence was the dependent variable and single subscales or synthetic scales were entered as independent variables (along with a variable that controlled for treatment in each study). For each study, a set of models were computed for the full-item versions of the WISDM subscales for which reduced-item versions were developed; a corresponding set of models were computed for the reduced-item versions of the WISDM subscales. The Bupropion–Gum Study analyses include only White smokers (N = 452 out of the total sample of 608) to provide a racially homogeneous sample to compare with the Break-Free sample that recruited only Black smokers.

Table 3. Correlations between WISDM-68 and Brief WISDM subscales and with validity measures

	Bivariate correlations between WISDM subscale and validity measure											
	WBHS (*N* = 366)				Bupropion–Gum Study (*N* = 608)				Break-Free Study (*N* = 393)			
	WISDM-68		Brief WISDM		WISDM-68		Brief WISDM		WISDM-68		Brief WISDM	
WISDM subscale	FTND[a]	CPD	FTND	CPD	FTND	CPD	FTND	CPD	HSI[b]	CPD	HSI	CPD
Affiliative Attachment	.40	.27	.35	.21	.25	.08	.23	.06	.37	.34	.33	.30
Automaticity	.55	.45	.52	.43	.42	.32	.39	.29	.33	.29	.31	.26
Loss of Control	.52	.38	.52	.38	.35	.25	.35	.25	.36	.28	.36	.28
Behavioral Choice/Melioration	.44	.33	–	–	.30	.14	–	–	.39	.32	–	–
Cognitive Enhance	.39	.25	.36	.24	.21	.14	.20	.15	.31	.26	.29	.26
Craving	.48	.33	.48	.33	.38	.20	.38	.20	.36	.29	.36	.29
Cue Exposure/Associative Processes	.32	.25	.26	.21	.23	.10	.23	.09	.32	.30	.29	.26
Negative Reinforcement	.33	.21	–	–	.21	.07	–	–	.37	.30	–	–
Positive Reinforcement	.31	.23	–	–	.20	.08	–	–	.35	.30	–	–
Affective Enhancement	–	–	.31	.21	–	–	.20	.07	–	–	.38	.31
Social/Environmental Goads	.10	.06	.09	.05	.11	.08	.10	.06	.17	.18	.18	.18
Taste	.28	.26	.27	.26	.19	.11	.19	.14	.37	.33	.34	.30
Tolerance	.75	.57	.77	.57	.66	.37	.68	.36	.52	.36	.53	.36
Weight Control	.04	.03	.04	.02	.03	.01	.05	.00	.11	.12	.11	.11
WISDM total[c]	.54	.40	.55	.40	.40	.22	.42	.23	.43	.36	.42	.36
Primary Dependence Motives scale[d]	.67	.50	.68	.51	.56	.35	.56	.35	.45	.35	.45	.34
Secondary Dependence Motives scale[e]	.40	.29	.37	.25	.27	.13	.26	.12	.39	.34	.36	.33

Note. CPD = cigarettes per day.

[a]FTND = Fagerstrom Test for Nicotine Dependence (Heatherton et al., 1991).

[b]HSI = Heaviness of Smoking Index (Heatherton et al., 1989).

[c]WISDM total score = mean of 13 WISDM subscale scores.

[d]Primary Dependence Motives scale = mean of Automaticity, Loss of Control, Craving, and Tolerance.

[e]Secondary Dependence Motives scale = mean of Affiliative Attachment, Behavioral Choice/Melioration, Cognitive Enhancement, Cue Exposure/Associative Processes, Affective Enhancement, Social/Environmental Goads, Taste, and Weight Control.

CFAs of the Brief WISDM

Mplus (Muthén & Muthén, 1998–2007) was used to compute CFAs with ML estimation for the Brief WISDM developed as described above. Approximate goodness-of-fit was evaluated via the following fit indices: (a) the standardized root mean square residual (SRMR) as an index of absolute fit, (b) the comparative fit index (CFI) and the Tucker–Lewis index (TLI) as incremental fit indices (of the relative improvement in model fit over a baseline model), and (3) the root mean square error of approximation (RMSEA) as a parsimony-corrected fit index (Brown, 2006). These fit indices were evaluated according to the general recommendations of Hu and Bentler (1999) such that SRMR values <0.09 indicate good fit, CFI and TLI values between 0.90 and 0.95 indicate acceptable fit, and RMSEA values between 0.06 and 0.08 indicate acceptable fit.

The WBHS sample was used to test an initial 11-factor model; modification indices (MIs) and expected parameter change (EPC) values were inspected to detect candidate parameters that could possibly be freed in a subsequent model (Brown, 2006) to improve fit. In the WBHS analyses, candidate parameters were successively freed one at a time and a one-degree-of-freedom (*df*) χ^2 difference test was computed to evaluate the improvement in model fit. The final model developed with WBHS data was then cross-validated with the Bupropion–Gum study data and the Break-Free study data.

Results

NR and PR consolidation

The 11 NR and PR items from the WBHS sample were analyzed in a two-factor SEM EFA (Asparouhov & Muthén, 2008). The theoretically stipulated pattern of factor loadings (NR items loading on one factor and PR items loading on the other factor with no significant cross-loadings) was not obtained. In fact, both factors contained a mix of NR and PR items with four items cross-loading on both. Similar results were obtained for the Bupropion–Gum and Break-Free samples. These results support consolidation of the NR and PR items into a single subscale for purposes of the reduced-item WISDM (see section below on item selection). The results of the parallel analyses and scree tests also suggested that these items could be efficiently represented as a single factor (e.g., the first five eigenvalues for the Bupropion–Gum sample were 6.08, 0.89, 0.77, 0.66, and 0.51; more detailed information on the results of these analyses can be obtained from the authors).

BC and AA consolidation

The pattern of the factor loadings of the combined set of 12 BC and AA items was examined in a two-factor SEM EFA. Results of this analysis showed that several BC and AA items loaded significantly on each of the two factors and there were four items that

Table 4. Univariate logistic regression results using WISDM-68 and Brief WISDM versions of subscales and synthetic scales as predictors of abstinence at 6-month follow-up, Bupropion–Gum Study, and Break-Free Study

| Univariate models with individual WISDM subscales[b] | Bupropion−Gum Study − White smokers[a] ($N = 452$) | | | | | | Break-Free Study − Black smokers ($N = 395$) | | | | | |
| | WISDM-68 versions | | | Brief WISDM versions | | | WISDM-68 versions | | | Brief WISDM versions | | |
	B	Wald	p	B	Wald	p	B	Wald	p	B	Wald	p
Affiliative Attachment	.04	0.35	.552	.06	0.73	.395	.07	0.09	.399	.05	0.31	.577
Automaticity	.20	8.66	.003	.18	7.86	.005	.09	0.94	.331	.10	1.33	.248
Loss of Control	.004	0.002	.967	.004	0.002	.967	.16	2.59	.108	.16	2.59	.108
Cognitive Enhancement	.05	0.50	.480	.03	0.16	.691	.07	0.55	.457	.10	1.20	.273
Craving	.10	1.21	.272	.10	1.21	.272	.21	4.46	.035	.21	4.46	.035
Cue Exposure–Associative Processes	.11	1.48	.223	.05	0.42	.518	−.01	0.01	.905	.01	0.02	.891
Social–Environmental Goads	.13	4.39	.036	.12	4.21	.040	.07	0.82	.367	.08	0.96	.326
Taste and Sensory Processes	.04	0.25	.617	.04	0.27	.603	.18	3.24	.072	.17	.3.73	.053
Tolerance	.26	9.50	.002	.27	12.83	<.001	.27	7.27	.007	.28	8.27	.004
Weight Control	−.07	1.19	.276	−.05	0.52	.473	.04	0.36	.716	.002	.001	.980
Univariate models with individual WISDM synthetic scales	B	Wald	p	B	Wald	p	B	Wald	p	B	Wald	p
Primary Dependence Motives scale[c]	.23	5.50	.019	.24	6.27	.012	.23	4.31	.038	.24	4.77	.029
Secondary Dependence Motives scale[d]	.08	0.60	.441	.10	0.81	.369	.15	1.54	.215	.14	1.41	.235

Note. [a]The Bupropion−Gum Study analyses include only White smokers ($N = 452$ out of the total sample of 608) to provide a racially homogeneous sample to compare with the Break-Free sample that recruited only Black smokers.

[b]Each model includes treatment as a predictor along with the WISDM subscale or scale; Negative Reinforcement and Positive Reinforcement subscales are not included because these scales were merged into one scale (Affective Enhancement) for the Brief WISDM version.

[c]Primary Dependence Motives scale = mean of Automaticity, Loss of Control, Craving, and Tolerance.

[d]Secondary Dependence Motives scale = mean of Affiliative Attachment, Behavioral Choice/Melioration, Cognitive Enhancement, Cue Exposure/ Associative Processes, Affective Enhancement, Social/Environmental Goads, Taste, and Weight Control.

cross-loaded on the two factors. Similar results were obtained for the Bupropion–Gum and Break-Free samples. These results support one factor rather than two separate factors. To test which BC and AA items load most strongly on a single factor, a one-factor ML EFA was computed. Results for all three samples showed that the factor loadings of all the AA items exceeded all the loadings of the BC items. These results suggest that BC and AA items reflect a single factor and that AA items reflect that factor better than the BC items. The parallel analysis and scree test results also suggest that the item set can be efficiently modeled by a single factor: for example, eigenvalues for the Bupropion–Gum sample were 6.09, 0.98, 0.79, and 0.70. A decision to drop the BC subscale from the Brief WISDM (and retain only AA items) was supported by the pattern of findings of the dimensionality analyses and also by a prior finding that BC was negatively related to relapse (Piper et al., 2004).

Item selection for the WISDM subscales

Our analyses of the overlap of the NR and PR subscales (described above) supported merging subscales into a single 3-item "Affective Enhancement" subscale. This was done because the two subscales were designed to tap smokers' perceptions that smoking improves mood (albeit from different starting points) and because of the results of the item-to-total and factor analyses of the NR and PR items that suggested that the items tapped a single Affective Enhancement factor (see Appendix). This

change, along with the elimination of the BC subscale, reduced the total number of Brief WISDM subscales from 13 to 11.

Evaluation of the item-to-total correlations, factor analysis results, and content coverage identified three- or four-item versions of the remaining subscales (see Appendix). Two of the original Taste and Sensory Processes items (numbers 53 and 66) tapped the rewarding aspects of sensory experiences related to inhaling and exhaling smoke, and a decision was made to select only "taste" items for the reduced-item version of the subscale in order to make the subscale construct more homogeneous. These 11 three- and four-item subscales (37 total items) constitute the Brief WISDM.

Internal consistency and long-term stability

We computed internal consistency and long-term stability for the Brief WISDM subscales relative to the WISDM-68 subscales. Table 2 provides Cronbach's alpha for the Brief WISDM and WISDM-68 subscales for each of the three samples. Alpha coefficients exceeded .80 for all Brief WISDM subscales in each of the three samples except for the Cue Exposure subscale (α ranged from .69 to .72), the Affective Enhancement subscale (.76–.78), and the SDM scale (.76–.86). In general, the reduction in the alpha coefficient for a Brief WISDM subscales relative to the corresponding, longer WISDM-68 subscales, was modest.

Table 2 also shows bivariate stability correlations for each WISDM-68 and Brief WISDM subscales for those WBHS participants who were smoking at both timepoints ($N = 218$) and who completed the WISDM-68 at enrollment and again approximately 1 year later. These correlations ranged from .63 to .81 and support long-term stability.

Concurrent and predictive validity

Concurrent validity was evaluated by assessing the correlations between the WISDM-68 and the Brief WISDM subscales with the FTND (or HSI in the Break-Free study) and CPD (see Table 3). In general, correlations for the Brief WISDM and WISDM-68 subscales were very similar. Table 3 also shows correlations between the full- and reduced-item versions for each of the WISDM subscales and scales from the same dataset. In general, the correlations exceed .97 except for Cue Exposure ($r = -.87$ to .89) and Taste ($r = .94$–.95).

Results for predictive validity analyses are presented in Table 4. Comparison of the results for the Bupropion–Gum study for the WISDM-68 and Brief WISDM subscales as predictors of 6-month abstinence showed that the same Brief WISDM and WISDM-68 subscales were significantly related to abstinence for both versions. B coefficients and Wald values were somewhat different, but the pattern of significant and nonsignificant effects in the models was identical. The results were similar for the Break-Free study with the Brief WISDM and WISDM-68 subscales demonstrating similar predictive validities (see Table 4). Taken together, the results of the validity analyses demonstrate that the Brief WISDM subscales are comparable with the WISDM-68 subscales in terms of concurrent and predictive validity.

CFAs of the Brief WISDM

An initial 11-factor CFA in the WBHS sample of the 37 Brief WISDM items yielded the following results: $\chi^2(df = 574) = 1,504.1$, SRMR = 0.049, CFI = 0.910, TLI = 0.896, and RMSEA = 0.067 (95% $CI = 0.062$–0.071). Examination of MI and EPC values showed very large misspecification due to correlated error variances for four pairs of items: 9 & 54, 62 & 63, 6 & 28, and 47 & 63. Models that freely estimated the error covariances of these item pairs resulted in improved model fit (Brown, 2006). The CFA results for the model freely estimating correlated errors in the Bupropion–Gum study showed acceptable-to-close fit: $\chi^2(df = 570) = 1,174.9$, SRMR = 0.039, CFI = 0.954, TLI = 0.947, and RMSEA = 0.042 (95% $CI = 0.038$–0.045). CFA for this same model for the Break-Free study showed acceptable fit: $\chi^2(df = 570) = 1,384.8$, SRMR = 0.043, CFI = 0.924, TLI = 0.911, and RMSEA = 0.060 (95% $CI = 0.056$–0.064). Thus, the 11-factor model for the 37-item Brief WISDM appears to fit the data reasonably well across three independent samples taking into account correlated errors for four-item pairs in which similarity of wording or meaning was apparent.

Discussion

The primary goal of the present research was to create a short form of the 68-item WISDM that has good reliability, validity, and a replicable well-fitting structure while preserving the multidimensional essence of the measure. Across three diverse independent samples of smokers, we developed an 11-factor 37-item version of the WISDM that showed good internal consistency, long-term (1 year) stability, and concurrent and predictive validity that was compa-

rable with the WISDM-68. The structure of the 11-factor Brief WISDM was found in CFAs to have acceptable-to-close fit across the three samples supporting the multidimensional nature of ND. In addition, the stability of the Brief WISDM scores after 1 year (in continuing smokers) suggests that the specific dependence motives are substantially stable. Of special note, internal consistencies also remained high despite a reduction in items for the subscales.

The construction of the Brief WISDM involved reducing the number of subscales from 13 to 11 based on subscale distinctiveness and overlap. It may be that NR and PR items loaded on the same factor because the distinction between smoking to achieve frank pleasure (PR) versus smoking to alleviate distress (NR) is not meaningful to smokers (although this may be of theoretical importance). Thus, the Brief WISDM consolidates the NR and PR items into a single Affective Enhancement subscale. In addition, the results of this research revealed that the BC and AA items did not form separable factors and that the AA items were stronger indicators in a one-factor EFA. These findings, plus findings from validity research reported by Piper et al. (2004), led to a decision to drop the BC subscale from the Brief WISDM. It is important to note that the modification of subscales in this research does not necessarily mean that the associated constructs are unimportant or motivationally inert. It is possible that the associated scales do not perform well because self-report items are not well suited to their specific and accurate assessment.

The current study provides important comparative data for three different groups of smokers: primarily White treatment-seeking smokers (Bupropion–Gum study); Black treatment-seeking smokers (Break-Free study); and smokers participating in a longitudinal, nontreatment, and observational study (WBHS). The WBHS sample has several advantages, including the fact that the sample comprises a broader range of smokers compared with treatment-seeking smokers in terms of smoking rates, FTND scores, and other factors. The 1-year inter-administration interval used in the WBHS demonstrated fairly impressive stability of the particular motives tapped by individual WISDM subscales. Finally, the fact that the revisions to the Brief WISDM were tested in three diverse samples suggests that this new instrument will be useful with the broad population of smokers.

Smith et al. (2000) articulated several steps to ensure methodological rigor in developing a short form. Consistent with their recommendations, we attempted to preserve as much of the content coverage as possible for each retained WISDM subscale. Other strengths of our approach include the use of multiple independent samples and a comprehensive comparison of the psychometric properties of the new versus existing instruments: for example, on the basis of internal consistency, stability, validity, and model fit.

One limitation of the current study is that both the reduced-item and the full-item versions of the WISDM subscales were based on the same administration of the WISDM-68. Smith et al. (2000) recommend that separate full and brief versions of a questionnaire be administered, but this was not possible in the three studies that provided data for the current study. Another limitation is that the WBHS and Break-Free sample sizes were only moderately large ($N = 366$ and $N = 393$, respectively in the CFA models), and this may decrease confidence in the CFA results. In particular, the CFA model fit for the Break-Free sample was not as good as the fit in the Bupropion–Gum study ($N = 608$). However, the overall pattern of results for the three samples across the various reliability and validity

analyses suggests that the Brief WISDM performs well and shows promise as a reliable and valid short form of the WISDM-68.

In summary, the current study provides convincing evidence that the 37-item Brief WISDM can be used in place of the original 68-item WISDM if researchers desire to reduce participant assessment burden but want to utilize a broad multidimensional dependence assessment. Additional research is needed to test the psychometric characteristics of the Brief WISDM when it is administered in its 37-item form rather than derived from the 68-item version of the WISDM.

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Declaration of Interests

None declared.

Acknowledgments

Appendix: Brief WISDM

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 often smoke without thinking about it	1	2	3	4	5	6	7
2. Cigarettes control me	1	2	3	4	5	6	7
3. I usually want to smoke right after I wake up	1	2	3	4	5	6	7
4. It's hard to ignore an urge to smoke	1	2	3	4	5	6	7
5. The flavor of a cigarette is pleasing	1	2	3	4	5	6	7
6. I frequently smoke to keep my mind focused	1	2	3	4	5	6	7
7. I rely upon smoking to control my hunger and eating	1	2	3	4	5	6	7
8. My life is full of reminders to smoke	1	2	3	4	5	6	7
9. Smoking helps me feel better in seconds	1	2	3	4	5	6	7
10. I smoke without deciding to	1	2	3	4	5	6	7
11. Cigarettes keep me company, like a close friend	1	2	3	4	5	6	7
12. There are particular sights and smells that trigger strong urges to smoke	1	2	3	4	5	6	7
13. Smoking helps me stay focused	1	2	3	4	5	6	7
14. I frequently light cigarettes without thinking about it	1	2	3	4	5	6	7
15. Most of my daily cigarettes taste good	1	2	3	4	5	6	7
16. Sometimes I feel like cigarettes rule my life	1	2	3	4	5	6	7
17. I frequently crave cigarettes	1	2	3	4	5	6	7
18. Most of the people I spend time with are smokers	1	2	3	4	5	6	7
19. Weight control is a major reason that I smoke	1	2	3	4	5	6	7
20. Some of the cigarettes I smoke taste great	1	2	3	4	5	6	7
21. I'm really hooked on cigarettes	1	2	3	4	5	6	7
22. Sometimes I feel like cigarettes are my best friends	1	2	3	4	5	6	7
23. My urges to smoke keep getting stronger if I don't smoke	1	2	3	4	5	6	7
24. Seeing someone smoke makes me really want a cigarette	1	2	3	4	5	6	7
25. I find myself reaching for cigarettes without thinking about it	1	2	3	4	5	6	7
26. I would feel alone without my cigarettes	1	2	3	4	5	6	7
27. A lot of my friends or family smoke	1	2	3	4	5	6	7
28. Other smokers would consider me a heavy smoker	1	2	3	4	5	6	7
29. When I haven't been able to smoke for a few hours, the craving gets intolerable	1	2	3	4	5	6	7
30. Most of my friends and acquaintances smoke	1	2	3	4	5	6	7
31. I smoke within the first 30 min of awakening in the morning	1	2	3	4	5	6	7
32. Smoking helps me think better	1	2	3	4	5	6	7
33. Smoking really helps me feel better if I've been feeling down	1	2	3	4	5	6	7
34. Smoking keeps me from overeating	1	2	3	4	5	6	7
35. My smoking is out of control	1	2	3	4	5	6	7
36. I consider myself a heavy smoker	1	2	3	4	5	6	7
37. Even when I feel good, smoking helps me feel better	1	2	3	4	5	6	7

Brief WISDM scoring procedure

The Brief WISDM consists of a subset of 37 items from the original 68-item WISDM (Piper et al., 2004). Please note the following:

The Behavioral Choice/Melioration subscale in the original 68-item WISDM has been dropped from the Brief WISDM due to lack of support for its predictive validity.
The NR and the PR subscales have been merged into a new subscale called AA.

As a result, there are 11 subscales in the 37-item Brief WISDM rather than 13 subscales as in the 68-item WISDM. In the table below, scoring procedures for each of the 11 subscales of Brief WISDM are provided. In addition, scoring is provided for the Primary and Secondary Dependence Motives scales described in Piper, Bolt, et al. (2008) and for the total score.

Please note that item numbers refer to the item numbers (1–37) in the Brief WISDM, not the item numbering in the original WISDM.

Brief WISDM subscale	Scoring procedure
Affiliative Attachment	Mean of 11, 22, 26
Automaticity	Mean of 1, 10, 14, 25
Loss of Control	Mean of 2, 16, 21, 35
Cognitive Enhancement	Mean of 6, 13, 32
Craving	Mean of 4, 17, 23, 29
Cue Exposure/Associative Processes	Mean of 8, 12, 24
Social/Environmental Goads	Mean of 18, 27, 30
Taste	Mean of 5, 15, 20
Tolerance	Mean of 3, 28, 31, 36
Weight Control	Mean of 7, 19, 34
Affective Enhancement	Mean of 9, 33, 37
Primary Dependence Motives (PDM) scale	Mean of means for Automaticity, Loss of Control, Craving, and Tolerance
Secondary Dependence Motives (SDM) scale	Mean of means for Affiliative Attachment, Cognitive Enhancement, Cue Exposure/Associative Processes, Social/Environmental Goads, Taste, Weight Control, and Affective Enhancement
Total score	Sum of means for the 11 subscales (do not include the PDM or SDM scales)

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