

# Depression and Anxiety Symptoms Moderate the Relation Between Negative Reinforcement Smoking Outcome Expectancies and Nicotine Dependence

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**ABSTRACT. Objective:** Smoking reinforcement expectancies—expectations that smoking modulates mood—can be powerful motivators to smoke, resulting in increased nicotine dependence. The impact of smoking reinforcement expectancies on nicotine dependence may be particularly strong in individuals with increased mood or anxiety symptoms because they may be more likely to act on expectancies with smoking behavior in order to offset their affective symptoms. This study examined levels of emotional symptom dimensions as moderators of the relation between positive and negative smoking reinforcement expectancies and nicotine dependence severity in a community sample. **Method:** In a cross-sectional design, 317 daily cigarette smokers (215 men) completed self-report measures of smoking reinforcement expectancies, mood and anxiety symptoms, and nicotine dependence. **Results:** Increasing levels

of negative affect and anxiety symptoms strengthened associations between negative reinforcement smoking expectancies and nicotine dependence severity (moderation effects;  $\beta_s > .13$ ;  $ps < .03$ ) but did not moderate relations between positive reinforcement expectancies and dependence. Anhedonia did not moderate relations involving either positive or negative reinforcement smoking expectancies. **Conclusions:** Distinct components of anxiety and depressive symptoms interact differently with smoking reinforcement expectancies. Emotional symptoms characterized by excesses in aversive (but not deficits in appetitive) functioning may amplify tendencies to compulsively act on negative reinforcement expectancies by smoking. Cessation treatments that target negative reinforcement expectancies may be particularly salient for emotionally distressed smokers. (*J. Stud. Alcohol Drugs*, 75, 775–780, 2014)

**S**MOKING REINFORCEMENT EXPECTANCIES—beliefs that smoking modulates mood—associate with nicotine dependence, initiation and escalation of smoking, and motivation to quit (Brandon and Baker, 1991; Carmody et al., 2012; Heinz et al., 2010; Herd et al., 2009; Khoddam and Doran, 2013; Kristjansson et al., 2011; Pulvers et al., 2004). Parsing expectancies into beliefs that smoking (a) relieves negative affect (negative reinforcement) and (b) enhances pleasure and sensory satisfaction (positive reinforcement) (Brandon and Baker, 1991) could be informative as these two processes may reflect distinct motivational mechanisms that differentially affect problematic substance use etiology (Edwards and Koob, 2010).

Emotional symptomatology may play a role in the relation between reinforcement expectancies and smoking. Prior research found college students and young adults with history of major depression versus no depression history and higher dispositional negative affect reported stronger positive and

negative reinforcement smoking expectancies, which then predicted current smoking status as part of a meditational pathway (McChargue et al., 2004; Morrell et al., 2010). In an adult community sample, depression symptoms and depression proneness were positively correlated with greater smoking reinforcement expectancies (Friedman-Wheeler et al., 2007). Although prior work has shown a link between emotional symptoms and smoking, dimensions of emotional symptoms in nonclinical samples have not consistently correlated with nicotine dependence severity (see Ameringer and Leventhal, 2010, for review).

Smokers endorsing reinforcement expectancies are more likely to have such beliefs come to mind, which may directly engender their compulsion to smoke. We propose a moderational pathway whereby the extent to which reinforcement expectancies provoke smoking may be stronger among those with emotional symptomatology, as beliefs may translate into action for those with high levels of affective disturbance in need of regulation via smoking. By contrast, for those without emotional symptomatology, the compulsion to act on reinforcement expectancies with smoking might be less robust, given that they may have little need of smoking-induced mood modulation. This moderational pathway could be reflected in the accumulation of synergistic transactions between reinforcement expectancies and emotional symptomatology on the momentary compulsion to smoke that may accrue over time and ultimately affect nicotine dependence severity.

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In this cross-sectional study, we examined emotional symptoms as a moderator of the relation between smoking reinforcement expectancies and nicotine dependence. We parsed anxiety and depression symptoms using a tripartite model of anxiety and depression developed by Watson et al. (1995). We hypothesized an affect-specific process involving two dissociable moderational associations. First, we expected the relation of negative reinforcement smoking expectancies to nicotine dependence to be stronger in individuals expressing higher levels of anxious arousal (AA), general distress anxiety (GDA), and general distress depression (GDD), because such individuals might be more liable to act on expectations that smoking alleviates negative affect in order to offset their aversive symptoms. Second, we expected the relation of positive reinforcement expectancies to nicotine dependence to be stronger in individuals expressing high levels of anhedonic depression (AD) because such individuals might be particularly motivated to act on expectations that smoking enhances pleasure in order to counteract their deficient appetitive emotions. In addition to providing a preliminary test of potential etiological pathways leading from reinforcement expectancies to the compulsion to smoke as a function of emotional symptom status, these analyses may also inform (a) clinical use of emotional symptom measures to identify patients at high risk for experiencing elevated motivation to smoke and (b) tailored cessation treatment strategies that target negative reinforcement expectancies in emotionally distressed smokers.

## Method

### Participants

The current report is a secondary analysis of baseline data from non-treatment-seeking daily smokers recruited from the Los Angeles area via advertisements for a study on personality and smoking (Leventhal et al., 2013). The University of Southern California Internal Review Board approved all procedures, and all participants completed informed consent. Inclusion criteria required participants to be (a) at least 18 years of age, (b) a regular smoker for at least the past 2 years ( $\geq 10$  cigarettes/day), and (c) fluent in English. Exclusion criteria included (a) current nonnicotine substance dependence (based on criteria from the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* [DSM-IV]; American Psychiatric Association, 1994), (b) current DSM-IV mood disorder or psychotic symptoms attributable to potential interference by these conditions with behavioral tasks administered in experimental sessions following the baseline visit, (c) baseline breath carbon monoxide levels  $< 10$  ppm, (d) use of noncigarette forms of tobacco or nicotine products, (e) current use of psychiatric or psychoactive medications, (f) current pregnancy, and (g) planning to quit or to substantially reduce smoking in the next 30 days.

### Procedure

Following a preliminary telephone eligibility screening, participants attended a baseline session at the laboratory involving eligibility assessments including breath alcohol and carbon monoxide analysis and administration of the Structured Clinical Interview for DSM-IV Non-Patient Edition (First et al., 2002) by trained research assistants supervised by a licensed clinical psychologist. Eligible participants continued with the remainder of the baseline session, which involved completing the paper-and-pencil measures described below, for which they were compensated \$15.

### Measures

*Demographic and smoking questionnaire.* An author-constructed questionnaire assessed demographic and smoking characteristics.

*Predictor: Smoking Consequences Questionnaire.* Participants rate different expected effects of smoking on a scale from 1 (*not true of me at all*) to 7 (*very true of me*). The negative reinforcement subscale of the Smoking Consequences Questionnaire (SCQ; Brandon and Baker, 1991) assesses smoking to relieve aversive states (12 items). The positive reinforcement subscale of the SCQ addresses smoking enjoyment and sensory satisfaction (15 items). The SCQ has previously been shown to have good predictive validity of smoking and discriminant validity between the two expectancies subscales (Wetter et al., 1994).

*Moderator: Mood and Anxiety Sensitivity Questionnaire–Short Form.* For the Mood and Anxiety Sensitivity Questionnaire–Short Form (MASQ-SF; Clark and Watson, 1991; Watson et al., 1995), participants rate the extent to which they experienced emotional symptoms during the previous week on a scale from 1 (*not at all*) to 5 (*extremely*). The AA subscale focuses on somatic tension and arousal specific to anxiety (17 items). The GDA subscale assesses anxious/tense mood and other nonspecific anxiety symptoms (11 items). The GDD subscale assesses depressed/sad mood and other nonspecific depressive symptoms (11 items). The AD subscale assesses low interest, pleasure, and positive affect specific to depression (22 items). Previous studies have shown good discriminant validity among these scales and convergent validity with related emotional disturbance measures in nonclinical samples (Reidy and Keogh, 1997; Watson et al., 1995).

*Outcome: Fagerström Test of Nicotine Dependence.* The Fagerström Test of Nicotine Dependence (FTND; Heatherton et al., 1991) is a widely used six-item self-report measure of nicotine dependence severity. Scores range from 0 to 10, with higher scores indicating higher levels of dependence. Past work illustrates that the FTND demonstrates good predictive and convergent validity to other measures of nicotine dependence (Watson et al., 1995) and dependence-relevant

processes (Etter, 2005; Payne et al., 1994; Reidy and Keogh, 1997).

### Data analysis

Data were analyzed using IBM SPSS Statistics for Windows Version 21 (IBM Corp., Armonk, NY). Alpha was set at .05 for all analyses. Preliminary analyses involved reporting sample descriptives, correlations between key measures, and the internal consistency of the key measures. Primary analyses investigated a moderational effect of emotion symptoms on the predictive effects of smoking reinforcement expectancies on nicotine dependence. In the first step, we ran linear regression models including the predictor (i.e., a single smoking reinforcement expectancies SCQ subscale) and moderator (i.e., a single mood or anxiety symptom MASQ-SF subscale) variables as simultaneous predictors to examine their “main effects” on nicotine dependence. In the second step, we added the Predictor  $\times$  Moderator interaction term to the model to explore if the relation between the expectancy variable and nicotine dependence was moderated by the anxiety or depressive symptom variable. Demographics that significantly correlated with smoking reinforcement expectancies and/or mood and anxiety subscales were controlled for in the models. Separate models were examined for each possible combination of SCQ variable (positive or negative reinforcement) and MASQ-SF scale (AA, GDD, GDA, AD), leading to eight overall models being tested. To follow up on moderation findings, we performed simple slopes analyses using the macros provided by O'Connor (1998). Results are reported as standardized regression coefficients ( $\beta$ s).

### Results

On average, the sample was composed of moderate to heavily nicotine-dependent ( $M$  [ $SD$ ]: FTND = 5.36 [1.94]) middle-aged smokers ( $M$  [ $SD$ ]: age = 43.89 [10.71]). The ethnic distribution was 51.2% African American, 30.4% White, and 18.4% other. On average, our sample showed low severity of anxiety and depressive symptoms ( $M$  [ $SD$ ]: AA = 1.27 [0.37]; GDA = 1.37 [0.48]; GDD = 1.46 [0.57]; AD = 2.40 [0.64]) but wide inter-individual variability (range: AA = 1.00–3.12; GDA = 1.00–3.18; GDD = 1.00–4.00; AD = 1.00–4.36). Gender and age correlated with reinforcement expectancies and were included as covariates in all models. Other factors, including race, were not associated with expectancies. The measures in this study showed good to excellent internal consistency (Cronbach's  $\alpha$  = .86–.96), with the exception of FTND (Cronbach's  $\alpha$  = .59).

Baseline models including a single SCQ variable and a single MASQ variable as simultaneous predictors (interaction term excluded) showed smoking reinforcement expectancies (both positive and negative) significantly predicted nicotine dependence in all models ( $\beta$ s = .27–.31,  $p$ s < .001).

In these models, emotional symptoms did not significantly predict nicotine dependence ( $\beta$ s = -.09–.07,  $p$ s = .14–.77).

For models examining positive smoking reinforcement expectancies as the predictor of nicotine dependence, there was no evidence of moderation by any MASQ scale ( $\beta$ s for interaction terms = .05–.13,  $p$ s = .06–.39). For models examining negative reinforcement expectancies as the predictors, emotional symptoms related to negative affect and anxiety significantly moderated the effect of negative reinforcement expectancies on nicotine dependence ( $\beta$ s interaction terms = .14–.19,  $p$ s = .01–.03). AD did not moderate the relation of negative reinforcement expectancies to dependence ( $\beta$  = .11,  $p$  = .06).

Simple slopes analysis illustrated that degree of predictive effect of negative reinforcement expectancies on nicotine dependence was strengthened with increasing levels of negative affect and anxiety (Figure 1). The standardized simple slope for FTND regressed on negative reinforcement expectancies for individuals 1  $SD$  below the mean of GDD was .18 ( $p$  = .02), the slope at a mean level of GDD was .30 ( $p$  < .001), and the slope at 1  $SD$  above the mean level of GDD was .41 ( $p$  < .001; Figure 1). For GDA, the simple slope at 1  $SD$  below the mean was .19 ( $p$  = .01), .31 ( $p$  < .001) at the mean, and .44 ( $p$  < .001) at 1  $SD$  above the mean (Figure 1). Similarly, for AA, standardized slope was .17 ( $p$  = .03) at 1  $SD$  below the mean, .29 ( $p$  < .001) at the mean, and .41 ( $p$  < .001) at 1  $SD$  above the mean (Figure 1).

### Discussion

This study found that different domains of emotional symptoms differentially moderated relations between smoking reinforcement expectancies and nicotine dependence among daily smokers. Negative reinforcement smoking expectancies appeared to more strongly correlate with nicotine dependence among individuals expressing higher levels of emotional symptoms in domains dominated by negative affect, manifested as anxious arousal or distress.

Prior research indicates that smokers expressing higher levels of negative reinforcement smoking expectancies are more sensitive to nicotine-induced changes in psychophysiological indicators of negative affect (Robinson et al., 2012), which could amplify expectancy-dependence relations among those with anxiety and depressive symptoms characterized by negative affect. Multiple studies have also shown that higher pre-quit depressive and anxiety symptoms and syndromes predict poorer smoking outcomes (Brown et al., 2001; Cinciripini et al., 2003; Haas et al., 2004; Leventhal et al., 2008a; Piper et al., 2010, 2011; Zvolensky et al., 2008). Similarly, negative reinforcement expectancies have been shown to predict cessation success (Correa-Fernández et al., 2012; Wetter et al., 1994). Although these findings are limited by a cross-sectional design, they may reflect that although negative reinforcement expectancies could

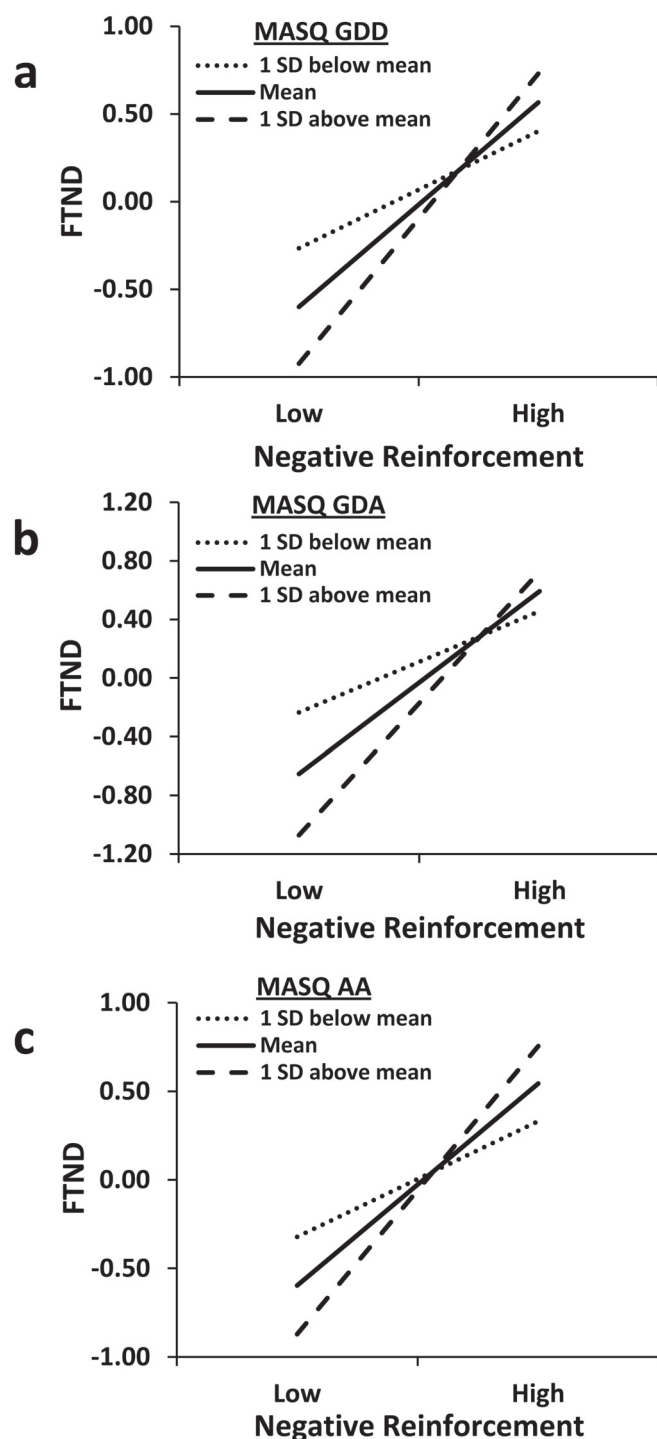


FIGURE 1. Simple slopes of negative reinforcement predicting nicotine dependence for general distress depression (GDD; Figure 1a), general distress anxiety (GDA; Figure 1b), and anxious arousal (AA; Figure 1c). Lines represent 1 *SD* below the mean, the mean, and 1 *SD* above the mean for each measure. The “low” and “high” measures of negative reinforcement represent 2 *SD* below and above the mean, respectively, on the Smoking Consequences Questionnaire–negative reinforcement subscale. Fagerström Test of Nicotine Dependence (FTND) score was standardized ( $M = 0$ ,  $SD = 1$ ) to facilitate ease of interpretation. MASQ = Mood and Anxiety Symptom Questionnaire.

provoke a compulsion to smoke in most smokers, individuals with concomitant negative affect–related anxiety and depressive symptoms may be particularly likely to act on these expectancies with smoking because of deriving greater smoking-induced mood modulation. As such, these findings have important implications for smoking interventions targeting those with higher levels of anxious and depressive symptoms. For instance, current results suggest that it may behoove clinicians to help emotionally distressed smokers learn about healthy alternatives to smoking in coping with aversive emotional symptoms (Kassel et al., 2003).

Our hypothesis, that anhedonia would moderate relations between positive reinforcement expectancies and nicotine dependence, was not supported. This is surprising given research showing that higher pre-cessation anhedonia predicts greater smoking relapse risk (Cook et al., 2010; Niaura et al., 2002; Zvolensky et al., 2009) and that individuals expressing high levels of anhedonia may smoke to offset positive affect deficits (Cook et al., 2007). Perhaps the extent to which anhedonia amplifies motivation to smoke to offset deficient positive affect is not manifested cognitively in terms of positive reinforcement expectancies. However, more research is needed examining the potential moderating effect of anhedonia.

Some limitations should be considered when interpreting current results. First, we used a non-treatment-seeking sample and cross-sectional design. Thus, results may not generalize to individuals seeking to quit smoking and do not allow for causal inferences. Second, only a single self-report measure of emotional symptoms was used. Although the MASQ-SF is a well-validated measure (Reidy and Keogh, 1997; Watson et al., 1995), additional measures would enhance the validity of our findings. We also removed individuals with a current mood disorder because of restrictions of the parent study. This raises the possibility that our range of scores was restricted (i.e., floor effect) and raises questions as to whether results would generalize to the severe end of the mood spectrum. Individuals with current anxiety disorders were not excluded; thus, there is the possibility that there may have been differential restriction of range across MASQ-SF scales for depression versus anxiety. However, visual inspection of the range of scores across the MASQ-SF subscales did not suggest more range restriction for anxiety versus depression scores, which potentially offsets this concern. Furthermore, prior work illustrates that inter-individual variation at low levels of depressive symptoms and among those without a current mood disorder predicts smoking cessation failure (Leventhal et al., 2008b; Niaura et al., 2002), which suggests that our findings may be clinically meaningful. Last, although the FTND is a common measure used to assess for nicotine dependence severity in clinical and research settings, its psychometric properties are not ideal (Etter et al., 1999; Payne et al., 1994), and it only exhibited modest internal consistency in this sample. Hence,



measurement error may have led to underestimation of the strength of relations to nicotine dependence reported in this sample.

Despite these limitations, current results highlight the importance of distinguishing between positive and negative reinforcement expectancies in smoking research, as these different expectancies may play unique roles for emotionally distressed smokers. Current findings also indicate that it may benefit scientists and practitioners to distinguish depressive symptoms that reflect excesses in aversive emotions (i.e., general distress) from those that reflect deficits in appetitive emotion (i.e., anhedonia), as the former may demarcate those in which nicotine dependence is more closely aligned with negative reinforcement expectancies.

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