



# Reward dependence moderates smoking-cue- and stress-induced cigarette cravings



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## HIGHLIGHTS

- Reward dependence predicted higher levels of smoking cue-induced craving.
- Reward dependence also predicted higher level of stress-induced craving.
- Dispositional traits are important in addressing triggered cravings.

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## ABSTRACT

**Background:** Cigarette cravings following exposure to smoking cues in a smoker's environment are thought to play an important role in cessation failure. The possibility that dispositional factors may impact cue-induced cravings, though intriguing, has received little attention. According to Cloninger's Tridimensional Personality Theory, factors such as reward dependence (RD), harm avoidance (HA), and novelty seeking (NS) may figure prominently in risk for addiction, as well as relapse, in individuals attempting to abstain from drug and alcohol use. Particularly interesting in this regard is the possibility that smokers with higher levels of RD, who are especially sensitive to reward signals, will have heightened craving reactions to smoking cues.

**Methods:** To that end, non-treatment-seeking nicotine dependent smokers ( $n = 96$ , mean age = 41.1, 47% African American, 17% Caucasian, 22% Hispanic, 19.3 cigs/day, FTND = 7.5) underwent a classic experimental cue-induction, during which they were exposed to imagery of: (1) smoking, (2) neutral, and (3) stress cues, and reported their cigarette cravings (0–100) before and after each exposure. Participants also completed the Tridimensional Personality Questionnaire.

**Results:** Not surprisingly, smoking and stress cues (but not neutral cues) elicited significant elevations in craving ( $p$ 's < 0.0001). Consistent with study hypothesis, smokers who scored higher on RD had stronger craving reactions to both smoking cues ( $p < .02$ ) and stress cues ( $p < .03$ ).

**Conclusions:** Findings raise the possibility that dispositional characteristics, in particular, reward dependence, influence smoking by potentiating reactions to environmental smoking cues. Furthermore, the similar effects of RD on stress-induced craving suggest that both cue- and stress-induced cravings may be influenced by a common underlying disposition.

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## 1. Introduction

Cigarette smoking is a major public health concern. The Centers for Disease Control and Prevention recently reported that although a majority of smokers aged 18 or older expressed a desire to quit and 52% had attempted to do so, only 6% of them had successfully quit at 12 months (CDC, 2011). Cigarette cravings figure prominently in smoking cessation failure. Prospective research has demonstrated that

smokers with high levels of cigarette craving during a quit attempt are more than twice as likely to experience a relapse as smokers with low levels of craving (Killen & Fortmann, 1997). In addition to the cravings that accompany withdrawal, research over the past several decades has highlighted the importance of environmental triggers, or cues, which can elicit cravings to smoke, even after acute symptoms of withdrawal subside during the early trajectory of a quit attempt (Ferguson & Shiffman, 2009). These “cue-elicited” cravings have been reliably modeled under laboratory conditions (e.g., Carter & Tiffany, 1999) and have been shown in some (e.g., Erblich & Bovbjerg, 2004, Waters et al., 2004), but not all (see Perkins, 2012) studies, to be related to increased likelihood of relapse. Similar studies (e.g., Erblich, Boyarsky,

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Spring, Niaura, & Bovbjerg, 2003; Sinha, Catapano, & O'Malley, 1999) have shown that stress can trigger strong cravings as well, and that craving responses to laboratory stressors are predictive of increased smoking behavior (McKee et al., 2011).

A separate line of research has demonstrated that personality factors may play an important role in the onset and maintenance of addiction (e.g., Munafo, Zettler, & Clark, 2007). In particular, Cloninger's (1986) Tridimensional Personality Theory has been postulated to be a potentially useful framework to understand addiction (Pomerleau, Pomerleau, Flessland, & Basson, 1992). Based on this theory, Cloninger (1987) developed the Tridimensional Personality Questionnaire [TPQ], which assesses three traits thought to be important in addiction: novelty seeking (NS), reward dependence (RD), and harm avoidance (HA). According to Cloninger (1987), novelty seeking is a tendency toward intense excitement in response to novel stimuli, which can lead high levels of boredom susceptibility, and the avoidance of monotony. Harm avoidance is a tendency to avoid aversive stimuli. Finally, reward dependence is a tendency toward excessive focus on behavioral reinforcement and external triggers of reward. Cloninger (1986, 1987) posited that these 'temperaments' are critical in the genesis and maintenance of addiction. Consistent with this possibility, Pomerleau et al. (1992) reported that Cloninger's TPQ scales were related to a number of smoking-related outcomes including smoking status and self-reported level of nicotine dependence.

Recent research has begun to investigate the potential interplay between personality factors and cue- and stress-induced cravings. For example, in a series of studies, Doran, Spring, and McChargue (2007), Doran, Cook, McChargue, Myers, and Spring (2008) found that impulsivity predicted heightened cue-induced craving and affective responses. To date, however, research has not addressed the possibility that RD, NS, and HA might predict cue-induced cravings. Particularly intriguing is the possibility that cue-induced craving is moderated by smokers' levels of RD; smokers' reward dependence may significantly impact the degree to which they respond to reward cues. Indeed, consistent with previous research by our group and others (e.g., Carter & Tiffany, 1999; Erblich & Bovbjerg, 2004; Styn, Bovbjerg, Lipsky, & Erblich, 2013), exposure to rewarding stimuli triggers strong craving reactions. Not yet explored is the possibility that smokers' background levels of reward dependence impact the intensity of cue-induced craving responses. In this study, we evaluated the role of RD in cue-induced craving. Specifically, we hypothesized that higher levels of RD will predict increased levels of cue-induced craving. In addition, given our previous results demonstrating the reward-seeking properties of exposure to stress (e.g., Erblich, Bovbjerg, & Diaz, 2012), we explored the possibility that RD would predict heightened stress-induced cravings as well. Finally, we explored the possibility that the other TPQ subscales (NS and HA) would also be predictive of changes in craving responses. Understanding the sources of variability in cue- and stress-induced craving responses continues to be important in the development of novel approaches to manage craving.

## 2. Materials and methods

### 2.1. Participants

Adult smokers ( $n = 96$ ) were recruited to an ongoing study of smoking behavior by advertisements placed in and around an urban medical center in New York City. Participants were a subset of those from an earlier report (Erblich & Bovbjerg, 2004) for whom data on Cloninger's Tridimensional Personality Questionnaire were available. Participants qualified for a current DSM-IV diagnosis of nicotine dependence (American Psychiatric Association, 1994) ascertained during initial telephone contact and re-ascertained in-person upon arrival using a structured clinical interview. As in the parent study, to qualify as a smoker, only participants who reported smoking at least 10 cigarettes per day for at least 5 years were included in the study.

Participants were excluded if they reported: 1) current treatment for smoking cessation, 2) a history of other substance abuse, or 3) a history of hospitalization for mental illness.

### 2.2. Measures

#### 2.2.1. Background questionnaire

Participants completed demographic (e.g., age, gender, education, income, ethnicity, marital status) and personal smoking history (e.g., age at initiation, cigarettes per day, years smoked) questionnaires.

#### 2.2.2. Fagerstrom Test of Nicotine Dependence (FTND)

The 6-item FTND was used as a measure of the strength of participants' dependence. The instrument has documented reliability and validity (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) and has been used extensively in the literature.

#### 2.2.3. Vividness of imagery

After each of the three imaginal exposures (neutral, stress and smoking), participants completed a four-item, face-valid (e.g., "How vivid did your images seem?", "How real did your images seem to you?") 0–25 scale of imagery strength. This instrument has been used in our previous work (Erblich & Bovbjerg, 2004; Erblich, Lerman, Self, Diaz, & Bovbjerg, 2005), and demonstrated strong internal consistency (Cronbach's alpha ranging from 0.85 to 0.92 for the three administrations) in the current sample.

#### 2.2.4. Tridimensional Personality Questionnaire [TPQ]

The TPQ is a 100-item true–false self-report instrument designed by Cloninger to identify the degree of each of the three personality traits [reward dependence (RD), harm avoidance (HA), and novelty seeking (NS)] in accordance with Cloninger's Unified Biosocial Theory of Personality (Cloninger, 1987). The instrument evidenced good internal consistency (Cronbach's alpha = 0.72), and was consistent with normative data for non-clinical samples (Cloninger, Przybeck, & Svrakic, 1991).

#### 2.2.5. Cigarette Craving Questionnaire

Improving on the use of single-item craving assessments, and following the recommendations of Kozlowski, Mann, Wilkinson, and Poulos (1989) and Kozlowski & Wilkinson (1987) that craving be assessed using multiple descriptors (e.g., crave, urge, desire), this brief, 5-item ("I have a desire for a cigarette right now," "If it were possible I would smoke now," "All I want is a cigarette right now," "I have an urge for a cigarette right now," "I crave a cigarette right now") 0–100 instrument is designed specifically to make rapid assessments of craving during experimental manipulations. The instrument has been used as an outcome measure in previous reports by us (Erblich et al., 2003) and others (Hutchison, LaChance, Niaura, Bryan, & Smolen, 2002). The instrument evidenced high levels of internal consistency (Cronbach's alpha = 0.96–0.97) at all administrations.

### 2.3. Procedures

Potential participants who responded to advertisements were screened via telephone to determine eligibility. The study was described over the phone, and if eligible, participants were scheduled for the study. Ninety percent of eligible respondents were enrolled in the study, and were scheduled for an in-person visit to the lab. To avoid ceiling effects in cigarette craving associated with cigarette deprivation, participants smoked one cigarette immediately before beginning the study procedures. Briefly, participants completed the questionnaires and were then exposed to a set of three imaginal cues (neutral, stress, smoking) in counterbalanced order. Participants listened to a 60-second script and were instructed to imagine the scene as vividly as possible, followed by a 30-second silent period,

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