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Smoking-Specific Experiential Avoidance Cognition: Explanatory Relevance to Pre- and Post-Cessation Nicotine Withdrawal, Craving, and Negative Affect

Samantha G. Farris, M.A.[a], **Michael J. Zvolensky, Ph.D.**[a,b,*], and **Norman B. Schmidt, Ph.D.**[c]

[a]University of Houston, Department of Psychology, 126 Heyne Building, University of Houston, Houston, TX, 77024

[b]The University of Texas MD Anderson Cancer Center, Department of Behavioral Science, 1155 Pressler Street, Houston, TX 77030

[c]Florida State University, Department of Psychology, 1107 W Call St Tallahassee, FL 32304

Abstract

Background—Negative-reinforcement based cognitive processes have been implicated in the maintenance of cigarette smoking. Given the expectation that smoking will attenuate aversive internal experiences, smokers may be particularly unwilling to experience or remain in contact with smoking-related distress (i.e., experiential avoidance). Yet, there is little known about a cognitive-based processes termed smoking-specific experiential avoidance in regard to withdrawal, craving, or negative affect during a quit attempt.

Method—Data were collected from adult daily smokers (n = 259) participating in a larger smoking cessation trial. Pre- and post-quit experiences of nicotine withdrawal, craving, and negative affect were examined in terms of cognitive-based smoking-specific experimental avoidance, measured by the Avoidance and Inflexibility Scale (AIS).

Results—Results indicated that baseline smoking-specific experiential avoidance was associated with greater overall levels of withdrawal, craving, and negative affect at treatment initiation (pre-cessation). Reductions in smoking-specific experiential avoidance from baseline to quit day were associated with increased likelihood of quit day abstinence. Such reductions were also predictive of lower levels of nicotine withdrawal, craving, and negative affect on quit day. Also, less

[*]**Corresponding author:** Michael J. Zvolensky, The University of Houston, 126 Heyne Building, Suite 104, Houston, Texas 77204-5502, United States. mjzvolen@central.uh.edu (Phone): 1+713-743-8056; (Fax): 1+713-743-8588.

Contributors

Drs. Zvolensky and Schmidt designed the study and wrote the protocol. Ms. Farris conducted literature searches and provided summaries of previous research studies. Ms. Farris conducted the statistical analysis. Drs. Zvolensky and Ms. Farris wrote the first draft of the manuscript and Drs. Zvolensky and Schmidt edited the manuscript. All authors have approved the final manuscript.

Conflict of Interest

Ms. Farris and Drs. Zvolensky and Schmidt declare that they have no conflict of interest.

reduction in experiential avoidance was associated with experiencing greater withdrawal in the early phase of quitting.

Discussion—The impact of cognitive-based experiential avoidance pertaining to smoking impacts both pre- and post-cessation experiences in terms of negative affect, withdrawal, and smoking cravings and may represent an important treatment target.

Keywords

Cognitive Flexibility; Smoking Cessation; Nicotine Withdrawal; Negative Affect

1. Introduction

Motivation to avoid the experience of discomfort and negative affective states is one of the strongest drivers of maladaptive drug use (i.e., negative-reinforcement model of addiction; Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; McCarthy, Curtin, Piper, & Baker, 2010). One of the clearest examples of negative reinforcement process is evident in cigarette smoking. While the majority of smokers report motivation to quit smoking (68.8%), only 6.2% are actual successful in maintaining abstinence (for six months or more; CDCP, 2011). Smokers are more likely to lapse and relapse to smoking after a cessation attempt in the context of experiencing high levels of negative affect (e.g., Shiffman, 2005), which is thought in part to be related to the *perceived* negatively-reinforcing nature of smoking (i.e., smoking will help me relax and feel less tense; Brandon & Baker, 1991; Kassel, Stroud, & Paronis, 2003). Indeed, *cognitive processes* are thought to explain the link between the experience of negative affect and continued drug use (Curtin, McCarthy, Piper, & Baker, 2006; Kassel, Wardle, Heinz, & Greenstein, 2010); based on the theoretical understanding that one's interpretation and appraisal of thoughts can impact the frequency and form of negative affect and behavioral responding (e.g., Nosen & Woody, 2009).

A developing line of research has focused on the role of experiential avoidance in the maintenance of various forms of psychopathology, including substance use disorders (Chawla & Ostafin, 2007; Hayes, Luoma, Bond, Masuda, & Lillis, 2006; Hayes, Wilson, Gifford, Follette, & Strosahl, 1996). Rooted in negative-reinforcement theories of behavior, experiential avoidance is a cognitive-affective regulatory process wherein individuals are unwilling to experience or remain in contact with aversive internal experiences (e.g., thoughts, emotions, memories, bodily sensations, images) and attempt to control the frequency or form of the experiences and the contexts in which they occur. This cognitive avoidance strategy, however, is theorized to actually lead to increased salience and functional importance of the avoided experiences, which in turn, yield increased control efforts to avoid expected negative outcomes (Hayes et al., 2006). Specific to smoking, one's tendency to inflexibly respond to smoking urges, negative affect, or interoceptive states (e.g., with avoidant strategies) may be a marker of 'risk' for continued reliance on cigarettes and cessation difficulties via experiencing more severe cessation sequelae (e.g., withdrawal, craving, negative affect). Evidence for this type of process can be found in work on thought suppression. For example, suppression of smoking-related thoughts is a common strategy utilized by smokers attempting to quit; resulting in short-term smoking reduction, but later increases in thoughts of smoking (i.e., a rebound effect), thereby making the process of

cessation more difficult (Erskine, Georgiou, & Kvavilashvili, 2010). In fact, smokers with a greater tendency of suppress thoughts (generally, non-smoking specific) report a greater number of failed cessation attempts (Erskine et al., 2010), are more likely to be a unsuccessful quitter (Toll, Sobell, Wagner, & Sobell, 2001), and apt to report more severe craving and some withdrawal symptoms (Erskine et al., 2010; Erskine et al., 2012), although these latter findings have been not fully consistent in past work (Litvin, Kovacs, Hayes, & Brandon, 2012; Nosen & Woody, 2009).

When smokers are provided cognitive-behavioral smoking cessation treatment specifically aimed at promoting psychological flexibility in the context of smoking-related distress (e.g., acceptance and commitment-based treatments; Bricker, Wyszynski, Comstock, & Heffner, 2013; Gifford et al., 2004), decreases in smoking-specific experiential avoidance is associated with increased likelihood of smoking abstinence after treatment (Gifford et al., 2004; Gifford et al., 2011). Similarly, reductions in thought suppression are associated with greater abstinence likelihood (Bowen et al., 2009) These data suggest that treatment-seeking smokers who continue to seek out opportunities to escape, avoid, or reduce distressing smoking-relevant thoughts, feelings, and bodily sensations (or more generally maintain tendencies to suppress negative thoughts) may do so by re-initiating smoking, despite their goal of smoking cessation; a pattern that is in line with the central role of 'cognitive control' in the regulation of drug use behavior (Curtin et al., 2006; McCarthy et al., 2010). Of note, while experiential avoidance can be conceptualized as a cognitive avoidance strategy, it is worth noting that a range of *behaviors* (e.g., smoking, drug use, self-harm, dysregulated eating) can be conceptualized to function similarly to cognitive avoidance strategies – that is, behaviors aimed at attempts for emotion regulation (Hayes et al., 1996).

Smoking-specific experiential avoidance has primarily been examined as a mechanism of change in smoking cessation treatment (Bricker et al., 2013; Bricker, 2011; Bricker, Mann, Marek, Liu, & Peterson, 2010; Gifford et al., 2004). More recent work has suggested that smoking-specific experiential avoidance also relates to the interplay of various emotional vulnerabilities and a host of pre-quit smoking processes (Farris, Zvolensky, Blalock, & Schmidt, 2014; Zvolensky, Farris, Schmidt, & Smits, 2014). Collectively, the current literature suggests that smokers who engage in avoidance of smoking-related distress are at greater risk cessation difficulties, including pre-cessation risk factors (e.g., perceiving greater barriers to successful cessation, more failed prior quit attempts, more severe problematic symptoms while quitting, and greater negative-reinforcement expectancies about the outcomes of smoking) and post-cessation outcomes (i.e., increased likelihood of cessation failure). However, it is presently unknown if and how smoking-specific experiential avoidance impacts the experience of nicotine withdrawal, smoking urges, or negative affect. Given the cognitive-based interpretation of affective/interoceptive states impacts the experience cessation processes (Langdon et al., 2013; Zvolensky, Farris, Guillot, & Leventhal, 2014), smokers with a greater tendency to engage in experiential avoidance when experiencing distressing smoking-related thoughts, feelings or sensations, may subjectively experience more severe nicotine withdrawal, more intense craving, and greater negative affectivity during the process of smoking cessation. It is also possible that reductions in smoking-specific experiential avoidance (increased cognitive flexibility) could

increase the likelihood of quit day abstinence and lessen the perceived cognitive, affective, and interoceptive distress experienced post-cessation.

Together, the current study aimed to examine the impact of smoking-specific experiential on nicotine withdrawal, craving, and negative affect among a sample of treatment-seeking smokers who were participating in a smoking cessation treatment program. Given the experience of withdrawal, craving, and negative affect has been shown to change and impact cessation both before and after quitting (McCarthy, Piasecki, Fiore, & Baker, 2006; Strong et al., 2009; Strong et al., 2011), these processes were examined in two phases – pre- and post-cessation. First, it was hypothesized that higher levels of cognitive-based experiential avoidance would be associated with greater withdrawal, craving, and negative affect during the three weeks prior to quitting. Second, it was expected that greater observed reductions in experiential avoidance from pre-quit to quit day would be associated with greater likelihood of smoking abstinence on quit day. Lastly, it was hypothesized that reductions in cognitive-based experiential avoidance for smoking by quit day would be associated with lower levels of withdrawal, craving, and negative affect during the post-cessation period.

2. Material and Methods

2.1. Participants

Participants in the current study were recruited as part of a larger smoking cessation and panic disorder prevention trial (clinicaltrials.gov #NCT01753141; baseline sample reported in Farris et al., 2014; Zvolensky, Farris, Schmidt, & Smits, in press). The parent trial included participants who were between the ages 18–65 who reported smoking ≥ 8 cigarettes per day for at least the past year, with motivation to quit rated as at least 5 or higher on a 10-point scale. Exclusion criteria included current use of smoking cessation products or treatment, or regular use of other tobacco products, unstable psychotropic medication (had to be stable ≥ 3 months), no history of panic disorder (defined by the DSM-IV-TR), past-month suicidality, a history of psychotic-spectrum disorders, current pregnancy or nursing, and inability to provide informed consent. Of the 724 who were evaluated for the trial, 574 participants completed baseline assessment. Eligible participants with all available data on study predictors who attended at least one treatment session (n = 259; 49% female; M_{age} = 38.13, SD = 3.46) were included in the analyses for the current study. Participants primarily identified race as White (88.0%). The sample reported being never married (39.8%), married (37.5%), divorced (17.0%), separated (3.1%), and widowed (2.7%). Participants were overall well-educated: 69.2% reported completing at least part college.

At baseline, participants averaged smoking 18.5 (SD = 8.69) cigarettes per day, with smoking initiation at age 14.8 (SD = 3.44); 30.5% of the sample indicated living in a household with another smoker. Moderate levels of nicotine dependence per the Fagerström Test of Nicotine Dependence (FTND) were reported on average (M = 5.6, SD = 2.10). Nearly all participants (94.6%) reported having made at least one prior serious attempt to quit smoking in their lifetime, and of those who did attempt, 91.0% reported being at to abstain from smoking for at least 24 hours, and made an average of 3.7 (SD = 2.21) serious attempts (possible and observed range 1–9). Regarding psychopathology, 44.8% of the

participants met criteria for a current (past year) Axis I disorder, which included primarily anxiety disorders (76.7%), mood disorders (27.6%), and substance use disorders (25.9%); psychiatric comorbidity was common (43.1% with two or more diagnoses; range 1–4).

2.2. Measures

2.2.1 Predictor Variables

Fagerström Test for Nicotine Dependence (FTND; Heatherton et al, 1991): The FTND is a 6-item scale that assesses gradations in tobacco dependence. Scores range from 0–10, with higher scores reflecting high levels of physiological dependence on nicotine. The FTND has adequate internal consistency and test-retest reliability and is associated with key smoking variables (e.g., saliva cotinine; (Heatherton, Kozlowski, Frecker, & Fagerström, 1991; Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994); internal consistency for the FTND in the current sample was acceptable (Cronbach α = .63).

Structured Clinical Interview-Non-Patient Version for DSM-IV Disorders (SCID-I/NP; First, Spitzer, Gibbon, & Williams, 2007): Diagnostic assessments of past year Axis I psychopathology were conducted using the SCID-I/NP, which were administered by trained research assistants or doctoral level staff and supervised by independent doctoral-level professionals. Interviews were audio-taped and the reliability of a random selection of 12.5% of interviews was checked for diagnostic accuracy; no disagreements were noted.

Avoidance and Inflexibility Scale (AIS; Gifford et al, 2004): The AIS is a 13-item self-reported measure of smoking-specific experiential avoidance. Respondents rate how they respond to difficult *thoughts* that encourage smoking (e.g., “I need a cigarette”), difficult *feelings* that encourage smoking (e.g., stress, fatigue, boredom), and *bodily sensations* that encourage smoking (e.g., “physical cravings or withdrawal symptoms”). Example items include “How likely is it you will smoke in response to [thoughts/feelings/sensations]?” and “How important is getting rid of [thoughts/feelings/sensations]?”. Items are rated on a 5-point Likert scale (1 = *Not at all* to 5 = *Very much)*, with higher scores reflecting greater levels of smoking-specific experiential avoidance (possible range 13–65). The AIS has documented psychometric properties, including internal consistency (Gifford et al., 2004).The AIS was administered as baseline and quit-day (treatment session 4). In the current sample, the internal consistency was very good at both time points (Cronbach α = .93).

2.2.2 Criterion Outcome Variables—The following measures were administered pre-quit (at each treatment session; session 1–3), on quit day (session 4), and post-quit (weeks 1, 2, 4 follow-up):

The Minnesota Nicotine Withdrawal Scale (MNWS; Hughes & Hatsukami, 1986) is an 9–item measure of nicotine withdrawal symptoms, which are rated on a 4-point Likert-type scale, ranging from 0 = *not present* to 3 = *severe* (e.g., insomnia, irritability/frustration, difficulty concentrating, restlessness); a total sum score is computed. Participants were asked to rate the extent they experience each associated withdrawal symptoms during the

past week. Internal consistently across all time points was good (Cronbach α range = .83 - .89).

The *Questionnaire of Smoking Urges (QSU; Tiffany & Drobes, 1991)* is a 32-item self-report measure of smoking urges and cravings in which respondents rate the extent to which they agree or disagree with each item based on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree). Items are summed to create a total index of craving severity. Internal consistently across all time points was very good (Cronbach α range = .94 - .96).

Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988): The PANAS is a self-report measure that requires participants to rate the extent to which they experience each of 20 different feelings and emotions (e.g., nervous, interested) based on a Likert-scale that ranges from 1 (“Very slightly or not at all”) to 5 (“Extremely”). The negative affect scale was used for the current study (10 items); possible range for each factor of 10–50. The PANAS has strong documented psychometric properties (Watson et al., 1988). Internal consistently across all time points was very good (Cronbach α range = .88 - .91).

2.2.3 Smoking Status—Biochemical verification of smoking status was completed by carbon monoxide (CO) analysis of breath samples using a CMD/CO Carbon Monoxide Monitor (Model 3110; Spirometrics, Inc.). A cutoff of ≤ 4ppm on quit day was used to index smoking abstinence (as recommended by Perkins, Karelitz, & Jao, 2013); coded 1 = abstinent; all values above this cutoff were coded 0 = non-abstinent.

2.3 Procedure

Participants were recruited through community-based advertisements at two treatment sites (University of Vermont, Burlington VT and Florida State University, Tallahassee, FL). Potentially-eligible participants were scheduled for a baseline assessment during which participants were assessed using the SCID-I/NP, provided a CO analysis to verify smoking status and completed a computerized battery of self-report questionnaires. Eligible participants were randomly assigned to one of two smoking cessation treatment programs and scheduled for treatment initiation approximately 1–2 weeks after the baseline assessment. Smoking cessation treatment consisted of either (1) a standard smoking cessation program (Fiore et al., 2008), or (2) anxiety-focused smoking cessation treatment (Zvolensky, Yartz, Gregor, Gonzalez, & Bernstein, 2008), both included use of nicotine replacement therapy via the transdermal nicotine patch, which was initiated at treatment session four (quit day). Treatment consisted of four 60-minute weekly individual sessions conducted by a trained doctoral-level graduate student. All treatment was supervised by study authors (MJZ and NBS) and checked for treatment fidelity by independent reviewers. Within-treatment (pre-quit, sessions 1–3), quit day, and follow-up (weeks 1, 2, 4 post-quit) assessments of withdrawal, craving and negative affect were conducted. All participants provided informed consent prior to participation and the study protocol was approved by the Institutional Review Boards at both institutions, where the study was conducted.

2.4 Data Analytic Strategy

A multi-level mixed model (MLM) analytic approach was used to examine the impact of experiential avoidance on pre- and post-cessation processes, as this approach is suggested for handling repeated measures in longitudinal analyses. Pre- and post-quit models were tested separately, and three different dependent variables were examined: nicotine withdrawal, craving, and negative affect. Inter-class correlation coefficients (ICC) were used to confirm acceptability of this multilevel approach and homogeneity of variance residuals was checked. All mixed-effects models were conducted in HLM 8.0. Three pre-cessation models were constructed, one each for the repeated assessments of the outcome variable, measured at treatment sessions 1, 2, and 3 (time centered at treatment cessation 1). Three post-cessation models were constructed similarly, one for each of the dependent variables, measured at quit day, and Week 1, 2, and 4 post-quit (a total of four time points; time centered at quit day). Restricted maximum likelihood estimation was used. Given linear and non-linear time effects are possible, both effects were tested (time and time^2). Grand mean centering was conducted for continuous predictors to improve interpretability of coefficients.

A backward model-trimming approach was used to reduce the number of theoretically-relevant predictors while comparing model fit to yield the most parsimonious model. The resulting change in model deviance to a chi-square distribution was compared to identify significant changes in model fit. Gender, presence of Axis I psychopathology, and nicotine dependence were examined as covarying between-subject effects. In the pre-quit models, the effect of baseline experiential avoidance on the intercept (pre-quit level of the outcome at treatment initiation) and slope (change in outcome over three time points) was examined. In the post-quit models, the effect of change in experiential avoidance by quit day (change score) on the intercept (quit-day) and slope (change in outcome over four time points) was examined.

To test for change in experiential avoidance as a predictor of quit-day abstinence, a hierarchical logistic regression analysis was conducted using IBM SPSS version 22.0. In the first block of this model, gender, presence of Axis I psychopathology, level of nicotine dependence, and mean levels of pre-quit withdrawal, urges, negative affect and positive affect (average of S1, S2, and S3 was computed for each variable) were entered as covariates. Next, a change score of baseline to quit-day levels of experiential avoidance (per the AIS) was computed for each participant. Here, larger positive scores on this variable reflect greater reductions in experiential avoidance from baseline to quit day, whereas larger negative values reflect greater increases in experiential avoidance. This change score was entered as the primary predictor in the logistic regression (block 2 of model). As in MLM models, continuous variables (including the change score) were grand mean centered. Abstinence status on quit day was entered as the outcome variable.

2.5 Study Attrition and Missing Data

Of the 259 participants who enrolled in treatment, the average number of sessions attended was 3.1 (*SD* = 1.12, mode = 4/4). Within-treatment missing data were as follows: Session 1 (n = 20, 7.8%), Session 2 (n = 54, 20.8%), and Session 3 (n = 72, 27.8%). On quit day, 139

participants provided complete data, thus the 120 without complete data were excluded from quit-day analyses (logistic regression) and post-quit analyses (MLM model). Excluded cases included 68 participants who did not provide any data on quit day, 24 who provided CO data but were missing some or all self-report data, and 26 provided self-report data but were missing CO data. Differences in baseline variables were compared for participants with completed data versus those without. There were no differences in completion status based on age, treatment site, presence of Axis I psychopathology, education status (college versus not), baseline experiential avoidance, or number of lifetime quit attempts. Excluded participants, relative to completers, did have significantly higher levels of baseline nicotine dependence (M = 5.9, SD = 2.03 vs. M = 5.3, SD = 2.12; p = .018). Of the 139 who were included in the post-cessation analyses, missing data post-quit day were as follows: Week 1 post-quit (n = 23, 16.5%), Week 2 post-quit (n = 22, 23.5%), and Week 4 post-quit (n = 53, 38.1%).

When missing outcome data exceed 20% in the entire dataset (32.7% of values on outcome variables missing in the current study), it is recommended to conduct missing value pattern analyses in order to determine how to handle the missing values in primary outcome analyses (Hall et al., 2001). First, patterns of missing data were examined for pre-quit variables (S1-S3) and then quit day and follow-up variables (quit day, Week 1, 2, 4 follow-up). The missing pattern analysis identified three general patterns for both pre- and post-cessation variables: (1) no missing session data; (2) missing session data after a certain time point (i.e., right censored; and (3) sporadically missing session data. Follow-up analyses indicated no significant differences on all tested variables including by missing data pattern in terms of pre-quit variables or quit day withdrawal, craving, negative affect or level of experiential avoidance.

3. Results

3.1 Pre-Quit Overview and Outcomes

Average scores on the AIS at baseline were 45.7 (SD = 10.99) [observed range 13–65]. Baseline levels of negative affect averaged 18.7 (SD = 6.94). Pre-cessation set of MLM models were constructed and refined to examine the contribution of between-subject fixed covariate effects. Participant gender was not significant predictor of any of the parameters. Higher levels of nicotine dependence were predictive of overall greater levels of craving at treatment initiation (b = 1.788, 2.113, p < .036), but not withdrawal or negative affect. The presence of past-year Axis I psychopathology was associated with overall greater levels of nicotine withdrawal severity at treatment start (b = 1.839, t = 2.964, p < .001), but not craving or negative affect. All covariates were retained in the analyses as covariates for theoretical relevance and because removal of these variables did not significantly reduce model deviance. Both linear and quadratic time effects were significant for two of three models, thus were retained across dependent variables for continuity.[1] Table 1 gives the fixed-effects estimates for the model for the prediction of pre-cessation outcomes. For this set of analyses, a bonferroni corrected alpha (.05/3 planned analyses = .0167) was used to control the family-wise Type I error rate. Results indicated that higher levels of smoking-specific experiential avoidance were related to higher levels of nicotine withdrawal (b = .

096, $t = 2.788$, $p < .001$), craving ($b = .814$, $t = 4.282$, $p < .001$), and negative affect ($b = .092$, $t = 3.314$, $p = .001$) at treatment initiation (session 1/intercept). The average linear slope of withdrawal symptoms ($b = -.102$, $t = -2.307$, $p = .021$) and craving ($b = -.851$, $t = -2.709$, $p = .007$) over time were statistically significant, such that withdrawal and craving decreased prior to quit day; although only craving was significant at the more conservative alpha level. However, there was an overall significant quadratic time effect for both nicotine withdrawal ($b = .006$, $t = 2.854$, $p = .004$) and craving ($b = -.063$, $t = -3.967$, $p < .001$), suggesting the slope of change for withdrawal symptoms became more positive as quit day approached (withdrawal increased), whereas craving became less positive (craving decreased) as time progressed. In contrast, there was a non-significant linear or quadratic effect of time (slope) for negative affect, indicating that changes in negative affect were not observed prior to quit day. Model results indicated that, however, experiential avoidance was not significantly related to the slope of withdrawal symptoms, craving or negative affect over time pre-cessation.

3.2 Quit Day Abstinence

Of the 139 participants who provided quit day data, changes in the AIS total score from baseline to quit day were computed ($M_{change} = 7.3$, $SD = 11.95$; 77.7% had a positive change score, indicating a reduction in AIS). On quit date, 36.0% (n = 50) of the sample was abstinent (verified by CO analysis). Results from the hierarchical logistic regression are presented in Table 2. For this set of analyses, alpha was set at .05, as only one planned analyses was conducted. Results indicated Block 1 model was significant [$x^2 = 15.496(6)$, $p = .017$, Nagelkerke $R^2 = .145$, −2Log Likelihood = 166.108]. Analyses revealed only average pre-cessation levels of craving were associated with increased likelihood of non-abstinence on quit day (*OR* = .985, *Wald* = 4.236, $B = -.015$, $p = .04$). With the addition of the AIS change score in Block 2, the full model was significant ($x^2 = 22.719(7)$, $p = .002$). Specifically, the AIS change score accounted for significant incremental prediction [$x^2 = 15.496(6)$, $p = .017$, Nagelkerke $R^2 = .145$, −2Log Likelihood = 166.108]. Results indicated that a reduction in AIS from baseline to quit day (positive change score) was significantly associated with increased odds of abstinence on the quit day (*OR* = 1.047, *Wald* = 6.571, $B = .046$, $p = .010$).

3.3 Post-Quit Outcomes

Similar to pre-cessation MLM models, initial models were constructed to examine post-cessation processes of nicotine withdrawal, craving, and negative affect (please see Table 3).

[1]Example of the final MLM equation is presented below. Of note, baseline negative affect was entered as a level-2 predictor of the intercept for the pre-cessation model of negative affect, only (not displayed here). In all post-cessation models, the average pre-cessation value of the outcome was entered as a level-2 predictor of the intercept. In pre-cessation models, baseline AIS was used as the target predictor of both the intercept and slope. In post-cessation models, the AIS change score was used.

Level-1 Model:

$$Y_{ij} = \beta_{0j} + \beta_{1j} * (Time_{ij}) + \beta_{2j} * (Time * Time_{ij}) + r_{ij}$$

Level-2 Model:

$$\begin{aligned} \beta_{0j} &= \gamma_{00} + \gamma_{01} * (\text{Gender}_j) + \gamma_{02} * (AxisI_j) + \gamma_{03} * (FTND_j) + \gamma_{04} * (AIS_j) + u_{0j} \\ \beta_{1j} &= \gamma_{10} + \gamma_{11} * (AIS_j) \\ \beta_{2j} &= \gamma_{20} + \gamma_{21} * (AIS_j) \end{aligned}$$

As in the pre-quit models, an adjusted alpha of .0167 was used. Neither participant gender nor Axis I psychopathology were predictive of any post-cessation dependent variables; higher levels of baseline nicotine dependence was associated with overall higher average levels of nicotine withdrawal on quit day (b = .342, t = 2.635, p = .009). Stepwise removal of all three covariates was conducted but all variables were retained in the analyses based on theoretical relevance and due to non-significant reduction in model deviance. As in pre-cessation models, both linear and quadratic time effects were retained in all models for continuity. Average pre-cessation values of each respective outcome variable was entered as a level-2 covarying effect of the intercept (quit day level of criterion).

Higher levels of average pre-cessation withdrawal, craving, and negative affect were significantly predictive of the respective outcome as measured on quit day (intercept); all p's < .001. Additionally, reductions in smoking-specific experiential avoidance from baseline to quit day were associated with lower levels of quit-day nicotine withdrawal (b = −.102, t = −3.979, p < .001), craving (b = −.842, t = −4.171, p < .001), and negative affect (b = −.058, t = −2.772, p = .006). Regarding the effects of time, there was a positive average linear slope of withdrawal symptoms (b = .129, t = 2.992, p = .003) over time during post-cessation, suggesting that withdrawal increased during the four weeks after quitting. The overall significant negative quadratic time effect for nicotine withdrawal (b = −.005, t = −3.268, p = .001) suggests that the slope of change for withdrawal symptoms became more negative as time further progressed. Reductions in experiential avoidance significantly predicted the change in the linear slope of withdrawal post-cessation, such that less reduction in experiential avoidance was associated with steeper positive linear slope (greater increases) in post-cessation withdrawal over time (b = .008, t = 2.200, p = .029); this effect, however, was non-significant at the more conservative alpha level. The non-significant interaction of quadratic time effect by experiential avoidance reductions suggests that the impact of reductions in experiential avoidance only impacts initial withdrawal following quit day, but not later with changes over time. There was non-significant effect of linear or quadratic time for craving or urges post-cessation changes, and model results indicated that changes in experiential avoidance were significantly related to the slope of craving or negative affect over time post-cessation.

4. Discussion

Consistent with expectation, baseline levels of smoking-specific experiential avoidance were associated with greater levels of nicotine withdrawal, craving, and negative affect at treatment initiation (session one). These data suggest smokers who have a stronger propensity to 'cognitively avoid' uncomfortable internal experiences related to smoking are more prone to subjectively experience higher levels of withdrawal, craving and negative affect, even prior to making a cessation attempt. It is possible that this pre-cessation subjective distress is reflective of individuals' *anticipation* about the distress that might be experienced while quitting smoking (i.e., cognitively forming expectations about what it would be like to quit smoking; Abrams, Zvolensky, Dorman, Gonzalez, & Mayer, 2011). This type of question could be empirically evaluated in future research by testing the interplay between experiential avoidance and anticipation about distress in terms of cessation outcome and processes. Given the high levels of subjective smoking-relevant

distress reported by these smokers, it would seem important to provide psychoeducational information before treatment initiation (e.g., at baseline assessment) about the role of functional role of cognitive avoidance as a potential ‘amplifier’ of subjective smoking experience.

Interestingly, although not the primary aim of the current study, the pattern of nicotine withdrawal and craving appeared to significantly change during treatment - prior to quitting. Specifically, reductions in nicotine withdrawal and craving were observed during cessation treatment, although increasing withdrawal symptom occurred as quit day approached. Notably, negative affect did not appear to change during the course of treatment. Such reductions are somewhat surprising given other work suggesting stability in these experiences pre-quit day (McCarthy et al., 2006), although the nature of the psychotherapeutic intervention in the current study may have accounted for a differential effect. Of importance, differential changes in withdrawal or craving were *not* observed as a function of trait (baseline) levels smoking-specific experimental avoidance, meaning that cognitive inflexibility related to smoking distress did not impact the experience of withdrawal and craving over time prior to cessation.

The majority of treatment-seeking smokers who attended quit day reported reductions in smoking-specific experiential avoidance relative to baseline (pre-cessation) levels (77.7%). Although the current study examined a change score and did not test the magnitude of the reductions in smoking-specific experiential avoidance (similar to approach by Gifford et al., 2004), these data provide novel and clinically significant evidence that reductions in smoking-specific experiential avoidance increased likelihood of quit day abstinence. This finding is consistent with work that has found that smoking cessation treatments specifically targeting cognitive flexibility (via acceptance and commitment-based therapy) and producing reductions in experiential avoidance is predictive of increased long-term abstinence likelihood (Gifford et al., 2004). From a smoking (cessation) “milestone” perspective (Japuntich, Piper, Leventhal, Bolt, & Baker, 2011; Shiffman et al., 2006), quitting smoking is a multi-phasic process; thus, it is important to examine aspects of this process in order to increase specificity of insight into the cessation processes. The ability to achieve initial short-term abstinence (e.g., on quit day) is often conceptualized as the 'first milestone' that smokers can achieve. Here, findings suggest that increased cognitive flexibility related to smoking distress may aid in the achievement initial abstinence.

Reductions in smoking-specific experiential avoidance also appeared to be related to lower subjectively reported nicotine withdrawal, craving, and negative affect on quit day. In practice, this would potentially look like a reduction in unnecessary attempts to change thoughts, emotional, and sensations related to smoking (e.g., greater willingness, acceptance to experience). This set of findings is consistent theoretical models of addiction, which posit that cognitive control is central to the *modulation* of drug-using behaviors (Curtin et al., 2006). Notably, only nicotine withdrawal appeared to increase during the post-cessation period, although appeared to reduce as time progressed. In particular, those smokers who report less reduction in experiential avoidance (i.e., still retained greater cognitive *inflexibility* related to smoking) experienced greater increases in initial withdrawal symptoms. This finding further illustrates the importance of cognition in the subjective

experience of withdrawal processes. While later smoking cessation milestones were not examined in the current study (e.g., time to first lapse), findings here suggest that smokers who remain less cognitive flexible (and less willing to experience smoking-related distress) experience greater initial nicotine withdrawal, which may increase likelihood of smoking re-initiation if such discomfort is perceived as intolerable.

Future work is needed to address limitations of the current study. First, the current sample of smokers, while recruited from two different geographic regions in the eastern United States, were relatively racially homogeneous, potentially limiting the generalizability of the present findings to other non-white racial groups. Given broad disparities in smoking by race/ethnicity (Caraballo, Yee, Gfroerer, & Mirz, 2008), extension of the current findings would be important to examine in other more diverse samples of smokers. Second, the current study examined reductions in smoking-specific experiential avoidance as a function of treatment; however, did not examine what specific aspects of treatment may have yielded such changes. This is an important area of follow-up investigation. Finally, while experiential avoidance to smoking has tended to be examined as a unified construct, our recent work has suggested that this construct may uniquely reflect two distinct dimensions: difficulty flexibility responding to (1) thoughts/feelings related to smoking and (2) somatic sensations related to smoking. The current study examined only global reductions in experiential avoidance due to our a priori model. Future work would benefit from examining the effect of treatment on specific aspects of experiential avoidance, and if/how these distinct domains differentially impact pre- and post-cessation processes.

Overall, enhancing openness and willingness to experience smoking-related distress appears to be a cognitive indicator that may mark risk for pre- and post-cessation quit difficulties, indexed by withdrawal, craving and negative affect. The malleability of experiential avoidance appears to aid the cessation experience.

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Highlights

1. Smoking-specific experiential avoidance is a malleable cognitive vulnerability
2. Experiential avoidance is associated with pre-quit withdrawal, craving and negative affect
3. Reductions in experiential avoidance predict quit-day abstinence
4. Less reductions in experiential avoidance predicts greater quit-day and early cessation withdrawal

Table 1

Fixed Effects Estimates for the Prediction of Pre-Cessation (Within-Treatment) Nicotine Withdrawal, Craving, and Negative Affect

	Nicotine Withdrawal				Craving				Negative Affect			
Fixed Effect	**Estimate**	**SE**	**T-ratio**	**Sig.**	**Estimate**	**SE**	**T-ratio**	**Sig.**	**Estimate**	**SE**	**T-ratio**	**Sig.**
Intercept	13.590	0.407	33.373	**<0.001**	131.589	2.845	46.251	**<0.001**	19.627	0.453	43.366	**<0.001**
Gender	−0.460	0.470	−0.979	0.329	0.394	3.511	0.112	0.911	−0.498	0.521	−0.957	0.340
Axis I	1.839	0.464	3.964	**<0.001**	3.315	3.450	0.961	0.337	0.687	0.555	1.239	0.217
FTND	−0.102	0.115	−0.882	0.379	1.788	0.846	2.113	**0.036**	−0.116	0.135	−0.862	0.390
AIS	0.096	0.025	3.788	**<0.001**	0.814	0.190	4.282	**<0.001**	0.092	0.028	3.314	**0.001**
Time	−0.102	0.044	−2.307	**0.021**	−0.851	0.314	−2.709	**0.007**	0.001	0.005	−0.746	0.456
$Time^2$	0.006	0.002	2.854	**0.004**	−0.063	0.016	−3.967	**<0.001**	19.627	0.453	−0.544	0.586
Time x AIS	−0.001	0.004	−0.313	0.754	−0.006	0.029	−0.210	0.834	−0.001	0.002	0.147	0.883
$Time^2$ x AIS	0.001	0.001	0.450	0.653	0.001	0.001	−0.270	0.787	−0.498	0.521	−0.545	0.586

Note: SE = Standard Error; Gender [coded 0=male, 1=female]; Axis I = Presence of Axis I psychopathology in past year [coded 0=no, 1=yes]; FTND = Fagerström Test of Nicotine Dependence; AIS = Avoidance and Inflexibility Scale (measure of smoking-specific experiential avoidance); Time [linear time; coded day 0=session one, day 7=session two, day 14=session three]; $Time^2$ [Time x Time].

Note: Effect of baseline negative affect on the between-subject intercept was also included as a covariate in the model of negative affect pre-cessation (coefficient = .646, SE = 0.043, t=15.086, p < .001).

Note: Significant values are bolded for ease in viewing.

Table 2

Change in Smoking-Specific Experiential Avoidance as a Predictor of Quit Day Abstinence

Variables	Time Point	OR	SE	Wald	B	Sig.
Constant	--	.431	.347	5.857	−.841	**.016**
Gender [Ref Female=1]	Baseline	.485	.391	3.439	−.724	.064
Axis I [Ref Yes=1]	Baseline	2.105	.417	3.185	.744	.074
Nicotine Dependence	Baseline	.858	.093	2.678	−.153	.102
Nicotine Withdrawal	Within-TX	1.081	.071	1.202	.078	.273
Craving	Within-TX	.985	.008	4.236	−.015	**.040**
Negative Affect	Within-TX	.995	.043	.013	−.005	.910
ΔExperiential Avoidance	BL – QD	1.047	.018	6.571	.046	**.010**

Note: OR = Odds Ration; SE = Standard Error, Significant values are bolded for ease in viewing.

Note: Time Point column indicates time in which the variable was assessed: baseline, Within-TX (mean values for sessions 1–3), BL - QD (Baseline value subtracted by quit day value).

Note: Significant values are bolded for ease in viewing.

Table 3

Fixed Effects Estimates for the Prediction of Post-Cessation Nicotine Withdrawal, Craving and Negative Affect

Nicotine Withdrawal					Craving				Negative Affect			
Fixed Effect	**Estimate**	**SE**	**T-ratio**	**Sig.**	**Estimate**	**SE**	**T-ratio**	**Sig.**	**Estimate**	**SE**	**T-ratio**	**Sig.**
Intercept	14.503	0.488	29.724	**<0.001**	79.306	4.832	16.411	**<0.001**	18.694	0.428	43.649	**<0.001**
Gender	0.817	0.504	1.621	0.107	7.070	4.917	1.438	0.153	−0.840	0.442	−1.900	0.060
Axis I	−0.401	0.572	−0.701	0.484	6.640	4.697	1.414	0.160	−0.033	0.463	−0.072	0.943
FTND	0.342	0.130	2.635	**0.009**	1.805	1.298	1.391	0.167	−0.158	0.096	−1.645	0.102
Pre-Score	0.767	0.067	11.429	**<0.001**	0.434	0.083	5.246	**<0.001**	0.828	0.051	16.198	**<0.001**
ΔAIS	−0.102	0.026	−3.979	**<0.001**	−0.842	0.202	−4.171	**<0.001**	−0.058	0.021	−2.772	**0.006**
Time	0.129	0.043	2.992	**0.003**	−0.578	0.315	−1.832	0.068	−0.030	0.042	−0.717	0.474
Time x ΔAIS	0.008	0.004	2.200	**0.029**	0.042	0.033	1.295	0.196	0.004	0.003	1.391	0.165
$Time^2$	−0.005	0.001	−3.268	**0.001**	0.020	0.011	1.881	0.061	0.001	0.001	0.106	0.915
$Time^2$ x ΔAIS	0.001	0.001	−1.529	0.127	−0.001	0.001	−1.247	0.213	0.001	0.001	−1.167	0.244

Note: SE = Standard Error; Gender [coded 0=male, 1=female]; Axis I = Presence of Axis I psychopathology in past year [coded 0=no, 1=yes]; FTND = Fagerström Test of Nicotine Dependence; Pre-score = mean pre-quit score of the respective post-quit outcome variable; ΔAIS = change in Avoidance and Inflexibility Scale (difference score of baseline value – quit day value); Time [linear time; coded day 0=quit day, day 7=week one post-quit, day 14=week two post-quit, day 21=week four post-quit]; $Time^2$ [Time x Time].