

Brief Report

Smoking Withdrawal in Smokers With and Without Posttraumatic Stress Disorder

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Abstract

Introduction: Previous research on smoking withdrawal in posttraumatic stress disorder (PTSD) has been limited by the use of retrospective and observational methods and has lacked repeated assessments on the first day of abstinence and evaluation of the conditioned effects of smoking.

Methods: Smokers with ($n = 17$; 59% female) and without ($n = 30$; 17% female) PTSD completed 3 randomly ordered experimental sessions using a 2 (group: PTSD vs. non-PTSD) \times 3 (smoking condition: usual brand vs. nicotine free vs. no smoking) design. Before the smoking manipulation, participants completed self-report measures of smoking urges and withdrawal, followed by withdrawal assessment after the smoking manipulation.

Results: Compared with smokers without PTSD, smokers with PTSD exhibited higher craving ($\chi_1^2 = 16.60, p < .001$) and habit withdrawal ($\chi_1^2 = 10.38, p = .001$) following overnight abstinence. PTSD smokers also exhibited worsening negative affect throughout the morning when not smoking a cigarette ($\chi_1^2 = 11.30, p = .004$). After smoking, smokers with PTSD reported diminished relief from craving ($\chi_1^2 = 6.49, p = .011$), negative affect ($\chi_1^2 = 4.51, p = .034$), arousal ($\chi_1^2 = 6.46, p = .011$), and habit withdrawal ($\chi_1^2 = 7.22, p = .007$), relative to smokers without PTSD.

Conclusions: Results of this preliminary investigation suggested that after overnight abstinence, PTSD smokers experienced worse withdrawal symptoms and greater urges to smoke for both positive and negative reinforcement. Research on smoking withdrawal early in the course of smoking abstinence in PTSD could inform interventions targeting abstinence early in the quit attempt.

Introduction

Individuals with posttraumatic stress disorder (PTSD) are twice as likely to smoke cigarettes and are among the most recalcitrant

of smokers to smoking cessation interventions (Lasser et al., 2000; Piper, Cook, Schlam, Jorenby, & Baker, 2010). Although PTSD smokers frequently lapse early in the course of smoking abstinence (Zvolensky et al., 2008), almost no data are available on withdrawal symptoms during the first 24 hr of smoking abstinence. Examination of early withdrawal symptoms is needed to inform models of smoking lapse and relapse in PTSD (Ziedonis et al., 2008).

While results are mixed, studies examining retrospective report suggest that PTSD is associated with increased smoking withdrawal symptoms (Breslau, Kilbey, & Andreski, 1992; Marshall et al., 2008; Weinberger, Maciejewski, McKee, Reutenauer, & Mazure, 2009). These studies are limited, however, by recall bias. Limited prospective evidence suggests that PTSD smokers have elevated total withdrawal symptoms in the first 24 hr of abstinence (Feldner, Vujanovic, Gibson, & Zvolensky, 2008; Zvolensky et al., 2008). There is a need for experimental studies evaluating changes in withdrawal across repeated assessments during the first day of smoking withdrawal.

Increased withdrawal symptoms early in the course of smoking abstinence are significant, especially viewed from the perspective of the affective processing model of negative reinforcement (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004). This model stresses the critical role of negative affect and the interoceptive cues that precede negative affect in smoking lapse and relapse. To address the limitations associated with previous studies in PTSD and smoking withdrawal, we conducted a prospective experimental study in smokers with and without PTSD. This study explored associations of PTSD, nicotine, and conditioned effects of smoking on nicotine withdrawal symptoms. Conditioned effects refer to reinforcing stimuli associated with nicotine administration, including the smoke aroma, irritant reactions in the mouth and throat, and olfactory cues. Evidence suggests that smoking behavior is driven in part by the conditioned effects of smoking (Rose & Levin, 1991), so conditioned effects could also influence smoking withdrawal.

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Methods

Participants and Procedures

Data from this preliminary investigation are from a larger study investigating acoustic startle in smokers with and without PTSD (Calhoun et al., 2011). Eligible participants were generally healthy, were not seeking treatment for nicotine dependence, and smoked at least 15 cigarettes/day with afternoon expired carbon monoxide (CO) ≥ 15 ppm. Participants were excluded for major unstable medical problems using noncigarette forms of nicotine, schizophrenia, current manic episode, lifetime but not current PTSD, current major depressive disorder, current substance abuse/dependence, current benzodiazepine use, or hearing deficits in the 500–3,000 Hz range.

Participants were recruited via flyers and clinician referrals from local outpatient clinics. Psychiatric diagnoses were based on the Clinician-Administered PTSD Scale (Blake et al., 1995) and the Structured Clinical Interview for *DSM-IV* Disorders (First, Spitzer, Williams, & Gibbon, 2002); average Fleiss' (1981) kappa across nine raters for diagnoses was .95. Participants completed three randomly ordered experimental sessions using a 2 (group: PTSD [$n = 17$] vs. non-PTSD [$n = 30$]) \times 2 (script: trauma script vs. neutral script) \times 3 (smoking condition: usual brand vs. nicotine free vs. no smoking) crossover design. Only neutral script sessions were evaluated in the current report.

Participants were asked to refrain from cigarette, alcohol, and marijuana use the night before testing but maintain their usual caffeine consumption. At the laboratory visit, breath samples confirmed abstinence from smoking based on a previously validated formula (Rose & Behm, 2004) that takes into account baseline CO levels. Participants completed self-report measures, then were offered a small breakfast, and completed startle procedures before smoking their first cigarette of the day approximately 40 min into the session. In the nicotine cigarette condition, participants smoked their choice of cigarette brand. They had the option to continue to smoke to maintain satiety but rarely did so because sessions ended after 60 min. After reading neutral scripts and completing startle and prepulse inhibition procedures, participants completed self-report measures to end the session. In the denicotinized cigarette condition, participants smoked cigarettes with only trace amounts of nicotine (Quest 3; $<.05$ mg).

Measures

Shiffman/Jarvik Withdrawal Scale

This 32-item measure assesses the following six common symptoms of nicotine withdrawal: craving (e.g., "Do you have an urge to smoking a cigarette"), negative affect (e.g., "Do you feel tense"), arousal (e.g., "Do you feel wide awake"), somatic (e.g., "Is your heart beating faster than usual"), appetite (e.g., "Do you feel hungrier than usual"), and habit withdrawal (e.g., "Do you miss having something to do with your hands"; Shiffman & Jarvik, 1976). Because participants completed this measure twice during the session, instructions read, "Please fill in the bubble for each question that most accurately reflects how you feel Right Now." The Shiffman/Jarvik Withdrawal Scale (SJWS) has demonstrated the expected decrease

in withdrawal symptoms across successive days of abstinence (Shiffman & Jarvik, 1976) and has shown consistent change scores upon abstinence for repeated abstinence periods (Hughes, Hatsukami, Pickens, & Svikis, 1984). Internal consistency in this sample was good (Cronbach's alpha = .82, .84, and .86 at baseline, presmoking, and postsmoking assessments, respectively).

Brief Questionnaire of Smoking Urges

This 10-item measure assesses two subscales of smoking urges. On Factor 1, a higher score indicates a greater urge to smoke in anticipation of pleasure from smoking. A higher score on Factor 2 indicates a greater urge to smoke for relief from withdrawal or negative affect (Tiffany & Drobes, 1991). Psychometric investigation has supported the factor structure and internal consistency in laboratory and clinical settings (Cox, Tiffany, & Christen, 2001). The current sample had good internal consistency (Cronbach's alpha = .92, .94 across presmoking and post-smoking assessments, respectively).

Smoking History and Nicotine Dependence Measures

General smoking history and nicotine dependence were measured at a baseline visit with a demographic and background questionnaire and the Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991).

Data Analysis Plan

Generalized estimating equations (GEE) were used to model smoking withdrawal symptoms and symptom change with one between-groups factor, PTSD status (PTSD vs. non-PTSD), one within-subjects factor, smoking condition (nicotinized cigarette vs. denicotinized vs. no smoking), and a PTSD \times Smoking Condition interaction. Each subscale on the SJWS was modeled separately. Analyses controlled for nicotine dependence at study entry, and analyses of postsmoking withdrawal symptoms controlled for presmoking withdrawal symptoms.

To test carryover effects of the sequence of smoking conditions on postsmoking withdrawal measures, we used procedures described by Senn (2002) to fit mixed effect linear models, with participants modeled as random effects. These models yielded no evidence of differential carryover of laboratory sessions between different smoking conditions.

Results

Demographic and Baseline Smoking Intensity Measures by Group

Demographic characteristics are summarized in Table 1. The majority of the sample was male (68%) and unmarried (79%), of minority racial background (81%), with a mean age of 43 and mean education of 12 years. The PTSD group had a higher proportion of women than the non-PTSD group (58% vs. 17%, respectively; $\chi^2_1 = 8.87, p = .003$). At baseline, neither PTSD diagnosis nor PTSD symptom severity (as measured by the clinician-administered PTSD scale and Davidson Trauma Scale) were significantly associated with smoking measures, including CO level, FTND, and cigarettes per day.

Table 1. Participant Demographic, Current Diagnostic, and Smoking Characteristics

Variable	PTSD (N = 17)	Non-PTSD (N = 30)
Age, <i>M</i> (<i>SD</i>)	45.82 (9.53)	42.53 (8.72)
Education, <i>M</i> (<i>SD</i>)	11.29 (1.93)	12.63 (2.53)
Sex (% female)	59% (10)*	17% (5)*
Race		
% Black	67% (12)	83% (25)
% Minority	71% (12)	87% (26)
% Married	44% (7)	33% (10)
% Veteran	29% (5)	37% (11)
PTSD-DTS	57.82 (33.36)*	14.83 (17.90)*
Months since trauma	212.15 (186.94)	183.23 (150.61)
CO level at screen	23.29 (7.67)	25.67 (12.75)
FTND	6.53 (1.46)	6.13 (1.98)
Trauma types		
None	0	4
Diagnosed with illness	2	4
Death/illness of loved one	3	6
Childhood sexual abuse	5	3
Childhood physical abuse	0	1
Combat-related traumas	2	1
Adult physical violence	3	7
Adult sexual assault	1	0
Motor vehicle accident	1	4
Current panic disorder	6% (1)	3% (1)
Current obsessive-compulsive disorder	12% (2)	0%
Current phobic disorder	35% (6)	3% (1)
Any non-PTSD anxiety disorder	47% (8)	7% (2)

Note. DTS = Davidson Trauma Scale; FTND = Fagerström Test for Nicotine Dependence; PTSD = posttraumatic stress disorder.

**p* < .05.

Withdrawal and Smoking Expectancies After Overnight Abstinence by PTSD Group

Withdrawal symptoms are listed by PTSD group and smoking condition in Table 2. GEE analyses of presmoking symptoms revealed that, relative to the non-PTSD group, the PTSD group was higher in craving ($\chi^2_1 = 16.60$, partial $\eta^2 = .179$, *p* < .001) and habit withdrawal ($\chi^2_1 = 10.38$, partial $\eta^2 = .124$, *p* = .001) following overnight abstinence. In addition, the PTSD group was higher in urge to smoke in anticipation of pleasure ($\chi^2_1 = 17.47$, *p* < .001) and to relieve withdrawal/negative affect ($\chi^2_1 = 6.09$, *p* = .014) on the “Brief Questionnaire of Smoking Urges.”

Change in Symptoms as a Function of PTSD and Smoking Condition

Main effects of PTSD and smoking condition on the change in withdrawal symptoms throughout the session are presented in Table 2. After the smoking manipulation, the PTSD group had significantly less relief from craving ($\chi^2_1 = 6.49$; *p* = .011) compared with the non-PTSD group. Smoking condition also had a

significant effect on craving ($\chi^2_2 = 51.57$; *p* < .001), such that nicotine cigarettes were associated with a larger decrease in craving than denicotinized cigarettes ($\chi^2_1 = 35.07$; *p* < .001) or the no-smoking condition ($\chi^2_1 = 51.56$; *p* < .001). Craving was significantly reduced by denicotinized cigarettes compared with the no-smoking condition ($\chi^2_1 = 5.82$; *p* = .016).

Analysis of change in negative affect revealed an interaction between PTSD and smoking ($\chi^2_2 = 11.30$; *p* = .004). Follow-up contrasts revealed no statistically significant differences between the PTSD group and the non-PTSD comparison group in the nicotine or denicotinized conditions. However, in the no-smoking condition, the non-PTSD group exhibited relatively stable levels of negative affect throughout the session, while the PTSD group reported increasing negative affect ($\chi^2_1 = 7.51$; *p* = .006).

Across smoking conditions, PTSD smokers reported greater reduction in arousal symptoms ($\chi^2_1 = 6.46$; *p* = .011) and less reduction in habit withdrawal ($\chi^2_1 = 7.22$; *p* = .007). As expected, there was a main effect of smoking condition on habit withdrawal ($\chi^2_2 = 18.79$; *p* < .001), with a significantly greater reduction following nicotine cigarettes, relative to denicotinized cigarettes ($\chi^2_1 = 9.23$; *p* = .002) or no-smoking condition ($\chi^2_1 = 18.78$; *p* < .001). Habit withdrawal also reduced more following denicotinized cigarettes, relative to no smoking ($\chi^2_1 = 5.84$; *p* = .016).

Discussion

The results of this experimental study of smoking withdrawal symptoms following overnight abstinence extend findings from previous research documenting more severe smoking withdrawal in PTSD. This report demonstrates worse withdrawal across repeated assessments during the morning following overnight abstinence. In addition, there was no statistically significant between-group difference in baseline nicotine dependence. This unintended design feature reduced the influence of this confound noted in previous reports of smoking withdrawal in PTSD (Feldner et al., 2008). The effects of smoking conditions on withdrawal were generally large, despite the short time interval (approximately 1 hr) between the two measurements of withdrawal.

An interaction of PTSD and smoking suggested that while smokers without PTSD experienced a steady level of negative affect in the first morning of smoking abstinence, smokers with PTSD experienced increasing levels of negative affect. It is noteworthy that negative affect is central to models of substance use relapse (Carmody, Vieten, & Astin, 2007; Cook, McFall, Calhoun, & Beckham, 2007), and smokers with PTSD report greater expectation that smoking will relieve negative affect (Calhoun et al., 2011). Consequently, elevated negative affect in the course of abstinence is particularly worthy of further research.

It is possible that more severe withdrawal in PTSD is due to increased sensitivity to the interoceptive cues that emerge early in the withdrawal process (Feldner et al., 2008). This is consistent with research indicating that smokers with PTSD experience elevated anxiety sensitivity (fear of anxiety-related symptoms), negative affectivity, and anxious arousal (Vujanovic, Marshall-Berenz, Beckham, Bernstein, & Zvolensky, 2010).

Table 2. Means and SDs of Withdrawal Symptoms by PTSD Status and Smoking Condition

	Nicotinized cigarette		Denicotinized cigarette		No smoking		Effect size estimates for overall tests		
	Presmoke	Posts smoke	Presmoke	Posts smoke	Presmoke	Posts smoke	PTSD partial η^2	Smoke partial η^2	PTSD \times Smoke partial η^2
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>			
Craving							.041*	.373*	.012
PTSD	37.2 (6.9)	25.7 (11.3)	36.8 (7.1)	35.9 (7.5)	37.2 (6.0)	37.4 (5.7)			
Non-PTSD	30.1 (8.4)	19.9 (7.2)	29.1 (7.8)	26.4 (7.9)	29.7 (8.6)	29.8 (7.8)			
Negative Affect							.039*	.131*	.056*
PTSD	14.6 (5.6)	12.6 (3.3)	15.3 (5.5)	14.0 (4.6)	15.9 (5.6)	17.5 (4.8)			
Non-PTSD	13.2 (3.4)	12.4 (2.8)	14.4 (4.1)	13.0 (3.4)	14.6 (3.1)	13.9 (4.0)			
Arousal							.067*	.007	.037
PTSD	14.0 (4.5)	13.4 (5.1)	14.1 (3.4)	13.1 (3.7)	13.1 (3.2)	10.9 (3.3)			
Non-PTSD	15.1 (3.6)	14.8 (4.1)	14.1 (4.5)	14.0 (4.0)	14.1 (3.7)	14.7 (4.1)			
Somatic							.006	.011	.012
PTSD	18.0 (5.7)	19.5 (8.2)	17.3 (4.7)	18.5 (5.9)	18.5 (5.1)	19.4 (5.5)			
Non-PTSD	17.0 (5.9)	16.7 (6.7)	16.3 (5.7)	18.2 (9.3)	16.6 (6.0)	16.4 (6.4)			
Appetite							.011	.035	.007
PTSD	8.3 (4.2)	7.7 (3.9)	8.1 (3.4)	7.6 (4.2)	6.4 (3.5)	7.5 (3.9)			
Non-PTSD	5.8 (3.3)	5.1 (2.5)	5.5 (2.7)	5.5 (3.3)	6.5 (3.9)	6.5 (4.1)			
Habit							.071*	.135*	.015
PTSD	11.1 (4.3)	8.6 (4.7)	11.9 (5.0)	10.9 (5.0)	11.3 (4.6)	12.5 (4.2)			
Non-PTSD	8.4 (3.9)	5.8 (2.7)	7.5 (3.2)	6.9 (3.4)	8.5 (3.9)	8.0 (3.7)			

Note. Means were not adjusted for covariates. All significance tests of change in smoking withdrawal model posts moking withdrawal symptoms as the outcome, with nicotine dependence and presmoking withdrawal symptoms statistically controlled and PTSD, smoking condition, and PTSD \times Smoking interaction as the predictors. Significance was tested with Wald significance tests generated by generalized estimating equations. Due to the lack of available effect size statistics for generalized estimating equations, effect sizes were estimated using η^2 calculations from analysis of covariance models.

* $p < .05$.

Each of these could worsen the experience of smoking withdrawal symptoms. Finally, the symptoms that worsened during smoking withdrawal, particularly negative affect and arousal, conceptually overlap with PTSD symptomatology.

This study was limited by the relatively small sample size, necessitating replication. Results are not generalizable beyond the first day of nicotine withdrawal and are also limited by a disparity in sex by PTSD group and overrepresentation of Blacks. Because participants were not trying to quit smoking, results might not generalize to smoking cessation attempts. Finally, although statistical evaluation did not reveal evidence of differential carryover, order effects remain a potential threat to validity in any crossover design. However, this threat is mitigated by the use of large washout periods between smoking condition sessions.

Nonetheless, this study provides preliminary evidence for increased smoking withdrawal among PTSD smokers early in the time course of abstinence. Comprehensive evaluation of withdrawal and smoking urges among PTSD smokers (including affective, attention, and neurocognitive measures) may inform targeted smoking cessation treatment among PTSD smokers. Potential modifications include frequent counseling contact on the quit date, behavioral activation to increase positive affect and reduce negative affect (Hopko,

Lejuez, Ruggiero, & Eifert, 2003), and/or precessation nicotine replacement therapy.

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Declaration of Interests

None declared.

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