Published in final edited form as:
Psychopharmacology (Berl). 2013 December ; 230(3): 363–373. doi:10.1007/s00213-013-3169-7.

Abstinence-related expectancies predict smoking withdrawal effects: implications for possible causal mechanisms

Peter S. Hendricks and
Department of Health Behavior, School of Public Health, University of Alabama at Birmingham, 227L Ryals Public Health Building, 1665 University Blvd., Birmingham, AL 35294, USA

Adam M. Leventhal
Departments of Preventive Medicine and Psychology, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

Abstract

Rationale—Despite the decades-long emphasis on withdrawal in leading models of addiction, the causal mechanisms driving smoking withdrawal effects are not well known. This gap in the knowledge base has stalled theory and treatment development for smoking dependence.

Objectives—As cognitive factors have been largely neglected as predictors of withdrawal, the current study sought to examine how smokers' abstinence-related expectancies relate to withdrawal symptomatology.

Methods—Adult smokers (N=180; ≥10 cigarettes/day) participated in two counterbalanced experimental sessions involving either 16 h of abstinence or smoking as usual. At baseline, participants completed three withdrawal-related scales of the Smoking Abstinence Questionnaire (Withdrawal, Optimistic Outcomes, and Weight Gain scales), a self-report measure of smokers' abstinence-related expectancies. During experimental sessions, participants completed a number of instruments that covered the range of smoking withdrawal effects (i.e., negative affect, urge/craving to smoke, diminished positive affect, concentration difficulty, hunger, and physiological symptoms).

Results—Even after controlling for the influence of demographic characteristics and cigarette dependence, smokers' abstinence-related expectancies were meaningful predictors of abstinence-induced changes in various withdrawal symptoms (mean adjusted standardized β=0.22). Stronger expectancies for withdrawal and weight gain predicted more severe withdrawal effects, whereas stronger expectancies for optimistic outcomes predicted less severe withdrawal effects.

Conclusions—These findings are consistent with the notion that expectancies actively shape future experience and are the first to support the suggestion that smokers' abstinence-related expectancies may be causal agents of withdrawal symptomatology. Future research is required to more conclusively determine whether abstinence-related expectancies mold withdrawal effects.

Keywords

Smoking; Cigarettes; Withdrawal; Expectancies; Abstinence

phendricks@uab.edu.

Conflict of interest
The authors have no conflicts of interest to report.

The withdrawal syndrome—undesired symptoms that emerge upon the cessation of chronic drug use—has a storied relationship with cigarette use and dependence. It is regarded as a fundamental characteristic of addiction in a number of esteemed models of drug use behavior (e.g., Marlatt 1977; Siegel 1983; Solomon 1977; Wikler 1973) and is considered the prepotent factor in the maintenance of dependence and relapse to drug use in leading contemporary theories of addiction motivation (e.g., Baker et al. 2004). Accordingly, nicotine replacement therapy was conceived with the principal action to reduce withdrawal symptoms, varenicline was designed in part to alleviate withdrawal from nicotine (Benowitz 2009), and withdrawal regulation is a prominent feature of contemporary cognitive–behavioral therapy for smoking cessation (e.g., Fiore et al. 2008; Hall et al. 2004). Although some research has failed to show a strong relationship between smoking withdrawal effects and smoking cessation outcome (e.g., Hall et al. 1990; Kenford et al. 1994), withdrawal symptoms prove robust predictors of relapse when assessed and analyzed using contemporary theory and methodology (McCarthy et al. 2006; Piasecki et al. 1998, 2000, 2003a, 2003b; Piper et al. 2011; Strong et al. 2009, 2011). Furthermore, mediational models indicate that both pharmacotherapy and behavioral treatments promote smoking abstinence by reducing withdrawal symptomatology (e.g., Piper et al. 2008; Vidrine et al. 2006). Hence, studying the origins of smoking withdrawal is of considerable scientific and clinical importance.

The characteristic features of smoking withdrawal are well known and include anger/irritability, anxiety, dysphoria/sadness, restlessness, urge/craving to smoke, diminished positive affect, difficulty concentrating, weight gain/increased appetite, and fatigue (American Psychiatric Association 1994; Leventhal et al. 2010). Unfortunately, the etiology of smoking withdrawal symptoms is not well understood. The most commonly cited determinants of smoking withdrawal symptoms include the homeostatic adaptation of the nervous system to the absence of nicotine after chronic nicotine exposure (i.e., pharmacologic processes) as well as the behavioral adaptation of the individual to the absence of the drug self-administration ritual (i.e., from behavioral dependence; Baker et al. 2004, 2006; Hughes 2007a). However, measures of smoking dependence, which presumably assess the pharmacologic and behavioral facets of the dependence construct, account for only a portion of the variance in smoking withdrawal symptoms (e.g., Baker et al. 2012; Robinson et al. 2011; Ríos-Bedoya et al. 2008). Clearly, a comprehensive appreciation of the origins of smoking withdrawal effects has not been reached. This is significant because a more thorough understanding on the etiology of withdrawal symptoms has the potential to advance the treatment of smoking dependence by informing intervention strategies that target all meaningful sources of withdrawal phenomena. Indeed, as noted by Piper et al. (2008), whereas withdrawal appears to exert a strong influence on smoking cessation treatment outcome, smoking cessation treatment may exert only modest effects on withdrawal.

While pharmacologic and behavioral processes have received much attention in the withdrawal literature, cognitive factors have often been overlooked as potential determinants of smoking withdrawal. Nevertheless, cognition is closely tied to affect, desire, and other features characteristic of the smoking withdrawal syndrome (Kavanagh et al. 2005; Teasdale 1999). Expectancies may be particularly meaningful cognitive determinants of smoking withdrawal because expectancies reflect the lifetime of learning (i.e., prior experience with abstinence; Brandon et al. 1999; Goldman et al. 2010) and, perhaps more importantly, because expectancies shape future outcomes, as illustrated by the placebo effect (Brody and Miller 2011; Kirsch 1985, 1997; Michael et al. 2012; Price et al. 2008). In the smoking literature, expectancies have been shown to influence future outcomes time and again. For instance, participants who are told that the cigarette they are about to smoke contains nicotine report greater reductions in anxiety after smoking only if they hold the expectancy

that smoking reduces negative affect (Juliano and Brandon 2002); placebo-tailored self-help materials yield superior smoking cessation outcomes compared to standard self-help materials, especially when smokers' expectancies for tailored materials are primed pre-intervention (Webb et al. 2007); and participants who are told that the cigarette they are about to smoke will enhance their cognitive and motor performance report greater reinforcement and craving reduction from the cigarette than those who are told that the cigarette they are about to smoke will impair such performance (Harrell and Juliano 2012).

Though expectancies for the consequences of cigarette *use* have been shown to predict withdrawal symptoms, they are believed to do so because they are associated with a loss of reinforcement upon quitting (Vidrine et al. 2009; Wetter et al. 1994). Accordingly, a more logical method for testing the effects of expectancies on withdrawal would involve assessing expectancies for the effects of smoking *abstinence* directly (i.e., cognitions regarding the likelihood of particular consequences of abstinence, such as "If I quit smoking, I would feel short-tempered or cranky."). Doing so might clarify the potential causal foundations of smoking withdrawal and provide valuable clinical data with which to increase the efficacy of existing smoking cessation interventions. For example, should abstinence-related expectancies prove meaningful predictors of smoking withdrawal symptoms, interventions might consider tailoring treatment on the basis of smokers' abstinence-related expectancies. Smokers' abstinence-related expectancies have only recently been investigated and have been shown to associate with dependence and other measures (Hendricks et al. 2011, 2013). The only examination of abstinence-related expectancies with respect to smoking withdrawal symptoms examined relations with symptoms experienced in the past 24 h on a composite measure among smokers who had been smoking ad lib (Hendricks et al. 2011). To clarify the influence of smokers' abstinence-related expectancies on smoking withdrawal, it is important to (a) examine a wider range of smoking withdrawal symptoms and (b) experimentally manipulate abstinence to characterize the prospective relationships between abstinence-related expectancies and withdrawal effects.

In this study, cigarette users participated in two counter-balanced experimental sessions involving either 16 h of abstinence or smoking as usual. At baseline, participants completed three scales with content relevant to withdrawal from the Smoking Abstinence Questionnaire (SAQ; Hendricks et al. 2011), a recently developed instrument of smokers' abstinence-related expectancies. During experimental sessions, participants completed a battery of measures that surveyed the range of smoking withdrawal effects (Hughes 2007b). We hypothesized that abstinence-related expectancies as measured by each of the three SAQ scales would meaningfully predict abstinence-induced withdrawal effects, particularly those with motivational relevance to cigarette use, namely negative affect, urge/craving to smoke (Baker et al. 2004,2012; Piper et al. 2008, 2011), and anhedonia (i.e., diminished positive affect; Strong et al. 2011). We further hypothesized that these relations would meaningfully predict withdrawal effects above and beyond other relevant participant characteristics, including a traditional index of cigarette dependence.

Method

Participants

Participants were 263 cigarette smokers who responded to community advertisements for a study on personality and smoking. Eligibility criteria were as follows: (1) ≥18 years old; (2) regular cigarette smoking for ≥2 years; (3) currently smoking ≥10 cigarettes/day; and (4) fluent in English. Exclusion criteria were (1) current non-nicotine substance dependence according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (*DSM-IV*); (2) current mood disorder or psychotic symptoms according to the *DSM-IV*; (3) expired breath carbon monoxide (CO) levels <10 parts per million (ppm) at intake; (4) use

of non-cigarette forms of tobacco or nicotine products; (5) planning to reduce or quit smoking in the next 30 days; (6) current use of psychiatric medications; and (7) currently pregnant. Subjects were compensated $200 for completing the study. Those who were ineligible following the in-person screening (*n*=64), dropped out after enrolling (*n*=18), or twice failed to meet abstinence criteria at the abstinent session (*n*=1; see below) were excluded from analyses, leaving a final sample of 180. This study was approved by the University of Southern California Internal Review Board and therefore complied with the standards of the 1964 Declaration of Helsinki.

Procedure

Following a telephone screen, participants attended a screening and baseline session involving informed consent, expired breath CO analysis, psychiatric interview, and completion of a variety of baseline measures, including the three SAQ scales.

Participants then attended two counterbalanced experimental sessions (one abstinent and one non-abstinent) that began at 12:00 p.m. For abstinent sessions, participants were instructed not to smoke after 8:00 p.m. the evening before the session. For non-abstinent sessions, participants were instructed to smoke normally. The procedures were identical across the two sessions with the following exception: at the beginning of the non-abstinent session, participants smoked a cigarette of their preferred brand in the laboratory in order to standardize abstinence levels. Experimental sessions commenced with CO assessment. Following published recommendations indicating a CO of 10 ppm or greater indicates recent smoking (Benowitz et al. 2002) and prior laboratory smoking withdrawal research (Benowitz et al. 2002; Leventhal et al. 2010), participants with CO indicating non-abstinence (>9 ppm) at their abstinent session could return later that week for a second attempt to complete their abstinent session (*n*=11). Individuals with CO >9 ppm on their second attempt to complete the abstinent session were discontinued from further participation (*n*=1). Participants were then administered measures of smoking withdrawal followed by other procedures (not reported here).

Measures

Baseline session

Structured Clinical Interview for DSM-IV Non-Patient Edition: This measure (First et al. 2002) was used to assess psychiatric symptoms and diagnoses to confirm study eligibility.

Demographic and smoking history questionnaire: An author-constructed questionnaire was used to measure demographic and smoking characteristics (e.g., cigarettes smoked per day, age of smoking onset, etc.).

Fagerström Test for Cigarette Dependence: The Fagerström Test for Cigarette Dependence (FTCD; Fagerström 2012; Heatherton et al. 1991) is a well-validated six-item measure of gradations in cigarette dependence.

SAQ: The SAQ (Hendricks et al. 2011) assesses smokers' abstinence-related expectancies on 10 scales, instructing respondents to rate how likely or unlikely they believe 55 consequences (i.e., items) would be for them if they attempted to quit smoking (0="not likely at all" to 6="extremely likely"). In the current study, three of the 10 SAQ scales with content deemed most relevant to withdrawal (16 items) were administered: *Withdrawal*, which measures expectancies for withdrawal effects (e.g., "I would feel short-tempered or cranky," "The demands of everyday life would seem like more of a struggle," "I would really crave a cigarette."); *Optimistic Outcomes*, which assesses the expectancy that quitting

would be easy and uncomplicated (e.g., “Withdrawal would not be much of a problem for me,” “My mood would not be affected,” “I would have few urges or cravings to smoke.”); and *Weight Gain*, which measures expectancies for weight gain and appetite increase (e.g., “I would gain weight,” “I would want to eat more food than I do now.”). The SAQ scales have demonstrated adequate to excellent reliability and strong concurrent associations with smoking dependence, motivation to quit and abstinence self-efficacy, and past 24-h withdrawal symptoms (Hendricks et al. 2011), and have distinguished between American-Indian and White smokers, African-American and White smokers, and men and women smokers (Hendricks et al. 2013).

Experimental sessions—Each of the measures below has shown adequate sensitivity to smoking abstinence effects and adequate psychometric properties (Hughes 2007b; Leventhal et al. 2010).

The Minnesota Nicotine Withdrawal Scale: The Minnesota Nicotine Withdrawal Scale (MNWS; Hughes and Hatsukami 1986) is a well-validated and widely used measure of smoking withdrawal. The MNWS variant used in this study assessed 11 withdrawal symptoms experienced “so far today” with one item each on a six-point Likert scale. Average score per item and a composite mean score (i.e., Total score) are reported (range 0–5), for a total of 12 scores, with greater scores reflecting more severe symptomatology.

The Wisconsin Smoking Withdrawal Scale: The Wisconsin Smoking Withdrawal Scale (WSWS; Welsch et al. 1999) is a 23-item multifactorial measure of smoking withdrawal that contains six scales (i.e., Anger, Anxiety, Concentration Difficulty, Craving, Hunger, and Sadness) and an overall severity scale (i.e., Total score). As in Leventhal et al. (2010), participants were instructed to respond based on how they were feeling “so far today,” and items that assess sleep problems were excluded because participants would not have been abstinent for a long period before going to sleep. Average scores per scale are reported (range 0–4) with greater scores representing more severe withdrawal effects.

The Brief Questionnaire of Smoking Urges: The Brief Questionnaire of Smoking Urges (QSU; Cox et al. 2001) is a measure of smoking urges experienced “right now.” It includes a total scale as well as scales that measure desire for the positive effects of smoking and intention to smoke (Factor 1, five items) and desire for relief of negative affect and an urgent need to smoke (Factor 2, five items). Items are rated on six-point Likert scales (range 0–5), and average scores per scale are reported. Greater scores reflect stronger urges to smoke.

The Profile of Mood States: The Profile of Mood States (POMS; McNair et al. 1971) is a multifactorial affect scale. We used a 72-item version in which participants rated affect adjectives on a five-item Likert scale based on how they were feeling “right now” (range 0–4). The scale produced seven affect scales (Anxiety, Vigor, Depression, Fatigue, Confusion, Anger, Friendliness, and Elation), including two composite scales computed by combining some of the individual affect scales [Arousal Composite = (Anxiety + Vigor) − (Fatigue + Confusion); Positive Mood Composite = Elation − Depression]. Higher scores indicate greater agreement with the mood state.

Data analysis

For preliminary analyses, we calculated Cronbach’s alpha coefficients for each SAQ scale as well as correlations among the SAQ scales and between the SAQ scales and baseline characteristics. To test the main effects of abstinence on our primary outcomes, we calculated abstinence-induced change scores (abstinent – non-abstinent) for each outcome

and then conducted single-sample *t* tests to test for significant departure from zero and reported Cohen *d* statistics as a measure of effect size for abstinence effects.

For the primary analyses, we used linear regression models to test the associations of SAQ scales with abstinence-induced changes in smoking withdrawal effects. Each model included a single SAQ scale as the predictor and an abstinence-induced change score as the outcome. Separate models were calculated for each outcome. We did not consider a multivariate approach because the acute smoking withdrawal syndrome is phenomenologically diverse, allowing for qualitatively distinct expressions of withdrawal effects for different individuals. Indeed, past work has shown that individual difference characteristics may predict greater exacerbations for certain symptoms, but not for others (e.g., Leventhal et al. 2007a, b). Hence, by amalgamating each of the outcomes using multi-variate approaches or composite scores, we could be vulnerable to overlooking qualitatively distinct patterns of withdrawal that may be differentiated by smokers' abstinence-related expectancies. In order to control for the association between non-abstinent ratings and degree of change, the corresponding non-abstinent outcome measure was included as a covariate in each model (see Grouin and Lewis 2004). To examine the incremental predictive validity of the SAQ scales over and above other relevant participant characteristics, we retested the models after adjusting for age, gender, ethnicity, race, and FTCD score.

Prior to testing regression models, the distributions of SAQ and outcome data were examined for normality. Non-abstinent WSWS and MNWS Total scores were positively skewed, and therefore, square root transformations were applied to these variables when they were included as covariates in each model. Primary results of the regression models are reported as standardized β's, which strongly correspond to correlation coefficients (Peterson and Brown 2005) and are recommended for use as effect size metrics (e.g., Becker and Wu 2007; Bowman 2012). As we were primarily interested in the degree of association between the SAQ scales and withdrawal symptoms, only statistically significant (alpha=0.05) standardized β's of 0.10 or greater were considered meaningful.

Results

Preliminary analyses

Descriptive statistics and intercorrelations among demographic and smoking characteristics and SAQ scales are reported in Table 1. On average, participants rated the likelihood of abstinence-related consequences in the middle of the continuum for the three scales (average scores around 3 to 4), and there was sufficient interindividual variability in SAQ scores. Greater Withdrawal scores on the SAQ were associated with female gender, younger age of regular smoking onset, heavier smoking, and more severe cigarette dependence. Greater Optimistic Outcomes scores on the SAQ were correlated with older age. Greater Weight Gain scores on the SAQ were associated with older age, female gender, African-American race, and more severe cigarette dependence. Each SAQ scale had at least adequate internal consistency (Cronbach's alpha >0.70) and sufficient discriminant validity among the other scales.

Descriptive statistics on outcome variables across abstinent and non-abstinent conditions are displayed in Table 2. There were significant differences between abstinent and non-abstinent conditions on each outcome measure (p's<0.05), except for Depression, Fatigue, and Arousal on the POMS and Physiological Symptoms and Drowsiness on the MNWS, which have illustrated smaller abstinence effects than other symptoms in prior work (Leventhal et al. 2010). The abstinence effects ranged from small to large in size (mean Cohen's d=0.43), suggesting that the strength of the abstinence manipulation was adequate.

Primary analyses

Table 2 also displays results from regression models predicting abstinence-induced change scores from SAQ scales. Greater Withdrawal scores on the SAQ predicted greater increases in Anxiety, Confusion, and Anger and greater reductions in Positive Mood scores on the POMS in unadjusted models, and greater increases in Anxiety and Confusion scores in adjusted models. Furthermore, greater Withdrawal scores on the SAQ predicted greater increases in urge to smoke on each of the three QSU scales in both unadjusted and adjusted models, greater increases in withdrawal symptoms on most of the MNWS scores in both unadjusted (9/12 scores) and adjusted (8/12 scores) models, and greater increases in withdrawal symptoms on all WSWS scales but Hunger in both unadjusted and adjusted models.

Greater Optimistic Outcomes scores on the SAQ predicted smaller decreases in Vigor, Elation, and Positive Mood scores on the POMS in unadjusted models, and smaller decreases in Elation and Positive Mood scores in adjusted models. Although Optimistic Outcomes scores were not associated with any components of the QSU or MNWS, greater scores on this scale predicted smaller increases in withdrawal on four of the seven WSWS scales in unadjusted models (Anxiety, Hunger, Sadness, and Total score) and on three of the seven WSWS scales in adjusted models (Hunger, Sadness, and Total score).

Finally, greater Weight Gain scores on the SAQ predicted greater increases in Anxiety, Depression, Fatigue, Confusion, and Anger scores on the POMS in unadjusted models. Results were similar in adjusted models, though greater Weight Gain scores also predicted smaller reductions in Arousal. In addition, greater Weight Gain scores on the SAQ predicted greater increases in urge to smoke on the QSU in both unadjusted (each of the three scales) and adjusted (all scales but Factor 1) models, greater increases in withdrawal on most of the scores of the MNWS in both unadjusted (9/12 scores) and adjusted (10/12 scores) models, and greater increases in withdrawal on all WSWS scales but Hunger and Sadness in both adjusted and unadjusted models.

Discussion

Consistent with the hypotheses, smokers' abstinence-related expectancies were meaningful predictors of motivationally relevant smoking withdrawal symptoms (i.e., negative affect, urge/craving to smoke, and anhedonia) and other withdrawal effects following overnight abstinence, with effect sizes in the small to medium range (mean adjusted standardized β=0.22). These results compare favorably with the predictive relationships of cigarette use expectancies with longer-term smoking withdrawal in a recent randomized clinical trial (mean standardized β=0.11; Vidrine et al. 2009) and suggest that smoking research should prioritize smokers' expectancies for abstinence. When adjusted for a range of covariates including demographic characteristics and cigarette dependence, abstinence-related expectancies remained significant predictors of withdrawal symptomatology in nearly 90 % of all cases. Importantly, these results were yielded within the context of a prospective, experimentally manipulated abstinence design. Hence, these results are less subject to methodological limitations associated with cross-sectional and retrospective designs, including recall biases, which could inflate associations between abstinence-related expectancies and recall of past withdrawal symptoms.

Participants who held stronger expectancies for postcessation withdrawal effects (e.g., "I would feel short-tempered or cranky," "The demands of everyday life would seem like more of a struggle," "I would really crave a cigarette.") reported greater abstinence-induced negative affect (i.e., anger, anxiety, concentration difficulty, confusion, impatience, irritability, restlessness, and sadness), urge/craving to smoke, headaches, hunger, and

anhedonia. Furthermore, those who held stronger expectancies that quitting would be uncomplicated and easy (e.g., “Withdrawal would not be much of a problem for me,” “My mood would not be affected”, “I would have few urges or cravings to smoke.”) were less likely to report some abstinence-induced negative affective symptoms of withdrawal (i.e., anxiety and sadness) and hunger but, more notably, were less likely to report abstinence-induced anhedonic symptomatology (i.e., reductions in vigor, elation, and positive mood). Finally, those who held stronger expectancies for postcessation weight gain and appetite increase (e.g., “I would gain weight,” “I would want to eat more food than I do now.”) were more likely to report abstinence-induced negative mood states and urge/craving to smoke, as well as hunger and changes in eating behavior, physiological symptoms, and fatigue, drowsiness, and reductions in arousal. Expectancies for postcessation weight gain and appetite increase predicted changes in several withdrawal measures indicative of arousal that did not significantly differ between non-abstinent and abstinent conditions (i.e., POMS Depression, Fatigue, and Arousal scores and MNWS Phsyiological Symptoms and Drowsiness scores), which suggests that these expectancies may be useful in identifying subgroups of individuals who are likely to experience otherwise uncommon withdrawal symptoms.

It is worth commenting that there was some construct “crossover” with regard to the domains assessed within the three SAQ scales and the variety of smoking withdrawal symptoms with which they were associated. For instance, weight concern expectancies did not solely predict abstinence-induced changes in eating; rather, they predicted exacerbations across a variety of withdrawal phenomena. The intercorrelations between the SAQ scales were minimal to moderate (*r*’s −0.03 to 0.43), suggesting that they were tapping different underlying cognitive constructs. Hence, finding that each SAQ scale predicted various manifestations of smoking withdrawal might reflect the possibility that abstinence-related expectancies have broad-spanning effects that impact multiple processes disrupted during abstinence, including affective, motivational, cognitive, and somatic systems. Future research incorporating each of the 10 SAQ scales can further inform this matter.

Our results are the first to demonstrate that smokers’ abstinence-related expectancies predict smoking withdrawal effects. Although this could be the case solely because abstinence-related expectancies reflect smokers’ actual experience with abstinence (see Brandon et al. 1999; Goldman et al. 2010), expectancies have been consistently shown to influence the future, often in dramatic fashion (Brody and Miller 2011; Kirsch 1985, 1997; Michael et al. 2012; Price et al. 2008). For example, in a randomized clinical trial of treatment for irritable bowel syndrome, participants receiving *open-label* placebo pills demonstrated significantly greater symptom improvement than no-treatment controls (Kaptchuk et al. 2010). Therefore, it is possible that smokers’ abstinence-related expectancies played an active role in constructing their withdrawal experience. This insight is useful because, despite the theoretical and clinical significance of smoking withdrawal (e.g., Baker et al. 2004; Benowitz 2009; Fiore et al. 2008; Hall et al. 2004; Piper et al. 2008; Vidrine et al. 2006), its etiology is poorly understood. Contemporary conceptualizations of withdrawal purport that withdrawal symptoms are primarily caused by pharmacologic (i.e., neuroadaptations expressed by drug removal) and behavioral (i.e., loss of the tobacco self-administration ritual) mechanisms (e.g., Baker et al. 2006). The majority of smoking dependence interventions that address these particular mechanisms may quell withdrawal symptoms only slightly despite directed efforts to substantially do so (Piper et al. 2008). Here, we show that an additional mechanism that is cognitive in nature (i.e., expected consequences of smoking abstinence) may be a third etiological determinant underlying the expression of withdrawal symptoms upon acute cigarette abstinence.

Nevertheless, the associations in the present study do not necessarily indicate causation, nor do they inform directionality. Future research should therefore attempt to confirm the causal role of abstinence-related expectancies in withdrawal symptomatology. This could be accomplished in a number of ways. For instance, longitudinal investigations with repeated assessments of expectancies, cessation attempts, and withdrawal symptoms could estimate the contribution of expectancies to cessation-induced withdrawal effects above and beyond prior cessation-related withdrawal experience (e.g., via cross-lagged modeling). Furthermore, studies using only smokers who have never attempted to quit or who have abstained from smoking only overnight could determine whether expectancies can predict withdrawal symptoms in the absence of direct, significant experience with abstinence. Finally, research could investigate whether manipulating abstinence-related expectancies affects the withdrawal symptoms smokers report to abstinence. This approach has parallels with a number of prior experiments (e.g., Harrell and Juliano 2012; Webb et al. 2007), including expectancy challenge interventions (Scott-Sheldon et al. 2012), which have received scarce consideration in the tobacco field (Hendricks and Brandon 2008).

Of course, the present study is not without limitations. First, as with any single-variable explanation, abstinence-related expectancies failed to provide a perfect predictive model of withdrawal symptomatology. Similar to relapse, smoking withdrawal is undoubtedly influenced by an array of factors (see Witkiewitz and Marlatt 2004). Second, results may not generalize to longer-term smoking withdrawal symptoms or to smokers attempting to quit (Hughes 2007a). However, it is possible that the use of participants paid to abstain from smoking overnight may have attenuated the relationships between abstinence-related expectancies and withdrawal, as this research paradigm tends to yield muted withdrawal effects (Hughes 2007a). Thus, abstinence-related expectancies may prove even more potent predictors of longer-term withdrawal and withdrawal symptoms among those trying to cease cigarette use. Third, the current research could not account for the relationship between abstinence-related expectancies and dimensions of the withdrawal symptom profile other than mean value, which may be influential determinants of relapse (e.g., extreme values; Piper et al. 2011). Future research is therefore needed to determine the associations between abstinence-related expectancies, the full smoking withdrawal symptom profile, and relapse. Fourth, we conducted a large number of tests without applying a correction to the significance criterion, which increases the likelihood of type I error. However, the consistent pattern of findings across multiple outcomes measures of the same construct (e.g., the WSWS Craving scale and the QSU) somewhat offsets concerns of type I error. Further, the overarching goal of this study was not solely to test for statistical significance per se; rather, we aimed to describe and quantify the predictive validity of abstinence-related expectancies across a wide range of smoking withdrawal symptoms. Thus, the 0.05 critical value served mainly as a guide for determining which associations to interpret for meaning. Finally, this study represented an initial test of abstinence-related expectancies as predictors of smoking withdrawal symptoms. Therefore, not all potentially relevant covariates were included in predictive models. Establishing the incremental validity of abstinence-related expectancies over tobacco use expectancies, dependence motives, abstinence self-efficacy, and other relevant constructs is an important topic for future investigations. Furthermore, our abstinence manipulation involved the maximal manipulation including both pharmacologic (e.g., nicotine removal) and behavioral (e.g., loss of the sensorimotor stimuli associated with the smoking ritual) abstinence in order to produce the largest influence on withdrawal phenomena. Future work that manipulates pharmacologic and non-pharmacologic factors separately is warranted to disentangle the differential impact of smokers' abstinence-related expectancies on these two processes.

In sum, our results illustrate that smokers' abstinence-related expectancies are meaningful predictors of smoking withdrawal. These findings underscore the importance of smokers'

abstinence-related expectancies and suggest that though the abstinence-related expectancy construct has only recently become a topic of scientific inquiry, it may prove instrumental to informing addictive behaviors and their treatment.

Acknowledgments

This study was supported by the NIDA grants R01 DA026831 and K08 DA025041.

References

American Psychiatric Association. Diagnostic criteria from DSM-IV. American Psychiatric Association; Washington, DC: 1994.

Baker TB, Piper ME, McCarthy DE, Majeskie MR, Fiore MC. Addiction motivation reformulated: an affective processing model of negative reinforcement. Psychol Rev. 2004; 111:33–51. doi: 10.1037/0033-295X.111.1.33.

Baker TB, Japuntich SJ, Hogle JM, McCarthy DE, Curtin JJ. Pharmacologic and behavioral withdrawal from addictive drugs. Curr Dir Psychol Sci. 2006; 15:232–236. doi:10.1111/j.1467-8721.2006.00442.x.

Baker TB, Piper ME, Schlam TR, Cook JW, Smith SS, Loh WY, Bolt D. Are tobacco dependence and withdrawal related amongst heavy smokers? Relevance to conceptualizations of dependence. J Abnorm Psychol. 2012; 121:909–921. doi:10.1037/a0027889.

Becker BJ, Wu M-J. The synthesis of regression slopes in meta-analysis. Statist Sci. 2007; 22:414–429. doi:10.1214/07-STS243.

Benowitz NL. Pharmacology of nicotine: addiction, smoking-induced disease, and therapeutics. Annu Rev Pharmacol Toxicol. 2009; 49:57–71. doi:10.1146/annurev.pharmtox.48.113006.094742.

Benowitz NL, Jacob P III, Ahijevych K, Jarvis MJ, Hall SM, LeHouezec J, Hansson A, Lichtenstein E, Henningfield J, Tsoh J, Hurt RD, Velicer W. Biochemical verification of tobacco use and cessation. Nicotine Tob Res. 2002; 4:149–159. doi:10.1080/14622200210123581.

Bowman NA. Effect sizes and statistical methods for meta-analysis in higher education. Res High Educ. 2012; 53:375–382. doi:10.1007/s11162-011-9232-5.

Brandon, TH.; Juliano, LM.; Copeland, AL. Expectancies for tobacco smoking. In: Kirsch, I., editor. How expectancies shape experience. American Psychological Association; Washington, DC: 1999. p. 263-299.

Brody H, Miller FG. Lessons from recent research about the placebo effect—from art to science. J Am Med Assoc. 2011; 306:2612–2613. doi:10.1001/jama.2011.1850.

Cox LS, Tiffany ST, Christen AG. Evaluation of the brief questionnaire of smoking urges (QSU-brief) in laboratory and clinical settings. Nicotine Tob Res. 2001; 3:7–16. doi: 10.1080/14622200020032051.

Fagerström K. Determinants of tobacco use and renaming the FTND to the Fagerström Test for Cigarette Dependence. Nicotine Tob Res. 2012; 14:75–78. doi:10.1093/ntr/ntr137.

Fiore, M.; Jaén, CR.; Baker, TB.; Bailey, WC.; Benowitz, NL.; Curry, SJ. Treating tobacco use and dependence: 2008 update. U.S. Dept. of Health and Human Services, Public Health Service; Rockville: 2008.

First, MB.; Spitzer, RL.; Gibbon, M.; Williams, JBW. Structured clinical interview for DSM-IV-TR axis I disorders. Biometrics Research Department, New York State Psychiatric Institute; New York: 2002.

Goldman, MS.; Darkes, J.; Reich, RR.; Brandon, KO. Anticipatory processing as a transdisciplinary bridge in addiction. In: Ross, D.; Kincaid, DL.; Spurrett, D.; Collins, P., editors. What is addiction?. MIT; Cambridge: 2010. p. 291-334.

Grouin JM, Lewis J. Committee for Proprietary Medicinal Products (CPMP): points to consider on adjustment for baseline covariates. Statist Med. 2004; 23:701–709. doi:10.1002/sim.1647.

Hall SM, Havassy BE, Wasserman DA. Commitment to abstinence and acute stress in relapse to alcohol, opiates, and nicotine. J Consult Clin Psychol. 1990; 58:175–181. doi:10.1037/0022-006X.58.2.175.

Hall SM, Humfleet GL, Reus VI, Munoz RF, Cullen J. Extended nortriptyline and psychological treatment for cigarette smoking. Am J Psychiatry. 2004; 161:2100–2107. doi:10.1176/appi.ajp.161.11.2100.

Harrell PT, Juliano LM. A direct test of the influence of nicotine response expectancies on the subjective and cognitive effects of smoking. Exp Clin Psychopharmacol. 2012; 20:278–286. doi:10.1037/a0028652.

Heatherton TF, Kozlowski LT, Frecker RC, Fagerström KO. The Fagerström Test for Nicotine Dependence: a revision of the Fagerström Tolerance Questionnaire. Br J Addict. 1991; 86:1119–1127. doi:10.1111/j.1360-0443.1991.tb01879.x.

Hendricks PS, Brandon TH. Smokers' expectancies for smoking versus nicotine. Psychol Addict Behav. 2008; 22:135–140. doi:10.1037/0893-164X.22.1.135.

Hendricks PS, Wood SB, Baker MR, Delucchi KL, Hall SM. The Smoking Abstinence Questionnaire: measurement of smokers' abstinence-related expectancies. Addiction (Abingdon, England). 2011; 106:716–728. doi:10.1111/j.1360-0443.2010.03338.x.

Hendricks PS, Westmaas JL, Ta Park VM, Thorne CB, Wood SB, Baker MR, Lawler RM, Web Hooper M, Delucchi KL, Hall SM. Smoking abstinence-related expectancies among American Indians, African Americans, and Women: potential mechanisms of disparities. Psychol Addict Behav. 2013 doi: 10.1037/a0031938.

Hughes JR. Effects of abstinence from tobacco: etiology, animal models, epidemiology, and significance: a subjective review. Nicotine Tob Res. 2007a; 9:329–339. doi:10.1080/14622200701188927.

Hughes JR. Effects of abstinence from tobacco: valid symptoms and time course. Nicotine Tob Res. 2007b; 9:315–327. doi:10.1080/14622200701188919.

Hughes JR, Hatsukami D. Signs and symptoms of tobacco withdrawal. Arch Gen Psychiatry. 1986; 43:289–294. doi:10.1001/archpsyc.1986.01800030107013.

Juliano LM, Brandon TH. Effects of nicotine dose, instructional set, and outcome expectancies on the subjective effects of smoking in the presence of a stressor. J Abnorm Psychol. 2002; 111:88–97. doi:10.1037/0021-843X.111.1.88.

Kaptchuk TJ, Friedlander E, Kelley JM, Sanchez MN, Kokkotou E, Singer JP, Kowalczykowski M, Miller FG, Kirsch I, Lembo AJ. Placebos without deception: a randomized controlled trial in irritable bowel syndrome. PLoS One. 2010; 5:e15591. doi:10.1371/journal.pone.0015591.

Kavanagh DJ, Andrade J, May J. Imaginary relish and exquisite torture: the elaborated intrusion theory of desire. Psychol Rev. 2005; 112:446–467. doi:10.1037/0033-295x.112.2.446.

Kenford SL, Fiore MC, Jorenby DE, Smith SS, Wetter D, Baker TB. Predicting smoking cessation: who will quit with and without the nicotine patch. J Am Med Assoc. 1994; 271:589–594. doi:10.1001/jama.1994.03510320029025.

Kirsch I. Response expectancy as a determinant of experience and behavior. Am Psychol. 1985; 40:1189–1202. doi:10.1037/0003-066X.40.11.1189.

Kirsch I. Response expectancy theory and application: a decennial review. Appl Prev Psychol. 1997; 6:69–79. doi:10.1016/S0962-1849(05)80012-5.

Leventhal AM, Waters AJ, Boyd S, Moolchan ET, Heishman SJ, Lerman C, Pickworth WB. Associations between Cloninger's temperament dimensions and acute withdrawal. Addict Behav. 2007a; 32:2976–2989. doi:10.1016/j.addbeh.2007.06.014.

Leventhal AM, Waters AJ, Boyd S, Moolchan ET, Lerman C, Pickworth WB. Gender differences in acute tobacco withdrawal: effects on subjective, cognitive, and physiological measures. Exp Clin Psychopharmacol. 2007b; 15:21–36. doi:10.1037/1064-1297.15.1.21.

Leventhal AM, Waters AJ, Moolchan ET, Heishman SJ, Pickworth WB. A quantitative analysis of subjective, cognitive, and physiological manifestations of the acute tobacco abstinence syndrome. Addict Behav. 2010; 35:1120–1130. doi:10.1016/j.addbeh.2010.08.007.

Marlatt, GA. Craving for alcohol, loss of control, and relapse: a cognitive-behavioral analysis. In: Nathan, PE.; Marlatt, GA.; Loberg, T., editors. Alcoholism: new directions in behavioral research and treatment. Plenum; New York: 1977. p. 271-314.

McCarthy DE, Piasecki TM, Fiore MC, Baker TB. Life before and after quitting smoking: an electronic diary study. J Abnorm Psychol. 2006; 115:454–466. doi:10.1037/0021-843x.115.3.454.

McNair, D.; Lorr, M.; Droppleman, DL. Profile of mood states. Educational and Industrial Testing Service; San Diego: 1971.

Michael RB, Garry M, Kirsch I. Suggestion, cognition, and behavior. Curr Dir Psychol Sci. 2012; 21:151–156. doi:10.1177/0963721412446369.

Peterson RA, Brown SP. On the use of beta coefficients in meta-analysis. J Appl Psychol. 2005; 90:175–181. doi:10.1037/0021-9010.90.1.175.

Piasecki TM, Fiore MC, Baker TB. Profiles in discouragement: two studies of variability in the time course of smoking withdrawal symptoms. J Abnorm Psychol. 1998; 107:238–251. doi: 10.1037/0021-843X.107.2.238. [PubMed: 9604553]

Piasecki TM, Niaura R, Shadel WG, Abrams DB, Goldstein M, Fiore MC, Baker TB. Smoking withdrawal dynamics in unaided quitters. J Abnorm Psychol. 2000; 109:74–86. doi: 10.1037/0021-843X.109.1.74.

Piasecki TM, Jorenby DE, Smith SS, Fiore MC, Baker TB. Smoking withdrawal dynamics: I. Abstinence distress in lapsers and abstainers. J Abnorm Psychol. 2003a; 112:3–13. doi: 10.1037/0021-843X.112.1.3.

Piasecki TM, Jorenby DE, Smith SS, Fiore MC, Baker TB. Smoking withdrawal dynamics: II. Improved tests of withdrawal-relapse relations. J Abnorm Psychol. 2003b; 112:14–27. doi: 10.1037/0021-843X.112.1.14.

Piper ME, Federmen EB, McCarthy DE, Bolt DM, Smith SS, Fiore MC, Baker TB. Using mediational models to explore the nature of tobacco motivation and tobacco treatment effects. J Abnorm Psychol. 2008; 117:94–105. doi:10.1037/0021-843x.117.1.94.

Piper ME, Schlam TR, Cook JW, Sheffer MA, Smith SS, Loh WY, Bolt DM, Kim SY, Kaye JT, Hefner KR, Baker TB. Tobacco withdrawal components and their relations with cessation success. Psychopharmacology (Berl). 2011; 216:569–578. doi:10.1007/s00213-011-2250-3.

Price DD, Finniss DG, Benedetti F. A comprehensive review of the placebo effect: recent advances and current thought. Annu Rev Psychol. 2008; 59:565–590. doi:10.1146/annurev.psych.59.113006.095941.

Robinson JD, Lam CY, Carter BL, Minnix JA, Cui Y, Versace F, Wetter DW, Cinciripini PM. A multimodal approach to assessing the impact of nicotine dependence, nicotine abstinence, and craving on negative affect in smokers. Exp Clin Psychopharmacol. 2011; 19:40–52. doi:10.1037/a0022114.

Ríos-Bedoya CF, Snedecor SM, Pomerleau CS, Pomerleau OF. Association of withdrawal features with nicotine dependence as measured by the Fagerström Test for Nicotine Dependence (FTND). Addict Behav. 2008; 33:1086–1089. doi:10.1016/j.addbeh.2008.04.005.

Scott-Sheldon LA, Terry DL, Carey KB, Garey L, Carey MP. Efficacy of expectancy challenge interventions to reduce college student drinking: a meta-analytic review. Psychol Addict Behav. 2012; 26:393–405. doi:10.1037/a0027565.

Siegel, S. Classical conditioning, drug tolerance, and drug dependence. In: Smart, RG.; Glaser, FB.; Israel, Y.; Kalant, H.; Popham, RE.; Schmidt, W., editors. Research advances in alcohol and drug problems. Plenum; New York: 1983. p. 207-246.

Solomon, RL. An opponent-process theory of acquired motivation: the affective dynamics of addiction. In: Maser, JD.; Seligman, MEP., editors. Psychopathology: experimental models. Freeman; San Francisco: 1977. p. 66-103.

Strong DR, Kahler CW, Leventhal AM, Abrantes AM, Lloyd-Richardson E, Niaura R, Brown RA. Impact of bupropion and cognitive-behavioral treatment for depression on positive affect, negative affect, and urges to smoke during cessation treatment. Nicotine Tob Res. 2009; 11:1142–1153. doi:10.1093/ntr/ntp111.

Strong DR, Leventhal AM, Evatt DP, Haber S, Greenberg BD, Abrams D, Niaura R. Positive reactions to tobacco predict relapse after cessation. J Abnorm Psychol. 2011; 120:999–1005. doi:10.1037/a0023666.

Teasdale, JD. Multi-level theories of cognition-emotion relations. In: Dalgleish, T.; Power, MJ., editors. Handbook of cognition and emotion. Wiley; New York: 1999. p. 665-681.

Vidrine DJ, Arduino RC, Gritz ER. Impact of a cell phone intervention on mediating mechanisms of smoking cessation in individuals living with HIV/AIDS. Nicotine Tob Res. 2006; 8:S103–S108. doi:10.1080/14622200601039451.

Vidrine JI, Vidrine DJ, Costello TJ, Mazas C, Cofta-Woerpel L, Mejia LM, Wetter DW. The Smoking Consequences Questionnaire: factor structure and predictive validity among Spanish-speaking Latino smokers in the United States. Nicotine Tob Res. 2009; 11:1280–1288. doi:10.1093/ntr/ntp128.

Webb MS, Hendricks PS, Brandon TH. Expectancy priming of smoking cessation messages enhances the placebo effect of tailored interventions. Health Psychol. 2007; 26:598–609. doi:10.1037/0278-6133.26.5.598.

Welsch SK, Smith SS, Wetter DW, Jorenby DE, Fiore MC, Baker TB. Development and validation of the Wisconsin Smoking Withdrawal Scale. Exp Clin Psychopharmacol. 1999; 7:354–361. doi:10.1037/1064-1297.7.4.354.

Wetter DW, Smith SS, Kenford SL, Jorenby DE, Fiore MC, Hurt RD, Offord KP, Baker TB. Smoking outcome expectancies: factor structure, predictive validity, and discriminant validity. J Abnorm Psychol. 1994; 103:801–811. doi:10.1037/0021-843X.103.4.801.

Wikler A. Dynamics of drug dependence: implications of a conditioning theory for research and treatment. Arch Gen Psychiatry. 1973; 28:611–616. doi:10.1001/archpsyc.1973.01750350005001.

Witkiewitz K, Marlatt GA. Relapse prevention for alcohol and drug problems: that was Zen, this is Tao. Am Psychol. 2004; 59:224–235. doi:10.1037/0003-066x.59.4.224.

Table 1

Descriptive statistics, intercorrelations, and Cronbach alpha coefficients of demographic and smoking characteristics and Smoking Abstinence Questionnaire scales

Variable	*M* (SD) or *N* (%)	Intercorrelations (*r*)									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Age	44.50 (10.97)	–	0.10	*0.26* †	0.02	*0.19* *	0.09	*0.15* *	−0.14	*0.18* *	*0.19* **
2. Male gender	122 (67.8 %)	–		0.02	0.04	−0.01	−0.05	−0.03	*− 0.17* *	0.14	*− 0.21* **
3. African-American race	87 (48.3 %)			–	*0.27* †	0.13	−0.12	0.06	−0.11	0.03	*0.20* **
4. Non-Hispanic ethnicity	167 (92.8 %)				–	0.11	−0.02	−0.04	−0.06	−0.06	0.10
5. Age of smoking onset	20.01 (6.16)					–	0.02	*− 0.19* *	*− 0.21* **	−0.04	0.00
6. Cigarettes/day	16.82 (6.98)						–	*0.46* ‡	*0.25* †	0.01	0.10
7. FTCD	5.27(1.91)							–	*0.36* ‡	0.07	*0.24* **
8. SAQ-Withdrawal	3.76 (1.43)								(0.88)	−0.03	*0.43* ‡
9. SAQ-Optimistic Outcomes	2.86 (1.34)									(0.72)	*0.17* *
10. SAQ-Weight Gain	3.27 (1.86)										(0.87)

N's range from 173 to 180 due to missing data. Variables in parentheses along the diagonal represent Cronbach alpha estimates for Smoking Abstinence Questionnaire scales. Point-biserial correlations are reported for relationships between continuous variables and between continuous and dichotomous variables; phi coefficients are reported for relationships between dichotomous variables. Cigarettes/day = average number of cigarettes smoked per day; SAQ-Withdrawal = Withdrawal scale of the Smoking Abstinence Questionnaire (possible range 0–6); SAQ-Optimistic outcomes = Optimistic Outcomes scale of the Smoking Abstinence Questionnaire (possible range 0–6); SAQ-Weight Gain = Weight Gain scale of the Smoking Abstinence Questionnaire (possible range 0–6). Findings in italics are significant

FTCD Fagerström Test for Cigarette Dependence (possible range 0–10)

* $p<0.05$

** $p<0.01$

† $p<0.001$

‡ $p<0.0001$

Table 2

Descriptive statistics on outcome variables by condition and standardized β's predicting withdrawal effects from Smoking Abstinence Questionnaire scales

	Descriptive statistics on outcome variables by condition			**Standardized β's predicting withdrawal effects from SAQ scales**					
				SAQ-Withdrawal		**SAQ-Optimistic Outcomes**		**SAQ-Weight Gain**	
Outcome variable	**Abstinent** ***M (SD)***	**Non-abstinent** ***M (SD)***	**Cohen's** ***d*** [a]	**Unadj** [b]	**Adj** [c]	**Unadj** [b]	**Adj** [c]	**Unadj** [b]	**Adj** [c]
POMS									
Anxiety	1.15 (0.93)	0.78 (0.76)	*0.42* ‡	*0.20* **	*0.16* *	−0.11	−0.04	*0.19* **	*0.23* **
Vigor	1.73 (0.97)	2.01 (0.93)	*− 0.31* ‡	−0.11	−0.08	*0.15* *	0.13	−0.09	−0.09
Depression	0.57 (0.75)	0.47 (0.66)	0.13§	0.13	0.09	−0.13	−0.13	*0.14* *	*0.18* *
Fatigue	0.89 (0.91)	0.90 (0.92)	−0.01	0.12	0.10	−0.01	0.02	*0.13* *	*0.19* **
Confusion	0.99 (0.75)	0.86 (0.68)	*0.18* *	*0.20* **	*0.17* *	−0.10	−0.07	*0.19* **	*0.24* †
Anger	0.69 (0.83)	0.46 (0.71)	*0.32* ‡	*0.19* **	0.09	−0.09	−0.04	*0.21* **	*0.24* **
Friendliness	2.16 (0.95)	2.52 (0.91)	*− 0.40* ‡	−0.09	−0.05	0.13	0.11	−0.11	−0.08
Elation	1.51 (0.92)	1.84 (0.90)	*− 0.36* ‡	−0.11	−0.06	*0.23* †	*0.20* **	−0.07	−0.05
Arousal	1.00 (1.48)	1.03 (1.49)	−0.02	−0.12	−0.11	0.05	0.03	−0.11	*− 0.15* *
Positive mood	0.94 (1.27)	1.36 (1.25)	*− 0.34* †	*− 0.15* *	−0.09	*0.24* †	*0.22* †	−0.13	−0.13
QSU									
Factor 1	4.16 (0.97)	1.33 (1.34)	*1.87* ‡	*0.26* ‡	*0.23* ‡	−0.03	−0.03	*0.13* **	0.09
Factor 2	2.54 (1.33)	0.81 (1.06)	*1.39* ‡	*0.32* ‡	*0.25* †	−0.04	−0.03	*0.33* ‡	*0.27* †
Total	3.35 (1.03)	1.07 (1.15)	*1.82* ‡	*0.33* ‡	*0.27* ‡	−0.03	−0.03	*0.26* ‡	*0.20* †
MNWS									
Craving	3.66 (1.18)	2.42 (1.49)	*0.77* ‡	*0.14* **	*0.12* *	−0.10	−0.09	0.10	0.09
Irritability/anger	1.79 (1.64)	0.78 (1.34)	*0.62* ‡	*0.33* ‡	*0.25* †	−0.03	−0.01	*0.24* †	*0.25* †
Anxiety/tension	2.14 (1.70)	1.16 (1.43)	*0.54* ‡	*0.27* ‡	*0.22* **	0.04	0.06	*0.20* **	*0.19* **
Concentration difficulty	1.70 (1.60)	0.98 (1.34)	*0.41* ‡	*0.29* ‡	*0.26* †	−0.07	−0.04	*0.19* **	*0.22* **
Restlessness	2.00 (1.73)	1.30 (1.43)	*0.41* ‡	*0.32* ‡	*0.27* †	−0.03	0.01	*0.22* **	*0.23* **

Psychopharmacology (Berl). Author manuscript; available in PMC 2014 February 25.

Outcome variable	Descriptive statistics on outcome variables by condition			Standardized β's predicting withdrawal effects from SAQ scales					
				SAQ-Withdrawal		SAQ-Optimistic Outcomes		SAQ-Weight Gain	
	Abstinent *M (SD)*	Non-abstinent *M (SD)*	Cohen's *d*[a]	Unadj[b]	Adj[c]	Unadj[b]	Adj[c]	Unadj[b]	Adj[c]
Impatience	2.32 (1.69)	1.42 (1.59)	*0.49* ‡	*0.29* ‡	*0.27* †	−0.01	0.01	*0.23* †	*0.26* †
Excessive hunger	1.95 (1.78)	0.98 (1.28)	*0.49* ‡	*0.14* *	0.09	−0.04	−0.03	*0.18* **	*0.17* *
Physiological symptoms[d]	0.78 (1.38)	0.69 (1.25)	0.06	0.08	0.06	0.07	0.09	*0.15* *	*0.17* *
Increased eating	1.69 (1.73)	0.80 (1.25)	*0.50* ‡	0.10	0.05	−0.02	−0.01	*0.18* **	*0.18* *
Drowsiness	1.19 (1.47)	1.15 (1.41)	0.03	0.07	0.04	−0.01	−0.01	0.11	*0.14* *
Headaches	0.91 (1.42)	0.51 (1.07)	*0.27* †	*0.22* **	*0.17* *	−0.05	−0.08	0.11	0.11
Total	1.83 (1.10)	1.11 (0.92)	*0.67* ‡	*0.29* ‡	*0.23* **	−0.03	−0.01	*0.26* †	*0.28* †
WSWS									
Anger	1.70 (1.16)	1.04 (1.07)	*0.55* ‡	*0.27* ‡	*0.23* **	−0.07	−0.05	*0.19* **	*0.21* **
Anxiety	2.06 (0.86)	1.70 (0.93)	*0.41* ‡	*0.24* †	*0.21* **	*− 0.14* *	−0.12	*0.19* **	*0.20* **
Concentration difficulty	1.57 (0.94)	1.14 (0.85)	*0.47* ‡	*0.27* ‡	*0.24* **	−0.12	−0.08	*0.26* †	*0.30* ‡
Craving	2.71 (0.89)	1.72 (0.87)	*0.96* ‡	*0.29* ‡	*0.24* †	−0.11	−0.08	*0.20* **	*0.18* **
Hunger	2.09 (0.86)	1.84 (0.80)	*0.25* **	−0.04	−0.06	*− 0.14* *	*− 0.14* *	0.06	0.04
Sadness	1.48 (0.74)	1.18 (0.73)	*0.41* ‡	*0.20* **	*0.17* *	*− 0.26* ‡	*− 0.26* ‡	0.11	0.09
Total	1.97 (0.63)	1.48 (0.59)	*0.79* ‡	*0.27* ‡	*0.23* **	*− 0.21* **	*− 0.18* **	*0.24* †	
CO, ppm	5.96 (2.11)	27.11 (12.21)	*− 1.82* ‡						

N's range from 177 to 180 due to missing data. Factor 1 = desire for the positive effects of smoking and intention to smoke; Factor 2 = desire for relief of negative affect and an urgent need to smoke; CO = expired breath carbon monoxide. SAQ-Withdrawal = Withdrawal scale of the Smoking Abstinence Questionnaire; SAQ-Optimistic Outcomes = Optimistic Outcomes scale of the Smoking Abstinence Questionnaire; SAQ-Weight Gain = Weight Gain scale of the Smoking Abstinence Questionnaire. Findings in italics are significant

POMS Profile of Moods States (possible range 0–4), *QSU* Brief Questionnaire of Smoking Urges (possible range 0–5), *MNWS* Minnesota Nicotine Withdrawal Scale (possible range 0–5), *WSWS* Wisconsin Smoking Withdrawal Scale (possible range 0–4)

§ p=0.07

* p<0.05

** p<0.01

† p<0.001

NIH-PA Author Manuscript
NIH-PA Author Manuscript

‡ $p<0.0001$

[a] Cohen's *d* statistic for abstinence-induced change score (*M/SD*) on outcome variable departure from zero

[b] Unadjusted models include only non-abstinent score as a covariate

[c] Adjusted models include non-abstinent score, age, gender, ethnicity, race, and Fagerström Test for Cigarette Dependence score as covariates

[d] Physiological symptoms were assessed with one item that referenced "any of the following": tremor, racing heart, sweatiness, dizziness, and stomach or bowel problems