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Intolerance for Smoking Abstinence among Nicotine-Deprived, Treatment-Seeking Smokers

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Abstract

Introduction—The Intolerance for Smoking Abstinence Discomfort Questionnaire (IDQ-S) assesses distress tolerance specific to nicotine withdrawal. Though developed to assess withdrawal-related distress, the IDQ-S has not been validated among nicotine-deprived, treatment-seeking smokers. The present study extended previous research by examining the predictive utility of the IDQ-S among abstinent, motivated-to-quit smokers.

Methods—Abstinent, treatment-seeking smokers completed the IDQ-S Withdrawal Intolerance and Lack of Cognitive Coping scales, assessments of nicotine dependence and reinforcement, and smoking history at baseline. At baseline and at 24-hr, 2-week, and 1-month follow-up, participants completed a smoking cue-reactivity task (collection of cue-elicited craving and negative affect), and assessments of cigarettes per day (CPD; daily diaries at follow-up), carbon monoxide (CO), and cotinine.

Results—Greater IDQ-S Withdrawal Intolerance was associated with younger age, higher nicotine dependence and reinforcement, and less smoking years ($p < .03$). Greater IDQ-S Lack of Cognitive Coping was associated with less education, lower nicotine dependence and reinforcement, higher baseline CPD, and no prior quit attempts ($p < .04$). IDQ-S scales did *not*

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Contributors

Dr. Saladin designed the study and wrote the protocol. Dr. Germeroth developed the research question for a secondary data analysis of the collected data. Mr. Baker conducted the statistical analysis. Dr. Germeroth wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

Conflict of Interest

All authors declare no conflicts of interest.

significantly predict cue-elicited craving or negative affect, CPD, CO, or cotinine levels at follow-up ($p > .10$).

Conclusions—Withdrawal intolerance and lack of cognitive coping did not predict smoking outcomes among nicotine-deprived, treatment-seeking smokers, but were associated with smoking characteristics, including nicotine dependence and reinforcement. Withdrawal intolerance and lack of cognitive coping may not be especially useful in predicting craving and smoking behavior, but future studies should replicate the present study's findings and assess the stability of the IDQ-S before forming firm conclusions about its predictive utility.

Keywords

withdrawal intolerance; treatment-seeking; nicotine; smoking; abstinence

1. Introduction

Most smoking cessation attempts result in early lapse and often progress to full relapse (Fiore, 2000; Hughes, Keely, & Naud, 2004). One presumed contributing factor of relapse is distress intolerance, or the inability to continue pursuing a goal due to affective discomfort/distress (Brown, Lejuez, Kahler, Strong, & Zvolensky, 2005). Distress intolerance has been operationalized as task persistence in stressful behavioral laboratory tasks (Quinn, Brandon, & Copeland, 1996) and has been assessed using self-report measures indexing the ability to tolerate feelings of distress (Simons & Gaher, 2005) and anxiety (Zvolensky et al., 2006). These measures of distress intolerance have been associated with prior smoking lapse and relapse (Brown, Lejuez, Kahler, & Strong, 2002; Hajek, 1991; Hajek, Belcher, & Stapleton, 1987), future smoking lapse (Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001; Brown et al., 2009), and nicotine dependence (Leyro, Bernstein, Vujanovic, McLeish, & Zvolensky, 2011). However, behavioral distress intolerance tasks may be difficult to implement in clinical settings and self-report assessments evaluate difficulty tolerating emotions *in general* relative to difficulty tolerating affective and physical symptoms of smoking abstinence specifically (Sirota et al., 2010). Abstinence-specific distress intolerance may serve as a more targeted, proximal measure of withdrawal-related affective experiences that can be assessed easily in clinical settings. Importantly, initial evidence suggests that abstinence-specific distress intolerance is a more robust predictor of smoking-related outcomes relative to general distress intolerance (Sirota, Rohsenow, Dolan, Martin, & Kahler, 2013).

The Intolerance for Smoking Abstinence Discomfort Questionnaire (IDQ-S; Sirota et al., 2010) was one of the first self-report measures designed to assess distress intolerance specific to withdrawal effects. The IDQ-S evaluates two aspects of abstinence-related distress tolerance: (1) *withdrawal intolerance* (i.e., intolerance of affective, cognitive, and physical symptoms of withdrawal), and (2) *lack of cognitive coping* (i.e., difficulty engaging in cognitive strategies to cope with withdrawal). Given that the IDQ-S assesses abstinence-specific distress intolerance, it is probably most profitably studied among smokers who are actively nicotine-deprived. However, only two studies have investigated the IDQ-S among abstinent smokers (Kahler, McHugh, Metrik, Spillane, & Rohsenow, 2013; Rohsenow et al., 2015), and those studies administered the IDQ-S to smokers also abusing non-nicotine substances (e.g., alcohol, marijuana, cocaine). Substance use disorder comorbidities could

complicate the examination of coping with nicotine-specific withdrawal symptoms because individuals with substance dependence have greater *general* distress intolerance relative to non-diagnosed individuals (Ozdel & Ekinici, 2014), potentially exacerbating abstinence-specific distress intolerance. Moreover, the IDQ-S was developed to investigate relationships between intolerance to nicotine withdrawal and cessation outcomes. Thus, research on these relationships would be optimally conducted among treatment-seeking smokers.

The IDQ-S has demonstrated significant associations with smoking level, nicotine dependence, and quit attempts (Kahler et al., 2013; Rohsenow et al., 2015; Sirota et al., 2013; Sirota et al., 2010). However, no studies have examined the utility of abstinence-specific distress intolerance in prospectively predicting smoking behavior via daily recordings of cigarette smoking in the real-world. Extant research has been limited to testing associations between the IDQ-S and cessation outcomes assessed: (a) retrospectively (Sirota et al., 2013; Sirota et al., 2010), which may be prone to recall bias (Cunningham & Selby, 2008), (b) prospectively, but using timeline follow-back (TLFB) procedures to assess smoking behavior (Rohsenow et al., 2015), which is susceptible to inaccuracies (Shiffman, 2009), or (c) within a single laboratory session (Kahler et al., 2013), which may not generalize to real-world behavior.

The present study advanced prior work by examining the ability of withdrawal intolerance and lack of cognitive coping, assessed using the IDQ-S, to predict daily smoking in the natural environment, with biochemical verification at follow-up laboratory sessions. Moreover, the current study was the first investigation to assess the extent to which the IDQ-S scales predicted cue-elicited craving. Cue-elicited craving reflects the desire or urge to smoke a cigarette in response to smoking-related cues (e.g., a lit cigarette) that have been repeatedly paired with drug reward. Cue-elicited craving may play a central role in smoking lapse and smokers who experience heightened cue-elicited craving may be less likely to quit successfully (Abrams, Monti, Carey, Pinto, & Jacobus, 1988; Ferguson & Shiffman, 2009; Waters et al., 2004). Thus, elucidating the relationship between intolerance to smoking abstinence and cue-elicited craving may provide critical information about cessation outcomes and inform cessation interventions.

Altogether, the present study was the first to examine intolerance to smoking abstinence among acutely nicotine-deprived, treatment-seeking smokers without comorbid substance use. Smokers engaged in a memory reconsolidation-based smoking cessation intervention consisting of smoking memory retrieval or non-smoking, neutral memory retrieval (i.e., control group) followed by protracted smoking cue exposure (Germeroth et al., 2017). We hypothesized that greater withdrawal intolerance and lack of cognitive coping would predict: (a) worse smoking outcomes regardless of treatment condition (as we did not expect the cessation intervention to affect IDQ-S scale scores), including higher cigarettes smoked per day (CPD), breath carbon monoxide (CO) levels, and urine cotinine levels, and (b) greater cue-elicited craving. Given that this was the first investigation assessing the IDQ-S among nicotine-deprived, treatment-seeking smokers, we also sought to characterize withdrawal intolerance and lack of cognitive coping using demographic (e.g., sex, age) and smoking (e.g., CPD, nicotine dependence) characteristics.

2. Methods

2.1 Participants

Participants were 88 treatment-seeking smokers recruited for a randomized clinical trial (Germeroth et al., 2017) evaluating a behavioral intervention for smoking cessation. Participants were recruited through the Charleston, SC community. Primary inclusion criteria included willingness to be abstinent at the baseline session and make a 3-day cessation attempt, meeting Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria for current nicotine dependence, and smoking ≥ 10 CPD for ≥ 3 years. Verification of smoking abstinence was confirmed using breath CO. To verify abstinence from non-nicotine substances, participants had to produce a negative breathalyzer (alcohol) assessment and urine drug screen (benzodiazepines, amphetamines, methamphetamines, cocaine, tetrahydrocannabinol [THC], and opiates) at the baseline session. Additional non-primary inclusion criteria, including the requirement of no psychiatric diagnoses, are described in the supplementary materials. All participants underwent a Medical University of South Carolina Institutional Review Board-approved informed consent process prior to participation.

2.2 Assessments

Participants completed assessments of demographics (e.g., sex, age, race) and smoking history (e.g., number of past quit attempts, years of regular smoking). Motivation to quit smoking was assessed using a 1-item Contemplation Ladder with a 0 (*I have no thoughts about quitting smoking*) to 10 (*I am taking action to quit smoking*) Likert scale (Biener & Abrams, 1991). The 17-item IDQ-S assessed intolerance of affective, cognitive, and physical symptoms associated with nicotine withdrawal (Withdrawal Intolerance scale; e.g., “I cannot stand how I feel when I need a cigarette,” “I can’t tolerate being irritable from not smoking”) and ability to cope cognitively with withdrawal, reverse-scored to reflect lack of cognitive coping (Lack of Cognitive Coping scale; e.g., “I just have to tolerate how I feel in order to quit cigarettes,” “It’s OK if I have to feel lousy for a while in order to quit smoking”). Participants rated items on a 1 (*strongly disagree*) to 5 (*strongly agree*) Likert scale. Cronbach’s alpha reliability indicated that the IDQ-S scales were at or above threshold for acceptable reliability ($\alpha = 0.70$; Tavakol & Dennick, 2011; Withdrawal Intolerance: $\alpha = 0.88$; Lack of Cognitive Coping: $\alpha = 0.70$). Prior research has provided support for construct validity of the IDQ-S scales, with IDQ-S scales sharing 29% variance with depression and emotional vulnerability measures (Sirota et al., 2010). In addition, this extant research has indicated discriminant validity and excellent convergent validity of the IDQ-S scales, correlating with smoking-related measures of motivation, dependence, and smoking behavior (Sirota et al., 2013; Sirota et al., 2010).

The 68-item Wisconsin Inventory of Smoking Dependence Motives-68 (WISDM-68; Piper et al., 2004) total score ($\alpha = 0.97$) was used to assess nicotine dependence. The 13-item Michigan Nicotine Reinforcement Questionnaire (M-NRQ; Pomerleau, Fagerstrom, Marks, Tate, & Pomerleau, 2003) total score ($\alpha = 0.83$) was used to measure negative nicotine reinforcement (e.g., anxiety, irritability associated with not smoking) and positive nicotine reinforcement (e.g., smoking associated with pleasure) consequences of smoking. Baseline and cue-elicited craving were assessed at baseline and 24-hr, 2-week, and 1-month follow-up

sessions using the 4-item Craving Questionnaire (Carter & Tiffany, 2001; baseline: α s=0.89-0.95; post-cue: α s=0.91-0.97). Participants reported their craving on a 1 (*strongly disagree*) to 5 (*strongly agree*) Likert scale. Given the strong, positive association between craving and negative affect (Tiffany, 2010), collateral measures of baseline and cue-elicited negative affect were collected at each session. Negative affect was assessed using a 5-item Mood Form (baseline: α s=0.77-0.94; post-cue: α =0.88-0.95; Diener & Emmons, 1984) modified to include one item assessing subjective stress. Participants reported their negative affect on a 0 (*not at all*) to 6 (*extremely*) Likert scale. Smoking behavior was assessed using (a) CPD averaged over the past 14 days using TLFB (Brown et al., 1998) interviews at baseline and smoking diaries at follow-up, (b) breath CO, and (c) urine cotinine at each session. The TLFB is a calendar-based instrument that uses specific probes to help quantify daily smoking. Additional information regarding the validity of self-report assessments are reported in the supplementary materials.

2.3 Procedure

Participants engaged in six sessions: a baseline session, two consecutive days of memory reconsolidation intervention 24-hr after the baseline session, and three follow-up sessions 24-hr, 2-week, and 1-month after the intervention days. Prior to the baseline session, participants were overnight abstinent. At baseline, smoking abstinence was assessed using self-report and breath CO verification. Consistent with previous recommendations (SRNT Subcommittee on Biochemical Verification, 2002), participants were considered overnight abstinent if their CO level was ≤ 10 parts per million (ppm). Urine samples were collected to establish cotinine levels. Participants provided demographic information and completed a smoking history questionnaire and assessments of nicotine dependence, nicotine reinforcement, motivation to quit, withdrawal intolerance, and lack of cognitive coping. Participants completed baseline measures of craving and negative affect before engaging in a cue-reactivity task during which they viewed smoking-related video cues (e.g., person lighting a cigarette and smoking). Immediately after viewing the videos, participants provided craving and negative affect ratings.

Participants then engaged in two consecutive days of intervention during which they were required to remain abstinent from smoking. Upon verification of smoking abstinence (CO ≤ 10 ppm) at the first training session, participants were randomly assigned to one of two memory retrieval groups. One group (designated retrieval-extinction, or 'R-E') viewed a 5-min video with smoking-related content *prior to* massed cue exposure (i.e., 60-min of exposure to in vivo, picture, and video smoking cues) while the second group (designated non-retrieval-extinction, or 'NR-E') viewed a 5-min video with neutral, nonsmoking-related content prior to massed smoking cue exposure. Both intervention training days were identical in procedures. R-E training targets the "reconsolidation window," which is a period of time occurring after memory retrieval (achieved via presentation of a 5-min smoking video) when cue-reward memories are unstable and modifiable. Exposing participants to massed cue exposure (i.e., extinction training) *during memory reconsolidation*, updates former cue-reward memories with new information that is inconsistent with the established cue-reward association. In fear-based and drug-reinforced learning, memories have been modified during reconsolidation through both behavioral (i.e., R-E training) or

pharmacological means in animals (Bernardi, Lattal, & Berger, 2006; Duvarci, Nader, & LeDoux, 2005; Font & Cunningham, 2012; Milton, Lee, Butler, Gardner, & Everitt, 2008; Monfils, Cowansage, Klann, & LeDoux, 2009; Muravieva & Alberini, 2010; Nader, Schafe, & LeDoux, 2000; Robinson & Franklin, 2010) and humans (Kindt, Soeter, & Vervliet, 2009; Saladin et al., 2013; Schiller et al., 2010; Soeter & Kindt, 2010, 2015; Tollenaar, Elzinga, Spinhoven, & Everaerd, 2009). Moreover, R-E training has successfully attenuated cue-elicited heroin craving (Xue et al., 2012) and cue-elicited cigarette craving and smoking behavior in our parent study (Germeroth et al., 2017).

Participants completed follow-up sessions 24-hr, 2-week, and 1-month after the second R-E/NR-E intervention day. CO and cotinine samples were collected and participants received a smoking cue-reactivity assessment at each follow-up session. Participants were encouraged, but not required, to remain abstinent during follow-up. Participants completed diaries with daily CPD reported between the 24-hr and 2-week and between the 2-week and 1-month follow-up sessions. Complete procedures are described in Germeroth et al. (2017).

2.4 Data Management and Statistical Analysis

Summary values were computed for baseline demographic and smoking characteristics (Table 1). Continuous characteristics are noted as means (M) and associated standard deviations (SD), and categorical characteristics are noted as proportions (%) and counts (n).

To develop an understanding of which concurrently-measured characteristics were associated with IDQ-S scale scores, a simple regression modeling approach was implemented. To assess the simple relationships between concurrent (baseline) demographic and smoking history variables with IDQ-S scale scores, bivariate associations were tested using linear regression models. Further, generalized linear models were constructed to analyze the relationships between baseline IDQ-S scale scores and treatment study outcomes (cue-elicited craving and negative affect, CPD, CO level, and cotinine level) between follow-up test sessions. To remain consistent with previously-reported analyses (Germeroth et al., 2017), individual IDQ-S scale scores were independently added to the final primary outcome models described previously. In addition to the primary IDQ-S analysis, the differential effects of treatment efficacy based on levels of IDQ-S scale scores (IDQ-S $\times$ Treatment interaction) were evaluated. The primary smoking outcomes of interest were the associations of IDQ-S scale scores with (1) average CPD for the two weeks leading up to the 2-week and 1-month follow-up test sessions, (2) CO levels, and (3) cotinine levels. Generalized linear models were developed to analyze associations of these three primary smoking outcomes. Details on model development and inclusion of covariates are included in the supplementary materials. Analyses were conducted using SAS version 9.4 and SPSS version 22.0. Models were noted as statistically significant with a two-sided $p < .05$.

3. Results

3.1 Participant Characteristics

Of the 88 participants who completed the baseline session and were randomized to R-E/NR-E training, one participant was withdrawn due to cotinine levels at the baseline session

indicating that individual was a non-smoker. The CONSORT flow diagram has been reported previously (Germeroth et al., 2017). Baseline demographic and smoking characteristics are reported in Table 1.

3.2 Associations between IDQ-S Scales and Baseline Demographic and Smoking Characteristics

At baseline, IDQ-S Withdrawal Intolerance and Lack of Cognitive Coping were significantly correlated with each other ($r=-0.35$, $p=.001$), such that greater withdrawal intolerance was associated with *lower* lack of cognitive coping.

Greater withdrawal intolerance was significantly associated with higher nicotine dependence ($p<.001$), nicotine reinforcement ($p<.001$), less years of regular smoking ($p=.023$), and younger age ($p=.013$; Table 2). Females reported slightly higher withdrawal intolerance than males (females: $M=3.15$ [$SEM=0.12$]; males: $M=2.88$ [$SEM=0.09$]; $p=.086$). Lack of cognitive coping was significantly associated with lower nicotine dependence ($p=.016$), lower nicotine reinforcement ($p=.021$), higher baseline CPD ($p=.038$), no prior quit attempts (no prior quit attempt: $M=2.84$ [$SEM=0.18$]; prior quit attempt: $M=2.37$ [$SEM=0.08$]; $p=.020$), and less education (high school: $M=2.68$ [$SEM=0.12$]; >high school: $M=2.29$ [$SEM=0.10$]; $p=.012$).

3.3 IDQ-S Scales as Predictors of Cue-Elicited Craving and Negative Affect, and Smoking Outcomes

Analytic models indicated no significant effect of withdrawal intolerance or lack of cognitive coping on cue-elicited craving at follow-up ($ps=.644$ and $.316$, respectively [adjusted for sex and age at which regular smoking was initiated]; Table 3). Although greater withdrawal intolerance was marginally associated with higher cue-elicited negative affect at baseline ($p=.090$), this scale was not significantly associated with cue-elicited negative affect at follow-up (withdrawal intolerance: $p=.998$; lack of cognitive coping: $p=.999$).

Additionally, IDQ-S scales did not significantly predict CPD (withdrawal intolerance: $p=.947$; lack of cognitive coping: $p=.105$ [adjusted for sex, age, and baseline negative affect]), CO level (withdrawal intolerance: $p=.493$; lack of cognitive coping: $p=.312$ [adjusted for race and baseline negative affect]), or cotinine level (withdrawal intolerance: $p=.560$; lack of cognitive coping: $p=.213$ [adjusted for race]). IDQ-S scales did not significantly modify the effect of R-E training on treatment outcomes (all interactions: $p>.100$).

4. Discussion

The present study was the first to examine the effects of withdrawal-specific distress tolerance on smoking outcomes, including CPD in the real-world, among nicotine-deprived, treatment-seeking smokers. Contrary to hypotheses, withdrawal intolerance and lack of cognitive coping did *not* significantly predict CPD, CO, or cotinine levels through 1-month follow-up. These results were surprising given previous associations between IDQ-S scales and risk of smoking initiation (Kahler et al., 2013), quit attempts (Sirota et al., 2013; Sirota et al., 2010), and relapse (Rohsenow et al., 2015).

The null relationships between IDQ-S scales and smoking outcomes in the present study could be attributable to participants' combined treatment-seeking status and state of nicotine deprivation. Extant research has typically examined the predictive utility of the IDQ-S scales in non-treatment-seeking smokers (Kahler et al., 2013; Sirota et al., 2013; Sirota et al., 2010) and the IDQ-S was originally validated among non-abstinent smokers (Kahler et al., 2013; Sirota et al., 2010). Though these prior studies reported significant associations between the IDQ-S scales and smoking-related outcomes, the combination of seeking treatment and undergoing acute abstinence may have precluded significant IDQ-S-smoking associations from emerging. However, the mechanism contributing to null associations between the IDQ-S scales and smoking outcomes in the present sample remains unclear and future research is needed to systematically evaluate the effects of treatment-seeking status and acute abstinence on smoking behavior.

Alternatively, the null relationship between IDQ-S scales and smoking outcomes may reflect the use of baseline IDQ-S scores to predict *distal* smoking outcomes. Little is known about the potentially dynamic nature of withdrawal intolerance and lack of cognitive coping. These constructs may fluctuate over time, especially as smoking lapse/relapse behavior (Catley, O'Connell, & Shiffman, 2000) and quitting motivations (Piñeiro et al., 2016) wax and wane throughout the quit attempt. The 'distal relationship' explanation, however, likely does not completely explain the null IDQ-S scale-smoking outcome associations given that prior research (e.g., Rohsenow et al., 2015) reported significant relationships between baseline withdrawal intolerance and distal (i.e., 3-month) abstinence.

IDQ-S scales also did not predict cue-elicited craving at baseline or follow-up. In the main outcomes paper (Germeroth et al., 2017), we reported an overall dampening effect of cue-elicited craving at follow-up regardless of R-E/NR-E condition. Thus, the massed cue exposure presented to both groups may have obscured significant relationships between IDQ-S scale scores and cue-elicited craving at follow-up. Though greater withdrawal intolerance marginally predicted higher cue-elicited negative affect at baseline, it did not predict cue-elicited negative affect at follow-up. The relationship of withdrawal intolerance with negative affect may have been stronger than its relationship with cue-elicited craving given the affective nature of the withdrawal intolerance items. Moreover, the relationship between IDQ-S scales and negative affect might be more robust in future studies that do not have such a pronounced floor effect of negative affect scores ($M=0.88$ on a 0-6 rating scale range).

Given that this was the first investigation of withdrawal intolerance and lack of cognitive coping among acutely nicotine-deprived, treatment-seeking smokers, we sought to characterize these IDQ-S scale scores by demographic and smoking characteristics. Consistent with prior research, individuals with higher nicotine dependence and nicotine reinforcement reported greater withdrawal intolerance (Kahler et al., 2013; Rohsenow et al., 2015; Sirota et al., 2013; Sirota et al., 2010) and, complementarily, higher CPD was associated with greater lack of cognitive coping. However, higher nicotine dependence and reinforcement were also significantly associated with *lower* lack of cognitive coping (i.e., greater coping). Smokers with greater nicotine dependence who find cigarette smoking more reinforcing may struggle with tolerating withdrawal symptoms, but may still be able to cope

cognitively with withdrawal, perhaps more strongly believing that the current cessation attempt will be successful. Given that our sample was comprised of treatment-seeking smokers, these individuals may be able or willing to suppress difficulties coping with withdrawal when motivated to quit smoking, even when nicotine-deprived.

Further analysis of demographic characteristics indicated that younger smokers reported greater difficulty tolerating withdrawal, perhaps because they have had fewer opportunities to learn to effectively tolerate withdrawal. Similarly, greater withdrawal intolerance was associated with less years of regular smoking, a possible correlate of younger age. Previous estimates indicate that the average number of quit attempts a smoker can expect to make prior to quitting successfully is 6.1 attempts, though more recent reports (e.g., Chaiton et al., 2016) estimate that some smokers may have 30 or more unsuccessful quit attempts prior to successful abstinence. Thus, less years of regular smoking and younger age may reflect less prior quit attempts and, thus, less experience tolerating withdrawal symptoms.

We also found that less educated smokers reported greater lack of cognitive coping in response to nicotine deprivation, an intuitive finding given extant research that has reported associations between lower education level and engagement in less adaptive coping skills (Roohafza et al., 2009). Moreover, smokers with lower education are less likely to make a quit attempt (Reid et al., 2010), consistent with our finding that those without prior quit attempts reported greater lack of cognitive coping (Rohsenow et al., 2015; Sirota et al., 2013; Sirota et al., 2010). Despite previous null findings (Kahler et al., 2013; Sirota et al., 2010), we also found a marginal effect of sex, such that women tended to report greater withdrawal intolerance relative to men. Women in the present study may have perceived their withdrawal state to be more aversive or distressing than men (Leventhal et al., 2007). Alternatively, women may have been more willing to report difficulty tolerating withdrawal (Weinberger, Platt, Shuter, & Goodwin, 2016).

Some of our unexpected findings may have been the result of another surprising, underlying finding: greater withdrawal intolerance was significantly associated with *lower* lack of cognitive coping (i.e., greater cognitive coping). Previous investigations, though, have found that treatment-seeking smokers, despite high nicotine dependence (and likely greater withdrawal intolerance), experience high confidence in quitting ability (Samokhvalov et al., 2014). This could explain the initially surprising dichotomy of lower lack of cognitive coping despite higher withdrawal intolerance among our nicotine-deprived, treatment-seeking smokers.

4.1 Limitations and Future Directions

Some of the present study's findings were unexpected and, at times, inconsistent with prior research. For example, we did not observe significant associations between smoking outcomes and the IDQ-S scores despite prior investigations finding significant relationships between smoking outcomes and both general and withdrawal-specific distress tolerance. Referenced earlier, the present study's findings may have been at odds with prior findings given that the present study was the only investigation of IDQ-S and smoking outcome associations among treatment-seeking, nicotine-deprived smokers. Future research to elucidate the influence of treatment-seeking status and nicotine deprivation might directly

test the effects of both treatment-seeking (i.e., between-subject test of treatment- vs. non-treatment-seeking status) and nicotine deprivation (i.e., within-subject test of nicotine deprivation vs. satiation) on withdrawal intolerance and lack of cognitive coping. Conducting these investigations would also help validate the IDQ-S for use among treatment-seeking smokers undergoing acute abstinence given that the IDQ-S was originally validated among non-treatment-seeking, satiated smokers. Future research would also benefit from investigating the effects of IDQ-S scale scores on smoking outcomes within a more diverse sample of smokers. For instance, the current sample was free of psychiatric diagnoses. Extant research has indicated that participants with mood, anxiety, alcohol use, or substance use disorders report greater withdrawal-related discomfort and smoking relapse relative to non-diagnosed individuals (Weinberger, Desai, & McKee, 2010). Thus, IDQ-S scores and smoking outcomes may be different among individuals with vs. without psychiatric diagnoses. The present study was also the first investigation to examine associations between IDQ-S scores and both tonic and cue-elicited craving, finding no significant associations. However, the effect of cue exposure on craving response in the present study may have dampened overall cue-elicited craving during follow-up and interfered with the effects of IDQ-S scores on cue-elicited craving. Thus, future research should test the effects of withdrawal intolerance and lack of cognitive coping on cue-elicited craving and negative affect outside of the context of a smoking cessation treatment study.

Finally, the extent to which withdrawal intolerance and cognitive coping skills are static (i.e., 'trait-like') vs. dynamic attributes of smokers is unknown. Though previous researchers have suggested that the IDQ-S "may tap a more stable set of beliefs" (pp. 22; Rohsenow et al., 2015), no studies have investigated the stability of IDQ-S scale scores. Assessing the stability of withdrawal intolerance and lack of cognitive coping would involve administering multiple IDQ-S assessments beyond 24 hours of abstinence, a relatively brief period of abstinence which could have restricted increases in withdrawal intolerance and lack of cognitive coping levels in the present study. Multiple assessments of the IDQ-S would also allow for measurement of smoking outcomes more proximal to assessments of withdrawal intolerance and lack of cognitive coping, potentially improving the predictive utility of the IDQ-S.

4.2 Conclusions

This was the first study of withdrawal intolerance and lack of cognitive coping among abstinent, treatment-seeking smokers. Withdrawal intolerance and lack of cognitive coping did *not* significantly predict smoking outcomes through 1-month follow-up, nor predict cue-elicited craving or negative affect at follow-up. However, withdrawal intolerance and lack of cognitive coping were significantly associated with various smoking-related variables including nicotine dependence, nicotine reinforcement, CPD, prior quit attempts, and years of regular smoking. Findings from the present study should be replicated to determine the extent to which associations between IDQ-S scales and smoking outcomes reflect true null relationships potentially influenced by treatment-seeking status and nicotine deprivation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Withdrawal intolerance was related to smoking variables (e.g., nicotine dependence)
- Lack of cognitive coping was also associated with various smoking characteristics
- However, these scales did not predict cue-elicited craving or negative affect
- Moreover, these scales failed to predict CPD, CO, and cotinine at 1-month follow-up
- Replication of these findings is needed among nicotine-deprived, treatment-seekers

Table 1

Baseline Demographic and Smoking Characteristics of Sample

Characteristic	Statistic (N=87)	Range
Age [†]	47.52 (12.58)	•
Sex ^f		
Male	64.4 (56)	•
Female	35.6 (31)	•
Race ^f		
White	46.0 (40)	•
Black and other	54.0 (47)	•
Education ^f		
HS grad or equivalent	41.4 (36)	•
Some college or college grad	58.6 (51)	•
Carbon monoxide level (ppm) [†]	6.14 (2.43)	1-10
Cotinine level (µg/L)	968.15 (603.92)	0-2000
CPD [†]	16.47 (7.25)	5-50
Years of regular smoking [†]	28.60 (13.04)	4-49
WISDM-68 total score [†]	50.61 (13.47)	16.6-77.5
M-NRQ total score [†]	17.46 (6.15)	3-34
IDQ-S Withdrawal Intolerance [†]	2.97 (0.70)	1.0-4.3
IDQ-S Lack of Cognitive Coping [†]	2.45 (0.72)	1.2-5.0
Any prior QA ^f		
Yes	83.9 (73)	•
No	16.1 (14)	•
Number of past QAs [†]	3.70 (4.04)	0-20
Motivation to quit [†]	8.28 (1.94)	2-10
Cue-elicited craving [†]	3.76 (1.03)	1.3-5
Cue-elicited negative affect [†]	0.88 (1.10)	0-5

Note. HS=high school; ppm=parts per million; CPD=cigarettes per day; WISDM-68=Wisconsin Inventory of Smoking Dependence Motives-68; M-NRQ=Michigan Nicotine Reinforcement Questionnaire; IDQ-S=Intolerance for Smoking Abstinence Discomfort Questionnaire.; QA=quit attempt. Carbon monoxide assessment collected after overnight abstinence.

[†] $M(SD)$;

^f percent (number)

Table 2

Simple Bivariate Relationships between IDQ-S Scales and Baseline Characteristics

IDQ-S Withdrawal Intolerance			IDQ-S Lack of Cognitive Coping			
Characteristic	β (SEM)	F statistic	p-value	β (SEM)	F statistic	p-value
Demographic Characteristics						
Age ^a	-0.07 (0.03)	$F_{1,85}=6.46$	.013	-0.01 (0.03)	$F_{1,85}=0.15$	.703
Sex ^b	-0.27 (0.16)	$F_{1,85}=3.02$	.086	0.19 (0.16)	$F_{1,85}=1.31$	.256
Race ^c	0.22 (0.15)	$F_{1,85}=2.19$	.142	0.03 (0.16)	$F_{1,85}=0.04$	.844
Education ^d	-0.06 (0.15)	$F_{1,85}=0.13$	.719	-0.39 (0.15)	$F_{1,85}=6.56$	.012
Baseline Smoking and Cue-Reactivity Characteristics						
CPD (14 day avg) ^e	0.00 (0.10)	$F_{1,85}=0.00$	.999	0.22 (0.11)	$F_{1,85}=4.42$	.038
Yrs of regular smoking ^f	-0.06 (0.03)	$F_{1,85}=5.35$	.023	-0.01 (0.03)	$F_{1,85}=0.16$	.689
WISDM-68 total score	0.03 (0.01)	$F_{1,85}=44.25$	<.001	-0.02 (0.01)	$F_{1,85}=6.05$	.016
M-NRQ total score	0.06 (0.01)	$F_{1,85}=39.34$	<.001	-0.03 (0.01)	$F_{1,85}=5.50$	.021
Any prior QA	0.22 (0.20)	$F_{1,85}=1.17$	.282	-0.47 (0.20)	$F_{1,85}=5.58$	.020
Number of past QAs	0.03 (0.05)	$F_{1,85}=0.30$	.588	-0.08 (0.05)	$F_{1,85}=2.38$	.127
Motivation to quit	-0.01 (0.04)	$F_{1,85}=0.11$	.737	-0.01 (0.04)	$F_{1,85}=0.13$	.717
Cue-elicited craving ^g	0.10 (0.08)	$F_{1,85}=1.80$	.184	0.05 (0.08)	$F_{1,85}=0.35$	.556
Cue-elicited negative affect	0.12 (0.07)	$F_{1,85}=2.94$	.090	0.06 (0.08)	$F_{1,85}=0.76$	.385

Note. CPD=cigarettes per day; WISDM-68=Wisconsin Inventory of Smoking Dependence Motives-68; M-NRQ=Michigan Nicotine Reinforcement Questionnaire; QA=quit attempt; IDQ-S=Intolerance for Smoking Abstinence Discomfort Questionnaire; SEM=standard error of the mean. Model results are shown such that β represents the change in each IDQ-S scale score for a unit change in the associated baseline characteristic. Significant models are in boldface.

^aNoted as a 5-yr increase in age.

^bSex comparison is between female vs. male.

^cRace comparison is between White vs. Black and other.

^dEducation comparison is between high school equivalent or less vs. some college or college graduate.

^eNoted as a 10-cigarette increase.

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^fNoted as a 5-yr increase in years of regular smoking.

^gThe craving model was additionally adjusted for sex and age at which regular smoking was initiated.

Table 3

Multivariable Relationships between IDQ-S Scales and Treatment-Related Outcomes

Treatment Outcome	IDQ-S Withdrawal Intolerance			IDQ-S Lack of Cognitive Coping		
	β (SEM)	F statistic	p-value	β (SEM)	F statistic	p-value
Cue-elicited craving ^a	−0.04 (0.08)	$F_{1,80}=0.21$	.644	0.08 (0.08)	$F_{1,80}=1.02$	.316
Cue-elicited negative affect	0.00 (0.08)	$F_{1,82}=0.00$	.998	0.00 (0.08)	$F_{1,82}=0.00$	.999
CPD ^b	−0.73 (11.0)	$F_{1,67}=0.00$	.947	17.3 (10.5)	$F_{1,67}=2.71$	.105
CO level (ppm) ^c	−1.12 (1.63)	$F_{1,68}=0.48$	.493	1.62 (1.59)	$F_{1,68}=1.04$	.312
Cotinine level (µg/L) ^d	−44.5 (76.1)	$F_{1,69}=0.34$	.560	89.6 (71.3)	$F_{1,69}=1.58$	.213

Note. CPD=cigarettes per day; CO=carbon monoxide; ppm=parts per million; SEM=standard error of the mean. Results reflect multivariable models containing treatment assignment, study visit, and days between visits. Model results are shown such that β represents the change in treatment outcome variables for a unit change in IDQ-S scale score. Significant models are in boldface.

^aThe cue-elicited craving model was additionally adjusted for sex and age at which regular smoking was initiated.

^bThe CPD model was additionally adjusted for sex, age, and baseline negative affect.

^cThe CO model was additionally adjusted for race and baseline negative affect.

^dThe cotinine model was additionally adjusted for race.