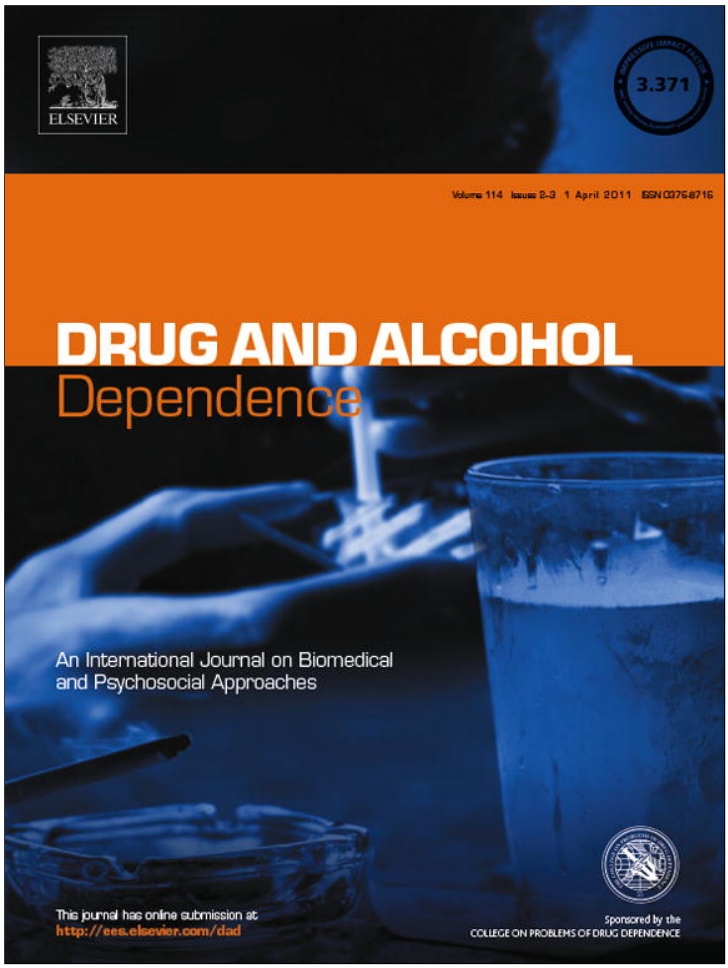

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Full length article

WISDM primary and secondary dependence motives: Associations with self-monitored motives for smoking in two college samples

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ABSTRACT

The Wisconsin Inventory of Smoking Dependence Motives (WISDM) assesses 13 domains of smoking motivation emphasized by diverse theoretical perspectives. Emerging findings support a distinction between four *primary dependence motives* (PDM) indexing core features of tobacco dependence and nine *secondary dependence motives* (SDM) indexing accessory features. The current study explored the validity of this distinction using data from two samples (*Ns* = 50 and 88) of college smokers who self-monitored their reasons for smoking with electronic diaries. PDM scores were associated with diary endorsement of habitual or automatic motives for smoking individual cigarettes, which are conceptually consistent with the content of the PDM subscales. SDM did not clearly predict conceptually related self-monitored motives when tested alone. However, when these two correlated scale composites were co-entered, PDM predicted being a daily vs. nondaily smoker, being higher in nicotine dependence, and smoking individual cigarettes because of habit or automaticity. Conversely, after PDM-SDM co-entry, the unique variance in the SDM composite predicted the tendency to report smoking individual cigarettes for situational or instrumental motives (e.g., to control negative affect). The results suggest that the PDM composite may reflect core motivational features of nicotine dependence in these young smokers. The relative prominence of primary motives in advanced or dependent use may be even clearer when motives for smoking are assessed in real time rather than reported via questionnaire.

1. Introduction

The Wisconsin Inventory of Smoking Dependence Motives (WISDM; Piper et al., 2004) is a psychometric instrument comprising 68 items organized into 13 subscales. Individual subscales were designed to tap dimensions of smoking motivation emphasized by distinct theoretical perspectives (Table 1). The WISDM was intended to facilitate exploratory investigations of the structure and nature of the dependence construct (Piper et al., 2004).

1.1. Primary vs. secondary dependence motives

Piper et al. (2008) reported a series of person- and variable-centered analyses suggesting that just four subscales – automaticity, craving, loss of control, and tolerance – represented the core features of dependence. Piper et al. (2008) dubbed these the *primary dependence motives* (PDM) and labeled the remaining scales *secondary dependence motives* (SDM). Summary PDM and SDM scores are computed by averaging the subscales in each domain.

PDM has been related to a diverse set of dependence-relevant validators, including other dependence measures, heavy tobacco use, nicotinic acetylcholine receptor haplotypes, tobacco self-administration, relapse, and craving (e.g., Baker et al., 2009; Piasecki et al., 2010; Piper et al., 2008; TTURC, 2007). In these studies, the SDM composite has often been found to predict the same criteria, but these relations are diminished or eliminated when the (correlated) PDM composite is entered as a covariate. Covarying SDM has generally not eliminated PDM's prediction of these criteria.

Overall, the findings to date suggest the PDM captures the more fundamental dependence-related variance and that many SDM-criterion relations depend upon the SDM-PDM overlap. The PDM score may reflect the emergence of clinical features (e.g., automatic or effortless self-administration and strong cravings) especially characteristic of advanced or problematic tobacco use. In contrast, the SDM scales may reflect instrumental or situational reasons for smoking that could be relevant for beginning and dependent smokers alike. In other words, the PDM scales may more specifically reflect *compulsion* to smoke while the SDM scales may reflect the many reasons people may *elect* to smoke (Piasecki et al., in press).

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Table 1
Content of the WISDM subscales.

Composite or subscale	Target construct
Primary dependence motives	
Automaticity	Smoking without awareness or intention
Craving	Smoking in response to craving or experiencing intense or frequent urges to smoke
Loss of control	The smoker believes he or she has lost volitional control over smoking
Tolerance	Need to smoke increasing amounts over time to experience the desired effects or the ability to smoke large amounts without acute toxicity
Secondary dependence motives	
Affiliative attachment	A strong emotional attachment to smoking and cigarettes
Behavioral choice/melioration	Smoking despite constraints on smoking or negative consequences and/or the lack of other options or reinforcers
Cognitive enhancement	Smoking to improve cognitive functioning
Cue exposure/associative processes	Frequent encounters with nonsocial smoking cues or a strong perceived link between cue exposure and a desire or tendency to smoke
Negative reinforcement	Tendency or desire to smoke to ameliorate negative internal states
Positive reinforcement	Desire to smoke to experience a "buzz" or "high" or to enhance an already positive feeling or experience
Social/environmental goads	Social stimuli or contexts either model or invite smoking
Taste/sensory processes	Desire or tendency to smoke to experience the orosensory/gustatory effects of smoking
Weight control	Use of cigarettes to control body weight or appetite

1.2. Questionnaire vs. self-monitored motives for smoking

Questionnaire measures of motives or reasons for smoking were once widely used, but their popularity waned as evidence accumulated that cast doubt on their validity (Shiffman, 1993). Reviving the assessment of smoking motives via the WISDM suggests a need to again confront this critical question: Do smokers' questionnaire ratings meaningfully predict relevant real-world behaviors or motives? Asking smokers to self-monitor their reasons for smoking individual cigarettes represents one method for gauging the accuracy of questionnaire smoking motives measures (Joffe et al., 1981; Klitzke et al., 1990; Leventhal and Avis, 1976; Shiffman and Prange, 1988; Tate and Stanton, 1990). Individuals who score highly on a questionnaire assessing a particular reason or motive for smoking should frequently endorse related motives in conjunction with "real-world" smoking events.

Piasecki et al. (2007) asked college student smokers to record their reason(s) for smoking over a 2-week period using electronic diaries. Relations between self-monitored motives and 7 of the 13 WISDM subscale were tested; the WISDM scales forecast congruent diary-reported smoking motives as predicted in three of eight tests performed. Three findings are notable in light of the subsequent identification of the PDM-SDM distinction. First, the three WISDM subscales that *did* forecast congruent diary-endorsed motives were each PDM scales (craving, automaticity, and loss of control). Second, the two most commonly endorsed self-monitored motives ("reduce craving," "habit/automatic") belong to the PDM conceptual domain. Finally, participants who were daily smokers or had higher scores on the Fagerström Test for Nicotine Dependence (FTND; Heatherton et al., 1991) were more likely to report self-monitored motives in the PDM domain ("reduce craving," "habit/automatic") and less likely to smoke for an SDM-related reason ("cope with negative emotion"). These findings suggest that (a) PDM scales may have especially good ecological validity, (b) PDM-like self-monitored motives are frequent antecedents of ad lib tobacco use, and (c) individuals who are heavier or more dependent smokers may be more likely to report PDM-like motives in either assessment modality, consistent with the suggestion that these motives are especially sensitive dependence indicators.

1.3. Current investigation

We sought to examine associations between these WISDM composites and self-monitored motives for smoking. We re-analyzed data from the Piasecki et al. (2007) investigation with PDM and SDM as the predictors in place of selected WISDM subscales. Additionally, we report parallel analyses using data from a new sample of college student smokers who used a similar diary protocol to self-monitor reasons for smoking.

The current research had two major goals. First, we sought to bolster the construct validity of the PDM and SDM composites by testing whether the PDM and SDM forecast self-monitored motives in the manner that would be expected based upon their contents. Such analyses speak to the validity of interpreting the composites in motivational terms implied by the scale contents. We focus on the composite WISDM measures rather than individual WISDM subscales as predictors of self-monitored motives because: (a) we have suggested these composites, particularly PDM, represent useful phenotypes for genetically informative research (Piasecki et al., 2010; Piper et al., 2008) and (b) we hypothesize that the most critical distinction between smokers occurs at this higher-order level. The second goal was to bolster this conjecture that PDM-type motives are especially associated with dependence among college smokers. To investigate this, we examined the relations of independent measures of tobacco involvement (daily smoking and FTND-assessed dependence) with: (a) the PDM and SDM composites, and with (b) self-monitored motives that correspond to the WISDM primary and secondary motive domains. If primary motives like automaticity and craving are uniquely related to more extensive tobacco involvement, this should be evident whether such relations are tested via either questionnaires or real-time motive reports. A secondary goal was to assess whether assessment modality (global questionnaire vs. real-time data collection) affected the relations of PDM-like motives with other dependence indices.

We expected PDM would predict endorsement of two self-monitored motives ("reduce craving," "habit/automatic") that correspond directly with constructs measured by subscales undergirding the PDM (craving and automaticity, respectively). Hereafter, we refer to these diary-measured reasons for smoking as *primary self monitored motives* (SMMs). We expected that PDM and SDM scores would be correlated, and that SDM would also be related to primary SMMs when considered alone. When PDM and SDM are pitted against one another in the same model, however, we expected PDM would emerge as the better predictor of the primary SMMs.

Many SDM scales appear to be "early emergent" instrumental motives that may be elevated even among fledgling or light smokers (Piper et al., 2004). For instance, even light smokers may smoke as a means of socializing (e.g., Moran et al., 2004). However, once a person has become highly dependent, such motives may be vestigial, with most cigarettes being smoked for primary motives such

Table 2
Rates of endorsement of self-monitored smoking motives and results of models predicting each motive from either daily smoking status and or FTND scores, Study 1.

Self-monitored motive for smoking	Endorsement *N* (%) cigarettes	Daily smoking		FTND	
		OR	(95% CI)	OR	(95% CI)
Individual motives					
Primary self-monitored motives					
Reduce craving	715 (62.8)	4.15***	(2.44–7.06)	1.53***	(1.29–1.81)
Habit/automatic	479 (42.1)	2.23**	(1.31–3.81)	1.20*	(1.04–1.39)
Secondary self-monitored motives					
Opportunity to socialize	262 (23.0)	1.23	(0.66–2.27)	0.56***	(0.45–0.69)
Boredom/to kill time	228 (20.0)	1.00	(0.58–1.71)	1.02	(0.87–1.19)
Soon going where can't smoke	170 (14.9)	1.78	(0.90–3.53)	1.05	(0.88–1.24)
Enhance positive emotion	134 (11.8)	1.10	(0.55–2.22)	1.12	(0.92–1.36)
Break from work/studying	117 (10.3)	0.89	(0.44–1.82)	1.15	(0.94–1.41)
Cope with negative emotion	116 (10.2)	0.40**	(0.24–0.69)	0.74**	(0.60–0.92)
Aggregated motive categories					
Any primary self-monitored motive	902 (79.2)	5.50***	(3.41–8.85)	2.00***	(1.61–2.49)
Any secondary self-monitored motive	758 (66.5)	1.00	(0.61–1.64)	0.87	(0.75–1.00)
Only primary self-monitored motives (s)	354 (31.1)	1.00	(0.61–1.64)	1.15	(0.99–1.32)
Only secondary self-monitored motives (s)	210 (18.4)	0.18***	(0.11–0.29)	0.50***	(0.40–0.62)

Note: OR, odds ratio; CI, confidence interval; FTND scores were standardized prior to model entry. Percentages of cigarettes evaluated with respect to the total number of 1,139 smoking records. Aggregated categories do not add up to this figure because the motive item was skipped in 27 diary records and these records were counted as missing. Results for individual motives were previously reported by Piasecki et al. (2007).

* $p < .05$.
** $p < .01$.
*** $p < .001$.

as habit and craving. Consistent with this, when PDM and SDM are entered simultaneously in regression models, the residual variance in SDM is negatively related to heavy use, breath carbon monoxide, and laboratory tobacco self-administration (Piasecki et al., 2010; Piper et al., 2008). In this article, we refer to diary-measured motives that describe opportunistic or instrumental reasons for smoking, and that correspond to content tapped by specific SDM subscales, as *secondary SMMs*. We expected that SDM scores would outperform PDM in predicting endorsement of secondary SMMs. However, this was expected to be most evident when the PDM-related variance (i.e., the influence of a general dependence factor) was statistically covaried from SDM.

2. Study 1

2.1. Participants and procedure

Study 1 is a re-analysis of data from a study described at greater length in Piasecki et al. (2007). Briefly, the analyzed sample consisted of 50 college students (62% female) in introductory psychology classes who reported smoking at least one cigarette per week in the past month. Participants ranged from 18 to 21 years of age ($M = 18.5$, $SD = 0.7$). The mean score on the FTND was 0.9 ($SD = 1.3$); 30 smokers (60%) scored zero. Daily smokers ($n = 33$, 66%) reported an average of 6.9 cigarettes per day ($SD = 4.5$, range 3–20). Nondaily smokers ($n = 17$, 34%) reported an average of 3.4 smoking days per week ($SD = 1.3$, range = 2–6) and an average of 4.4 cigarettes per smoking day ($SD = 3.5$, range = 2–15). Participants received partial course credit and $75 for completing the study.

Electronic diaries (EDs) were programmed using Pendragon Forms software (version 3.2; Pendragon Software, Libertyville, IL) and run on Palm Zire (Palm, Inc., Sunnyvale, CA) personal digital assistants. At an initial visit, participants completed a battery of questionnaires (including the FTND and WISDM) and were issued an ED. Participants were asked to initiate recordings before smoking each cigarette during the subsequent 14-day monitoring period. The analyses focus on 1139 diary records completed prior to smoking a cigarette.

2.2. Measures

2.2.1. WISDM composites. Scores for each of the 13 subscales of the WISDM were computed by taking the average item score for all items belonging to the subscale (Piper et al., 2004). Following Piper et al. (2008), a PDM score was calculated for each participant by averaging scores from the automaticity, craving, loss of control, and tolerance subscales (α for 18 items = .92, α for 4 subscales = .82). Similarly, an SDM score was calculated by taking an average of the remaining 9 subscales (α for 50 items = .97, α for 9 subscales = .90).

2.2.2. Self-monitored motives for smoking. When smokers initiated a pre-smoking diary entry, one question on the diary interview asked "Why are you smoking this cigarette?" and supplied a checklist of possible motives. Table 2 lists the response options and shows their overall rates of endorsement (previously reported by Piasecki et al., 2007). Smokers could check more than one response; the modal number of motives endorsed was two. Checklist responses were treated as separate dichotomous variables indicating whether or not the motive was endorsed. For the current analyses, we created 4 additional (overlapping) aggregate motive variables based on the presence of primary SMMs ("reduce craving," or "habit/automatic") or secondary SMMs (any of the remaining responses). We coded whether each cigarette was attributed to (a) *any* primary SMM, (b) *any* secondary SMM (c) *only* primary SMM(s) or (d) *only* secondary SMM(s). Note that Piasecki et al. (2007) used a slightly different strategy for classifying motives. In that report, "soon going where can't smoke" was grouped together with the current primary SMMs in a category labeled "dependence-like motives." "Soon going where can't smoke" was presumed to reflect attempts to stave off withdrawal symptoms. However, our current working understanding suggests that withdrawal may be better indexed by SDM than PDM (Piasecki et al., 2010; Piper et al., 2008). Accordingly, we counted "soon going where can't smoke" as one of the secondary SMMs in the current analyses.

2.3. Data analysis

This research uses four indicators of tobacco involvement and dependence: daily smoking status, FTND scores, PDM, and SDM.

Table 3
Rates of endorsement of self-monitored smoking motives and results of models predicting each motive from PDM and SDM scores univariately and simultaneously, Study 1.

Self-monitored motive for smoking	Composite entered alone				Composites entered simultaneously			
	PDM		SDM		PDM		SDM	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Individual motives								
Primary self-monitored motives								
Reduce craving	1.70***	(1.36–2.13)	1.21	(0.97–1.51)	2.76***	(1.91–3.99)	0.54***	(0.37–0.77)
Habit/automatic	1.39***	(1.15–1.69)	1.27*	(1.04–1.56)	1.48*	(1.09–2.01)	0.92	(0.67–1.28)
Secondary self-monitored motives								
Opportunity to socialize	0.56***	(0.44–0.71)	0.75*	(0.59–0.96)	0.39***	(0.26–0.58)	1.57*	(1.08–2.28)
Boredom/to kill time	1.19	(0.97–1.46)	1.03	(0.82–1.28)	1.49*	(1.07–2.07)	0.73	(0.51–1.05)
Soon going where can't smoke	1.20	(0.96–1.50)	1.29*	(1.01–1.65)	1.00	(0.70–1.42)	1.30	(0.88–1.89)
Enhance positive emotion	1.21	(0.94–1.57)	1.26	(0.95, 1.66)	1.08	(0.72–1.62)	1.18	(0.76–1.82)
Break from work/studying	1.01	(0.76–1.34)	0.97	(0.72–1.30)	1.11	(0.71–1.74)	0.89	(0.55–1.44)
Cope with negative emotion	0.88	(0.68–1.14)	1.07	(0.82–1.41)	0.63*	(0.42–0.95)	1.56*	(1.02–2.37)
Aggregated motive categories								
Any primary self-monitored motive	2.42***	(1.87–3.12)	1.51**	(1.19–1.91)	4.52***	(2.94–6.94)	0.48***	(0.33–0.70)
Any secondary self-monitored motive	0.90	(0.74–1.09)	0.93	(0.76–1.15)	0.87	(0.64–1.19)	1.04	(0.75–1.46)
Only primary self-monitored motives (s)	1.11	(0.92–1.34)	1.07	(0.87–1.31)	1.15	(0.84–1.56)	0.95	(0.69–1.33)
Only secondary self-monitored motives (s)	0.41***	(0.32–0.53)	0.66**	(0.52–0.84)	0.22***	(0.14–0.34)	2.07**	(1.42–3.02)

Note: OR, odds ratio; CI, confidence interval; PDM and SDM composites were standardized prior to model entry.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

For all analyses involving the PDM and SDM composites, we performed separate tests in which these indices were entered singly or simultaneously. This was done because prior findings suggest simultaneous entry may more clearly reveal distinctive correlates of the WISDM composites (Baker et al., 2009; Piasecki et al., 2010; Piper et al., 2008).

A first set of models used *t*-tests and regression analyses to examine associations among the four dependence indicators. A second set of models tested how each dependence indicator was related to self-monitored smoking motives. A generalized estimating equations (GEE; Zeger and Liang, 1986) approach was used to account for the non-independence of repeated assessments within participants. In each model, an individual self-monitored motive or an aggregate motive category was the dependent measure, and GEE analyses specified a binomial family, a logit link function, and a first-order autoregressive working correlation structure. Continuously scaled indicators were standardized across participants and these standardized scores were used as predictors in GEE models; thus, reported odds ratios index the effect of a 1-*SD* change on the predictors. A supplementary set of GEE models explored relations between each individual subscale constituting the PDM and the primary SMMs. This permitted a determination of the extent to which any relations between PDM scores and primary SMMs were attributable to predictor-criterion overlap. Finally, correlations and *t*-tests were used to test relations of each individual WISDM motive subscale with FTND scores and daily smoking status and FTND scores. This permitted an appraisal of whether questionnaire-measured and self-monitored motives point to the same conclusions about the most important dependence features.

2.4. Results

2.4.1. Associations among dependence indicators. Daily smokers achieved significantly higher scores on the FTND ($M = 1.30$, $SD = 1.43$) compared to nondaily smokers ($M = 0.12$; $SD = 0.33$), $t(48) = 3.37$, $p < .01$. The PDM and SDM composites were significantly correlated with one another, $r = .82$, $p < .001$. Considered alone, PDM was significantly correlated with FTND scores ($r = .48$, $p < .001$) but SDM was not ($r = .25$, $p = .08$). When entered simultaneously as predictors of FTND scores in a linear regression model, PDM was significantly and positively related to FTND scores ($\beta = .83$, $p < .001$) and SDM was a significant, negative predictor ($\beta = -.43$, $p = .05$). In logistic regression analyses, both PDM and SDM were positively associated with daily smoking status when standardized and entered alone (PDM: OR = 5.35, 95% CI = 1.93–14.79, $p < .001$; SDM: OR = 3.21, 95% CI = 1.42–7.24, $p < .01$). When the two standardized composites were entered simultaneously, PDM remained significantly related to daily smoking (OR = 5.45, 95% CI = 1.14–26.15, $p < .05$) but SDM did not (OR = 0.98, 95% CI = 0.27–3.55, $p = .98$).

2.4.2. Associations between dependence indicators and self-monitored motives. Compared to nondaily smokers, daily smokers were more likely to endorse "reduce craving" and "habit/automatic" as motives for smoking individual cigarettes and were also less likely to endorse smoking to cope with negative emotion (Table 2). Similar findings were obtained when FTND was the predictor; the only difference was that students with higher FTND scores were also less likely to attribute individual cigarettes to socializing. Both daily smoking and FTND scores were associated with increased odds of endorsing at least one primary SMM and lower odds of exclusively citing secondary SMM(s) as a reason for smoking.

Considered as the sole predictor, PDM was associated with higher likelihood of endorsing both primary SMMs and a lower likelihood of endorsing "opportunity to socialize" as immediate motives for smoking (Table 3). Smokers higher in PDM were more likely to endorse at least one primary SMM and less likely to exclusively endorse secondary SMM(s) for individual cigarettes. SDM predicted greater endorsement of "habit/automatic" and "soon going where can't smoke" and lower endorsement of "opportunity to socialize" when entered alone. For aggregated self-monitored motive categories, SDM showed the same pattern of findings obtained for PDM.

When the two WISDM composites were entered simultaneously, the unique variance in PDM was associated with increased endorsement of both primary SMMs and "boredom/to kill time" and lower endorsement of "opportunity to socialize" and "cope with negative emotion." PDM was associated with increased endorse-

Table 4
Results of models predicting primary self-monitored smoking motives from the individual PDM WISDM subscales in both studies.

PDM subscale	Study 1				Study 2			
	Habit/automatic SMM		Craving SMM		Habit/automatic SMM		Craving SMM	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Automaticity	1.35***	(1.14–1.59)	1.15	(0.96–1.39)	1.83***	(1.47–2.28)	1.07	(0.87–1.32)
Loss of control	1.71***	(1.39–2.10)	1.27*	(1.01–1.59)	1.48***	(1.20–1.83)	1.12	(0.91–1.38)
Craving	1.01	(0.84–1.22)	1.83***	(1.48–2.26)	1.53***	(1.21–1.93)	1.23	(0.98–1.53)
Tolerance	1.18	(0.98–1.41)	1.71***	(1.39–2.10)	1.83***	(1.47–2.92)	1.08	(0.88–1.34)

Note: OR, odds ratio; CI, confidence interval; SMM, self-monitored motive; PDM subscales were standardized prior to model entry.
* $p < .05$.
*** $p < .001$.

ment of any primary SMM and decreased endorsement of only secondary SMM(s). The unique variance in SDM was associated with a higher endorsement of "opportunity to socialize" and "cope with negative emotion" and lower endorsement of "reduce craving" as reasons for smoking. With PDM covaried, SDM was positively related to exclusively endorsing secondary SMM(s) and negatively related to endorsing at least one primary SMM for a given cigarette.

As would be expected, the "habit/automatic" SMM was related to WISDM automaticity, but was also related to WISDM loss of control (left portion of Table 4). The "reduce craving" SMM was predicted by all PDM scales except automaticity.

2.4.3. Prominence of primary motives across assessment modalities. Fig. 1 depicts the mean level of endorsement of WISDM subscales and composites and the rate of endorsement of individual and aggregated self-monitored motives as a function of daily smoking status. A series of *t*-tests revealed that daily smokers achieved significantly higher scores ($ts > 2.0$, $ps < .05$) on all WISDM subscales except for affiliative attachment and weight control (left panel) compared to nondaily smokers. Consistent with analyses reported in Table 2, daily smokers tended to show higher rates of primary SMMs but equivalent or diminished rates of secondary SMMs (right panel). The left column of Table 5 reports the correlation between FTND scores and individual WISDM subscales. Only one correlation (affiliative attachment) had a negative sign, and none had a significant negative relation with FTND scores. This contrasts with the finding of some significant negative relations between the FTND and some SMMs (Table 2).

Table 5
Correlations between WISDM subscales and FTND scores in both studies.

WISDM subscale	Correlation with FTND in	
	Study 1	Study 2
Primary dependence motives		
Automaticity	.22	.50***
Craving	.27	.52***
Loss of control	.37**	.45***
Tolerance	.68***	.79***
Secondary dependence motives		
Affiliative attachment	−.01	.30**
Behavioral choice/melioration	.19	.42***
Cognitive enhancement	.19	.34**
Cue exposure/associative processes	.23	.40***
Negative reinforcement	.24	.35***
Positive reinforcement	.18	.37***
Social/environmental goads	.36*	.38***
Taste/sensory processes	.26	.48***
Weight control	.06	.07

* $p < .05$.
** $p < .01$.
*** $p < .001$.

3. Study 2

3.1. Participants, procedure, and data analysis

Study 2 recruited undergraduates who reported currently smoking at least 5 cigarettes per week and were enrolled in introductory psychology classes. For completing the study, partic-

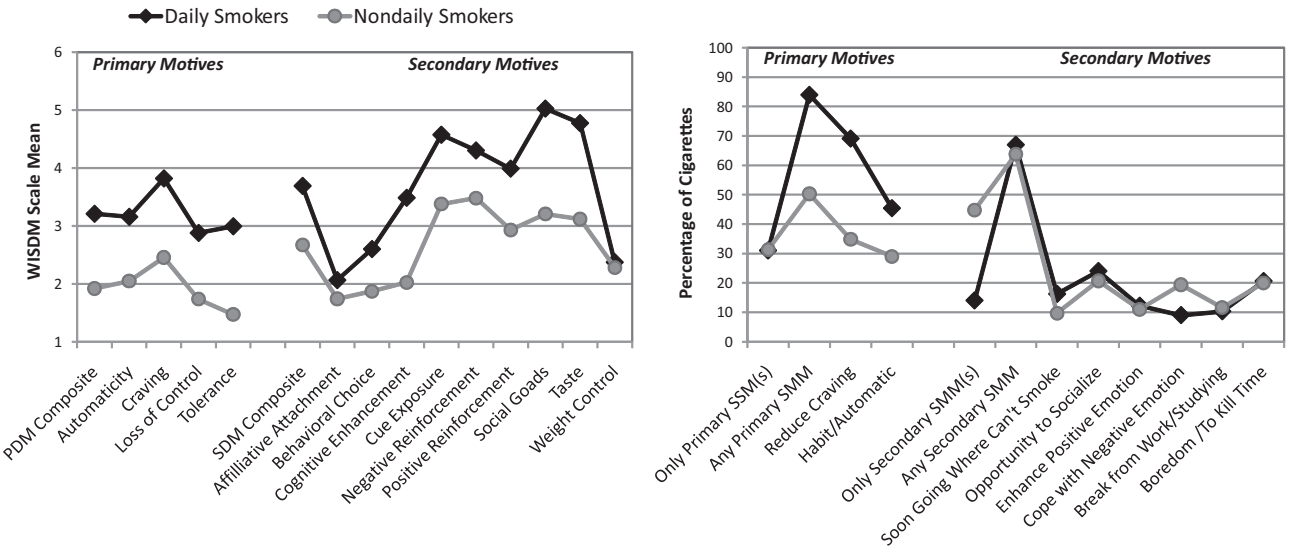

Fig. 1. WISDM composite and subscale means (left panel) and rates of aggregated and individual self-monitored motives (right panel) among nondaily and daily smokers in Study 1.

Table 6
Rates of endorsement of self-monitored smoking motives and results of models predicting each motive from either daily smoking status and or FTND scores, Study 2.

Self-monitored motive for smoking	Endorsement *N* (%) cigarettes	Daily smoking		FTND	
		OR	(95% CI)	OR	(95% CI)
Individual motives					
Primary self-monitored motives					
Reduce craving	265 (37.4)	2.08**	(1.27–3.42)	0.99	(0.81–1.21)
Habit/automatic	234 (33.1)	3.76***	(2.11–6.66)	1.67***	(1.36–2.05)
Secondary self-monitored motives					
Boredom/to kill time	185 (26.1)	1.58	(0.99–2.53)	1.05	(0.87–1.27)
Opportunity to socialize	124 (17.5)	0.64	(0.39–1.04)	0.81	(0.64–1.03)
Enhance positive emotion	114 (16.1)	0.40**	(0.24–0.68)	0.89	(0.69–1.14)
Enhance alcohol/drug effects	102 (14.4)	0.93	(0.50–1.73)	1.13	(0.86–1.48)
Break from work/studying	80 (11.3)	0.44**	(0.25–0.78)	0.95	(0.71–1.25)
Cope with negative emotion	74 (10.5)	0.45**	(0.25–0.79)	0.89	(0.67–1.18)
Environmental cue/trigger	55 (7.8)	0.57	(0.29–1.11)	0.69*	(0.49–0.99)
Soon going where can't smoke	52 (7.3)	1.64	(0.70–3.81)	1.51**	(1.12–2.03)
Concentrate/think better	50 (7.1)	0.38**	(0.19–0.79)	0.97	(0.68–1.37)
Curb hunger/control weight	23 (3.2)	0.62	(0.25–1.55)	0.76	(0.48–1.21)
Aggregated motive categories					
Any primary self-monitored motive	397 (56.1)	3.15***	(2.04–4.87)	1.39**	(1.14–1.68)
Any secondary self-monitored motive	509 (71.9)	0.46**	(0.27–0.77)	0.88	(0.72–1.07)
Only primary self-monitored motives (s)	147 (20.8)	3.15**	(1.63–6.11)	1.12	(0.89–1.41)
Only secondary self-monitored motives (s)	259 (36.6)	0.33***	(0.21–0.50)	0.68***	(0.55–0.83)

Note: OR, odds ratio; CI, confidence interval; FTND scores were standardized prior to model entry. Percentages of cigarettes evaluated with respect to the 708 cigarettes with non-missing motive reports. Aggregated categories do not add up to this figure because the participants chose none of the provided motives in 52 diary records.

* $p < .01$.
** $p < .05$.
*** $p < .001$.

ipants received partial course credit and $40. The current analyses used data from 88 students who provided WISDM data. The sample was mostly male (81%) and ranged in age from 18 to 23 years ($M = 18.9$, $SD = 0.9$). The mean score on the FTND was 1.6 ($SD = 1.8$), and 36 participants (41%) scored zero. Fifty-two participants (59%) reported smoking daily and averaged 8.6 cigarettes per day ($SD = 4.9$, range 1–23). The remaining 36 participants smoked on a nondaily basis, averaging 2.7 cigarettes on smoking days ($SD = 1.6$, range = 1–8).

ED assessments were programmed using the Purdue Momentary Assessment Tool (version 2.1.2; Weiss et al., 2004) and run on personal digital assistants (Palm Zire. Palm Inc., Sunnyvale, CA). Participants carried the ED for 7 days. Participants were instructed to make an ED entry immediately prior to each cigarette they smoked. To reduce assessment burden, the ED was configured so that each logged cigarette had a 50% chance of triggering a full questionnaire administration. Analyses focused on 708 pre-smoking records with completed responses for the motive questions. Statistical analyses were parallel to those used in Study 1.

3.2. Measures

3.2.1. Questionnaires. The FTND and the WISDM were administered at an initial study visit. Five students were missing data for some WISDM items. For these participants, the affected WISDM subscales were scored on the basis of the completed items. PDM (α for 18 items = .95, α for 4 subscales = .89) and SDM (α for 50 items = .97, α for 9 subscales = .90) composites were computed as described in Study 1.

3.2.2. Self-monitored motives for smoking. When a cigarette was recorded, the ED asked "Why are you smoking this cigarette? (check all that apply)" Response options included the motives assessed in Study 1 as well as four additional choices (Table 6). The motives were presented across three consecutive screens, with each offering 4 motives and a fifth "none of these" option. Dichotomous variables were created to index endorsement of the motives. Again, we computed aggregated motives categories related to presence or absence of primary SMMs ("reduce craving," "habit/automatic") and secondary SMMs (the remaining 10 checklist options).

3.3. Results

3.3.1. Associations among dependence indicators. As in Study 1, PDM and SDM were strongly correlated with one another ($r = .83$, $p < .001$). Daily smokers scored higher on the FTND ($M = 2.29$, $SD = 1.87$) compared to nondaily smokers ($M = 0.58$; $SD = 1.13$), $t(86) = 4.88$, $p < .001$. Both PDM and SDM were significantly correlated with FTND scores ($rs = .65$ and .47, respectively, $ps < .001$). When FTND scores were regressed on both composites simultaneously, PDM was positively related to FTND scores ($\beta = .82$, $p < .001$) and the coefficient for SDM was negative but not significant ($\beta = -.21$, $p = .15$). Both PDM and SDM were positively associated with daily smoking status when standardized and entered alone in a logistic regression model (PDM: OR = 8.76, 95% CI = 3.69–20.82, $p < .001$; SDM: OR = 3.54, 95% CI = 2.00–6.29, $p < .001$). When the two composites were entered simultaneously, PDM remained related to daily smoking (OR = 15.14, 95% CI = 3.73–61.48, $p < .001$) but SDM did not (OR = 0.58, 95% CI = 0.21–1.63, $p = .30$).

3.3.2. Associations between dependence indicators and self-monitored motives. Smokers used between 1 and 3 motives for most cigarettes (83.9%). Table 6 provides the rates at which each motive was endorsed in the diary and presents results from models predicting motive endorsement from daily smoking and FTND scores.

Daily smokers were more likely to attribute smoking to the primary SMMs and less likely to endorse several individual secondary SMMs. Daily smoking was associated with higher odds of reporting any primary SMM and only primary SMM(s) and with lower odds of reporting any secondary SMM or only secondary SMM(s) as reasons for smoking. Higher FTND scores were associated with

Table 7
Results of models predicting self-monitored smoking motives from PDM and SDM scores, Study 2.

Self-monitored motive for smoking	Composite entered alone				Composites entered simultaneously			
	PDM		SDM		PDM		SDM	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Individual motives								
Primary self-monitored motives								
Reduce craving	1.15	(0.92–1.44)	1.07	(0.86–1.34)	1.27	(0.88–1.83)	0.89	(0.62–1.28)
Habit/automatic	1.95***	(1.53–2.48)	1.41**	(1.11–1.79)	2.89***	(1.96–4.25)	0.61**	(0.42–0.89)
Secondary self-monitored motives								
Boredom/to kill time	1.19	(0.96–1.47)	1.28*	(1.03–1.58)	0.95	(0.67–1.34)	1.33	(0.94–1.89)
Opportunity to socialize	0.76*	(0.59–0.97)	1.04	(0.81–1.32)	0.41***	(0.27–0.63)	2.08**	(1.37–3.16)
Enhance positive emotion	0.84	(0.64–1.10)	1.14	(0.86–1.49)	0.45**	(0.28–0.72)	2.14**	(1.35–3.40)
Enhance alcohol/drug effects	1.02	(0.76–1.38)	1.37	(0.99–1.87)	0.53*	(0.33–0.88)	2.26**	(1.36–3.77)
Break from work/studying	0.78	(0.58–1.06)	0.98	(0.72–1.31)	0.53*	(0.32–0.89)	1.61	(0.98–2.66)
Cope with negative emotion	0.71*	(0.52–0.97)	0.94	(0.70–1.27)	0.43**	(0.25–0.73)	1.82*	(1.10–3.04)
Environmental cue/trigger	0.69*	(0.49–0.98)	0.99	(0.70–1.39)	0.36**	(0.20–0.64)	2.20**	(1.26–3.83)
Soon going where can't smoke	1.47*	(1.03–2.10)	1.34	(0.92–1.94)	1.53	(0.86–2.73)	0.95	(0.53–1.72)
Concentrate/think better	0.79	(0.54–1.16)	1.03	(0.71–1.51)	0.48*	(0.25–0.92)	1.86	(0.98–3.51)
Curb hunger/control weight	0.89	(0.56–1.44)	1.28	(0.77–2.11)	0.43*	(0.19–0.96)	2.52*	(1.12–5.66)
Aggregated motive categories								
Any primary self-monitored motive	1.52***	(1.23–1.88)	1.27*	(1.03–1.56)	1.88***	(1.32–2.68)	0.77	(0.54–1.08)
Any secondary self-monitored motive	0.78*	(0.63–0.98)	1.07	(0.86–1.34)	0.43***	(0.29–0.62)	2.14***	(1.46–3.12)
Only primary self-monitored motives (s)	1.24	(0.97–1.61)	0.91	(0.71–1.17)	2.31***	(1.50–3.57)	0.47***	(0.30–0.72)
Only secondary self-monitored motives (s)	0.60***	(0.49–0.75)	0.77*	(0.63–0.95)	0.43***	(0.30–0.63)	1.49*	(1.04–2.12)

Note: OR, odds ratio; CI, confidence interval; PDM and SDM composites were standardized prior to model entry.
* $p < .01$.
** $p < .05$.
*** $p < .001$.

increased odds of endorsing "habit/automatic" and "soon going where can't smoke" and decreased odds of endorsing "environmental cue/trigger." As in Study 1, higher FTND scores predicted increased endorsement of any primary SMM and decreased rate of exclusively attributing cigarettes to secondary SMM(s).

Considered alone, PDM was associated with an increased endorsement of "habit/automatic" and "soon going where can't smoke" and decreased endorsement of "opportunity to socialize," "cope with negative emotion," and "environmental cue/trigger" (Table 7). PDM was associated with increased endorsement of any primary SMM and a decreased likelihood of attributing a cigarette partly or wholly to secondary SMM(s). Higher SDM scorers were more likely to endorse "habit/automatic" and "boredom/to kill time" as immediate motives for smoking. SDM was also associated with increased attribution of cigarettes to any primary SMM and decreased attribution of smoking events to SMM(s) alone.

When PDM and SDM were entered simultaneously, PDM was positively related to "habit/automatic" and negatively related to numerous secondary SMMs. PDM was related to increased attribution of cigarettes to any primary SMM as well as exclusive attribution to primary SMMs. Higher PDM scorers were also less likely to attribute smoking events to any secondary SMM or exclusively to secondary SMM(s). The unique variance in SDM was negatively related to "habit/automatic" and to exclusively citing primary SMM(s) as reasons for smoking and positively related to numerous individual secondary SMMs and the likelihood of endorsing one or more secondary SMM(s) for a given cigarette.

Endorsement of the habit/automatic motive was positively related to each of the WISDM scales contributing to the PDM (right portion of Table 4). None of these scales was significantly related to the "reduce craving" motive in Study 2.

3.3.3. Prominence of primary motives across assessment modalities. Fig. 2 depicts the mean level of endorsement of WISDM subscales and rate of endorsement of individual self-monitored motives as a function of daily vs. nondaily smoking in Study 2. In this sample, daily smokers achieved significantly higher scores than nondaily smokers ($ts > 2.8$, $ps < .01$) on all WISDM subscales except for weight control (left panel). However, when real-time motives for smoking were examined, nondaily smokers tended to report several secondary SMMs more frequently (right panel; Table 6). In this sample, all subscales except Weight Control were significantly correlated with the FTND (Table 5). In contrast, analysis of real-time motives revealed the FTND was negatively related to "environmental cue/trigger" and exclusive attribution of a given cigarette to secondary SMM(s).

4. Discussion

The distinction between primary and secondary motives was inferred from configural analyses of WISDM subscale scores (Piper et al., 2008), and subsequent research has documented differential associations with clinical criteria (Piper et al., 2008), laboratory performance (Piasecki et al., 2010), and genetic markers (Baker et al., 2009). Nonetheless, our understanding of the construct validity and optimal interpretation of the PDM and SDM composites remains incomplete. The present analyses addressed two critical questions. One concerns the construct validity of the composites scored from the WISDM instrument. At a basic level, we investigated whether the motives smokers report via questionnaire reflect their reasons for smoking individual cigarettes provided in real-time reports. The second question concerns the theoretical distinction between primary and secondary motives per se. Thus, we addressed whether primary motives (i.e., craving, automaticity), assessed by either questionnaire or self-monitoring, are especially linked with more advanced tobacco involvement or dependence.

4.1. Construct validity of the PDM and SDM composites

PDM-unique variance was associated with primary SMMs (i.e., "habit/automatic" [both Studies] and "reduce craving" [Study 1]). The prediction of primary SMMs was not exclusively attributable

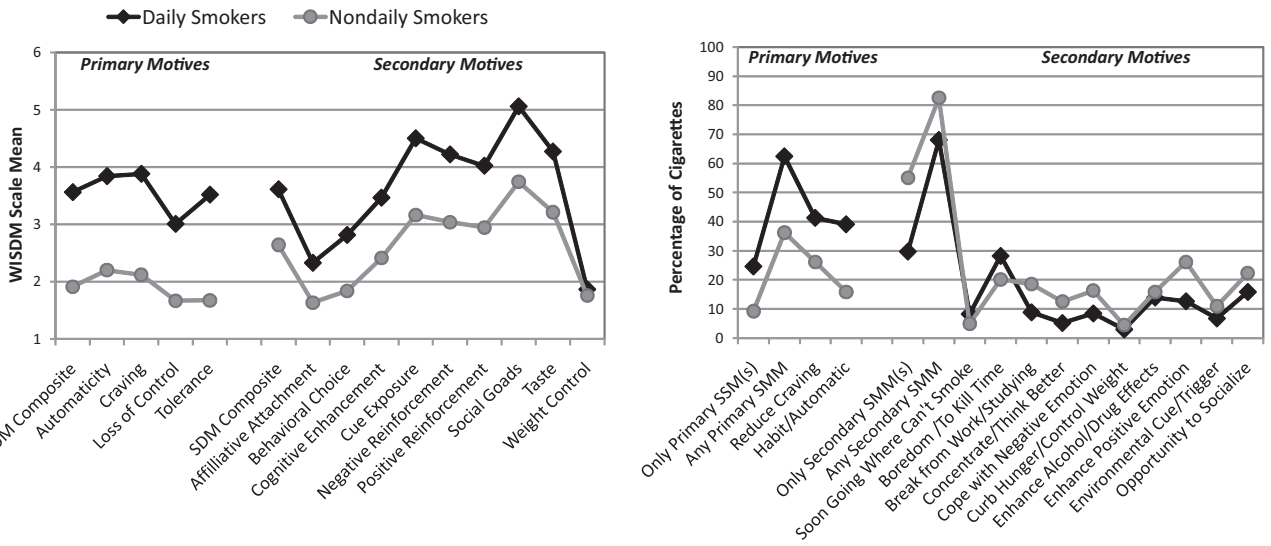

Fig. 2. WISDM composite and subscale means (left panel) and rates of aggregated and individual self-monitored motives (right panel) among nondaily and daily smokers in Study 2.

to semantic predictor-criterion overlap (Table 4), consistent with the assertion that primary motives may jointly define a coherent underlying trait. Notably, though, the strongest and most consistent evidence for cross-modality motive agreement linked the WISDM automaticity and loss of control scales to self-monitored "habit/automatic" motives. Thus, automaticity and loss of control may be especially good indicators of an underlying dependence trait. Less consistent findings for craving may be related to the varied nature and complex determination of craving responses (e.g., Piasecki et al., 2010).

Unique PDM variance was negatively associated with the odds that a smoker would attribute his/her smoking only to secondary SMMs. Conversely, unique SDM variance was positively associated with attributing smoking to secondary SMMs and was negatively related to attributing smoking to primary SMMs. In sum, while there were some discrepancies across studies, the WISDM PDM and SDM composites had clear, theoretically congruent associations with the types of motives that these young smokers offered for smoking individual cigarettes in their daily lives.

4.2. Primary vs. secondary motives: relations with tobacco involvement

The current data join other evidence in suggesting especially tight links between primary motives, measured by either questionnaire or electronic diary, and other indicators of tobacco involvement and dependence. In both samples, the WISDM PDM composite proved superior to the SDM composite in cross-sectional regressions predicting daily smoking and FTND scores. Additionally, FTND scores and daily smoking status were especially predictive of primary SMMs (Tables 2 and 6). Taken together, these findings suggest the transition to dependence may be accompanied by "late emergent" primary motives including craving and automatized self-administration (Piper et al., 2004). Numerous theoretical accounts emphasize that drug dependence is characterized by a shift in which drug use becomes less contingent on situational setting events, goals, or acute consequences. Instead, drug use takes on "a life of its own," becoming highly routinized and strongly craved (cf. Baker et al., 2004; Curtin et al., 2006; Everitt and Robins, 2005; Leventhal and Cleary, 1980; Newlin and Strubler, 2007; Robinson and Berridge, 1993; Shiffman and Paty, 2006; Tiffany, 1990). The current findings buttress these theoretical assertions, and it is noteworthy that the study of self-reported motives for smoking points to the same conclusions theorists have reached via other lines of evidence and inference.

Consistent with prior research (Piasecki et al., 2010; Piper et al., 2004), tolerance was the WISDM subscale most strongly related to FTND scores (Table 5). Both FTND and WISDM tolerance assess smoking heaviness. WISDM loss of control was the only other PDM constituent significantly correlated with FTND scores in both studies. Loss of control was also consistently predictive of "habit/automatic" SMMs. This pattern of findings reinforces the conclusion that tobacco dependence involves not only heavy use, but also a sense that tobacco use is frequently involuntary or automatic.

4.3. PDM and specific self-monitored smoking motives

In both samples, PDM was associated with the self-monitored "habit/automatic" motive, either when entered alone or in conjunction with the SDM composite. Momentary reports of the habit/automatic motive were also related to daily smoking and FTND scores in both samples (Tables 2 and 6). Therefore, the evidence clearly supported the notion that high PDM scores imply a subjective sense that actual instances of smoking are automatic or habitual, and also identify this pattern of self-administration as a characteristic of dependent smoking. It is true, of course, that this subjective sense cannot necessarily be equated with automaticity as it would be defined using information-processing methods (see Curtin et al., 2006; Tiffany, 1990).

As expected, immediate reports of smoking to reduce craving were related to PDM scores in Study 1. However, this effect was not replicated in Study 2. Although "reduce craving" was the most frequently endorsed self-monitored motive in both samples, it was markedly less common in Study 2 (37.4% of cigarettes vs. 62.8% in Study 1). Interestingly, the "reduce craving" motive was related to FTND scores in Study 1 but not Study 2. The reasons for the inconsistent findings are not clear. One possibility is that cravings may differ in kind and degree (e.g., Tiffany, 1990; Zinser et al., 1992) and that the admixture varied across samples. Additionally, the greater number of motive options offered in Study 2 could have affected smokers' allocation of responses.

4.4. SDM and situational self-monitored motives

We expected that the SDM composite would predict endorsement of situational motives that may be more characteristic of nondependent smoking. When SDM was considered as the sole predictor, this did not appear to be the case. The expected relations between SDM and secondary SMMs did not emerge until PDM was covaried. This pattern may indicate that the SDM scales are influenced by a general tobacco dependence factor. Once the influence of this factor is removed, the residual SDM scores may more cleanly reflect individual differences in situational or instrumental reasons for smoking. In real-time reports, such situational motives are more likely to be reported by less dependent or daily smokers.

4.5. Assessment modality and the prominence of primary motives

Self-monitored and questionnaire motive assessments apparently differ in how well they reflect nondependent use patterns. Questionnaire assessments may be more affected by retrospective or heuristic biases. Though less practical for many research applications, self-monitoring has the advantage of requiring fewer and less complex judgments compared to global questionnaires, and thus may reveal distinctive patterns of smoking motivation (Shiffman and Prange, 1988; Stone and Shiffman, 1994). Situational or opportunistic *immediate* motives for smoking (i.e., secondary SMMs) may be characteristic of nondependent tobacco use. However, many dependent smokers may never "forget" these motives or may fail to recognize that they no longer account for the majority of their smoking events. Thus, questionnaire endorsement of SDM motives is likely to rise as dependence progresses, though perhaps less dramatically than PDM motives (Piper et al., 2004). This tendency to never forget or disavow historically experienced reasons for smoking may help account for the existence of a general "smoking drive" factor (Shiffman, 1993). The current results showed that daily smokers and smokers with higher FTND scores are more likely to endorse essentially *all* questionnaire-based motives for smoking (Figs. 1 and 2; Table 5). It may not be possible to observe congruence of questionnaire and self-monitored measures of secondary smoking motives until the influence of this general dependence-like factor is removed from the questionnaire measure.

4.6. Limitations

Several limitations of the current studies deserve comment. Both studies recruited college student smokers. Different findings might be obtained in samples featuring older or heavier smokers. However, it is important to note that college students do represent an appropriate sample for investigating the development of increased tobacco involvement and dependence, given the fledgling nature of their tobacco use experience. Of course, cross-sectional comparisons have limitations for making inferences about dependence-motive transitions; ideally one would track the growth of individual motives over time to determine directly which most closely covary with the display of important clinical symptoms of tobacco dependence.

Some self-monitored motives (e.g. "reduce craving") were endorsed less commonly in Study 2 compared to Study 1. These differences could be related to discrepancies in sample composition. In Study 2, motives were split across several screens on the ED rather than being presented all at once and more motives were assessed. Some cigarettes that might have fallen into original motive categories may have been re-allocated to a new response option. Concerns about possible assessment burden limited the number of motives included in the diary assessments. Furthermore, the diary items were crafted prior to the identification of the PDM-SDM distinction. Future research should improve on the current work by assessing a larger array of self-monitored motives selected to more directly align with PDM and SDM subscale contents.

For many research applications, the WISDM may be unwieldy. We did not conduct empirical analyses aimed at paring down the instrument in the present research. The recently developed Brief WISDM (Smith et al., 2010) consists of 37 items organized into 11 subscales; this form may be useful when assessing both PDM and SDM is desired but 68 items cannot be accommodated.

Self-monitored motives may not be a "gold standard" against which to gauge WISDM scale performance. Some motives may be strongly held or valued yet rarely observed in diary reports because the environment does not often permit their expression. Such considerations limit, to some extent, the degree of overlap expected across assessment modalities.

4.7. Conclusions

PDM and SDM are correlated measures that, considered in isolation, each tend to be associated with daily smoking, FTND scores, and ecologically assessed motives for smoking that are characteristic of tobacco dependence. SDM shows tighter relations with conceptually congruent targets when the influence of the PDM factor is statistically covaried. Other research (e.g., Japuntich et al., 2009; Piasecki et al., 2007) suggests that some of the individual WISDM subscales have fairly modest relations with particular, conceptually linked self-monitored behaviors or affective phenomena. Relations between the WISDM and real-time smoking motives and behaviors may be most consistent or interpretable at the level of the higher-order PDM and SDM factors rather than at the level of the individual subscale. More generally, the current studies contribute to the growing body of evidence attesting to the value of distinguishing between primary and secondary smoking motives. Smoking for instrumental or situational reasons, particularly as assessed by real-time self-monitoring, is characteristic of nondependent smoking. Conversely, self-described automatic smoking, whether reported by questionnaire or self-monitoring, is indicative of tobacco dependence.

Conflict of interest

None declared.

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Contributors

T.M. Piasecki: principal investigator of the studies, conceptualization of the analysis, collection and analysis of data, composition of first draft, and incorporation of suggested revisions. M.E. Piper: conceptualization of the analysis, editing of the first draft. T.B. Baker: conceptualization of the analysis, editing of the first draft. E.E. Hunt-Carter: contributed to study design and collection of data, editing of first draft.

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