Do Individual Differences in Reinforcement Smoking Moderate the Relationship Between Affect and Urge to Smoke?

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The elucidation of individual differences in tobacco use motivation is of considerable interest. Accordingly, the present study tested the hypothesis that between-person variation in reinforcement smoking (RS)—a tendency to smoke to regulate affect—moderates the relationship between poor mood and urge to smoke. In this cross-sectional, correlational study, smokers (N = 212; \( \geq 5 \) cig/day) completed measures of RS, positive affect (PA), negative affect (NA), and smoking urge. RS significantly moderated the relation between PA and urge (\( \beta_s > .11, p_s < .04 \)), such that the inverse correlation between PA and urge was stronger among smokers higher in RS. NA was positively correlated with urge in the overall sample (\( r_s = .34, p_s < .0001 \)), but RS did not moderate this relationship. The overall results were consistent across 2 measures of mood and adjusted models that controlled for demographics and smoking characteristics. Continued investigation of these moderational pathways could identify which smokers may benefit most from treatments that target mood during smoking cessation.

Keywords: negative affect, positive affect, reinforcement smoking, smoking motivation, urge to smoke

There is considerable variation in the motivational determinants of smoking behavior across individuals. Identification of the factors that account for this variability is important to: (a) elucidate individual differences in the etiology of tobacco dependence and (b) provide information for tailoring smoking cessation treatments to a person’s particular motivational profile.

The Situation \( \times \) Trait Adaptive Response (STAR) model of smoking\(^3\) is a useful framework for understanding individual differences in tobacco-seeking behavior. The STAR model makes several hypotheses, including: (1) smoking is frequently mediated by anticipation of improved affective and cognitive states and (2) motivation to smoke is determined by the interaction of trait dispositions and state-specific circumstances. One trait that is pertinent to the STAR model is a tendency to smoke to modulate mood. This trait has been conceptualized in various ways throughout the literature, with multiple subfacets that are often intercorrelated (e.g., smoking for negative affect reduction,\(^4-6\) anxiety reduction,\(^5,7\) anger reduction,\(^5\) depression reduction,\(^5\) pleasurable relaxation,\(^4\) pleasure enhancement,\(^5,7\) positive reinforcement,\(^1\) negative reinforcement\(^7\)). The overarching construct, which bridges across these overlapping conceptualizations, is termed reinforcement smoking (RS), which is indicative of a general propensity to smoke in order to regulate affect.\(^8\) RS varies in degree across individuals. Some smokers report little or no propensity to smoke to improve their mood, whereas others report high propensity to smoke for mood regulation purposes. Although research indicates that RS is associated with the tendency to experience more frequent and severe smoking urges,\(^1\) little is known about the circumstances that interact with RS to elicit the urge to smoke. Given the affective nature of RS, it is possible that individual differences in RS may interact with mood to influence the urge to smoke. Specifically, poor mood may induce strong urges to smoke among individuals who are high in RS. Alternatively, poor mood may have little or no effect on smoking urges in low-RS smokers.

Poor mood is a multidimensional construct. Multifactorial models of mood identify 2 independent dimensions of positive (PA) and negative (NA) affect.\(^9\) PA involves the experience of positive emotions (e.g., feelings of joy, interest,
alertness). In contrast, NA is associated with the experience of aversive emotions (e.g., sadness, irritability, anxiety, agitation). These 2 dimensions are psychometrically distinct, associate with different neural underpinnings, and have unique psychosocial correlates. Thus, individuals experiencing low PA may not necessarily have high NA, and vice versa. Accordingly, poor mood may involve low PA, high NA, or both. Because low PA and high NA associate with different smoking-related variables, examination of the interrelation between RS, poor mood, and smoking urge is most informative if low PA and high NA are distinguished from each other.

This study was an initial test of the hypothesis that RS moderates the relationship between affect and urge to smoke. To test this prediction, a cross-sectional, correlational design was employed in a sample of 212 current smokers. It was expected that both aspects of poor mood (i.e., low PA and high NA) would correlate with smoking urge to a greater degree among those individuals with higher (versus lower) levels of RS.

METHODS

Participants

Participants were 212 current smokers enrolled at a southwestern university who were recruited to participate in a larger study on the cognitive effects of acute tobacco deprivation. The inclusion criteria were that individuals: (1) report normal or corrected-to-normal vision, (2) be 18 years of age or older, and (3) report smoking 5 or more cigarettes per day on average for the past 2 years. Individuals were excluded if they (a) planned to quit in the next 30 days, (b) were currently cutting down substantially, (c) were currently using some form of nicotine replacement therapy, or (d) could read or speak Chinese (1 of the cognitive tasks in the larger study required participants to rate Chinese ideographs intended to be novel).

The sample was predominately female (66.7%), with an average age of 24.3 years ($SD = 6.4$; range: 18–57); 9.2% self-identified as African-American, 15.5% as Asian or Pacific Islander, 66.2% as Caucasian, 6.8% as Hispanic, and 3.4% as Middle Eastern. On average, participants smoked 14.9 ($SD = 6.2$) cigarettes per day and had been smoking regularly for 6.5 ($SD = 6.2$) years. Participants had a mean Fagerström Test for Nicotine Dependence (FTND) score of 3.9 ($SD = 2.1$). Fagerström et al suggested that FTND scores of 0–2 indicate very low dependence, 3–4 indicates low dependence, 5 indicates medium dependence, 6–7 indicates high dependence, and 8–10 indicates very high dependence. Thus, most of the participants in this sample exhibited low to medium levels of dependence.

For completing the study, participants received a $15 voucher redeemable at a department store and course credit. Participants provided written informed consent, and the study was approved by the university’s Institutional Review Board.

Procedure

Participants initially attended a baseline session in which they completed several questionnaires. On a subsequent day, they attended an experimental session involving a tobacco deprivation manipulation and cognitive assessment. The present study focuses on the baseline session, because smoking behavior prior to arriving at that session was ad libitum, resulting in levels of craving and affect that should approximate typical daily experience.

Measures

Smoking History Questionnaire

This author-constructed measure assessed years of smoking, number of cigarettes smoked per day, and other smoking characteristics.

Fagerström Test for Nicotine Dependence (FTND)

The FTND is a widely used and well-validated measure of nicotine dependence severity.

Positive and Negative Affect Schedule (PANAS)

The PANAS was used to measure affect over the past week. It has 2 separate 10-item subscales to assess PA and NA, which are computed by averaging responses to the 10 items within each scale. These scales have evidenced excellent reliability, convergent validity with relevant correlates, and discriminant validity from each other.

The Center for Epidemiologic Studies Depression Scale (CESD)

The CESD was used as an alternate measure of affect. It is a 20-item, well-validated, self-report scale that has been widely used to assess depressive symptoms over the past week in nonclinical populations. Prior studies have consistently found a 4-factor structure of the CESD that distinguishes NA, PA, somatic features, and interpersonal problems as psychometrically distinct dimensions. Thus, as in previous research, separate PA (hopeful about future, enjoyed life, felt as good as others, was happy) and NA (felt sad, crying spells, could not shake blues, felt depressed, felt lonely, felt fearful, life is a failure) subscales were computed by averaging the responses for the respective items for each of these scales. These subscales have evidenced good reliability and validity in a prior sample of smokers.
Wisconsin Inventory of Smoking Dependence Motives (WISDM)\(^1\)

The WISDM is a trait-level, 68-item questionnaire that assesses several domains of tobacco dependence motives. Items are self-statements rated on a 7-point scale, anchored with “not true of me at all” and “extremely true of me.” The original WISDM scoring algorithm produced 13 subscales, some of which have been shown to be highly intercorrelated.\(^8\) Accordingly, the WISDM developers have used factor analysis techniques to develop a new scoring algorithm that drops redundant items and subscales and consolidates the measure into 10 psychometrically distinct subscales.\(^8\) The original Positive and Negative Reinforcement Scales, which were intended to distinguish appetitive and aversive motivation, have been strongly correlated in previous samples \((rs = .79–.80)^1,14\) and were found to be psychometrically redundant in the subscale consolidation analysis.\(^8\) Accordingly, these scales were consolidated into a single 3-item Reinforcement Smoking (RS) scale, which measures a tendency to smoke for general mood modulation purposes (“Smoking a cigarette improves my mood,” “Smoking helps me feel better in seconds,” and “Smoking really helps me feel better if I have been feeling down”). Similarly, the original Loss of Control scale and Tolerance scale were consolidated into a 3-item Heavy Smoking (HS) scale (“I’m really hooked on cigarettes,” “I smoke within the first 30 minutes of awakening in the morning,” “I consider myself a heavy smoker”). The present study uses the updated scoring algorithm and consolidated RS and HS scales, which have demonstrated excellent reliability and validity.\(^8\) The WISDM-RS scale was used as the primary measure of the RS construct. The WISDM-HS scale was used as a marker of nonaffective smoking motivation to compare findings against the RS scale.

Questionnaire for Smoking Urges–Brief (QSU)\(^24\)

This 10-item scale assesses current smoking urge. It has evidenced excellent psychometric properties in previous samples.\(^24\) Items are self-statements of urge states (e.g., “I have a desire for a cigarette now” and “All I want right now is a cigarette”). Participants are asked to indicate how strongly they agree or disagree with each item on the questionnaire using a scale from 0 (strongly disagree) to 5 (strongly agree). A composite score is calculated by averaging the responses to the 10 items.

Data Analyses

Preliminary analyses of internal consistency and intercorrelations among key variables were conducted to explore the overlap between predictor, moderator, and outcome variables. To examine whether RS moderated the influence of affect on urge, regression models were tested in which affect was the predictor variable, WISDM-RS was the moderator variable, and QSU was the outcome variable. Separate regression models were run for each affect predictor variable (PANAS-PA, CESD-PA, PANAS-NA, and CESD-NA). For comparative purposes, these analyses were repeated with WISDM-HS substituted as the moderator variable to examine if moderation of the affect-urge link was specific to RS, or was also present across a nonaffective measure of smoking motivation. The effect of the interaction between the predictor and moderator was reported in two sets of models: (1) a baseline model controlling the predictor and moderator; and (2) an adjusted model controlling for the predictor, moderator, demographics (age, sex), and smoking characteristics (FTND, cig/day, years smoking). The adjusted model tested whether moderating effects were incremental to overlapping variance with demographic and smoking characteristics. Significant interactions were deconstructed by examining the affect-urge correlation in subsamples separated on a median split of the moderator variable. Ethnicity was not controlled for because it did not significantly associate with any predictor or moderator variable. Supplemental analyses using the original WISDM Positive and Negative Reinforcement scales as the moderator variable that parallel those analyses mentioned previously were also conducted. Alpha was set at .05 and all tests were 2-tailed. All regression models were tested in SAS.\(^25\)

RESULTS

Descriptive statistics, Cronbach \(\alpha\)s, and intercorrelations among key variables are reported in Table 1. The mean of QSU scores indicated that the average level of craving was moderate, and that there was adequate variability across the craving continuum. The internal consistency of each key variable was adequate. The WISDM-RS was correlated with both NA scales, but was not significantly associated with PA. QSU scores were inversely correlated with both PA scales and positively correlated with both NA scales, WISDM-RS, and WISDM-HS (see Table 1).

Regression analyses indicated that the relation between PA and QSU was significantly moderated by WISDM-RS (see Table 2). The moderating effect was significant for both measures of PA and was not reduced in models that controlled for demographics and smoking characteristics. By contrast, WISDM-RS did not significantly moderate the relationship between NA and QSU for either measure of NA. Comparative analyses showed that WISDM-HS did not significantly moderate the effect of any affect predictor on QSU (see Table 2).

To deconstruct the significant interaction, the sample was categorized into High-RS and Low-RS based on whether participants scored above or below the median WISDM-RS score of 4.0. Among High-RS participants \((n = 94)\), the inverse correlations between PA and QSU were robust for both PANAS-PA \((r = −.37, p = .0003)\) and CESD-PA \((r = −.35, p = .0006)\). Among Low-RS participants \((n = 95)\), the corre-
The 2 scales were highly correlated with each other ($r = .16$).

Supplemental analyses using the original WISDM Positive and Negative Reinforcement Scales were also performed. The 2 scales were highly correlated with each other ($r = .84$). Consistent with the primary analyses, both reinforcement scales significantly moderated the effects of PANAS-PA and CESD-PA on QSU and did not significantly moderate the effects of NA scales on QSU.

**COMMENT**

This study tested the hypothesis that the association between poor mood and urge to smoke was moderated by RS. Results of this cross-sectional, correlational study partially supported the hypothesis. Moderation was found only for the low PA aspect of poor mood, but not for the high NA aspect of poor mood. The direction of the moderational pathway involving PA was in line with expectations and consistent across 2 measures of PA (the PANAS and CESD). Among people high in RS, the inverse relationship between PA and smoking urge was robust. Among people low in RS, the relationship between PA and smoking urge was weak and nonsignificant. These moderational effects remained significant when controlling for demographics and smoking characteristics. By contrast, comparative analyses showed that the WISDM-HS, a nonaffective measure of smoking motivation, did not significantly moderate affect-urge relationships. Thus, moderation of the PA-urge link was specific to the tendency to smoke for affect regulation purposes. This study also found that smoking urges had univariate associations with RS, NA, and low PA, which is generally consistent with previous reports.1,14

Some extant data exists regarding moderation of the PA-urge association by constructs relevant to RS. In a laboratory

<table>
<thead>
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<th>Scale</th>
<th>$M^a$</th>
<th>$SD^a$</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. QSU</td>
<td>2.14</td>
<td>1.13</td>
<td>(.92)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. PANAS-PA</td>
<td>3.32</td>
<td>0.81</td>
<td>−0.23</td>
<td>***</td>
<td>(.90)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. PANAS-NA</td>
<td>2.30</td>
<td>0.78</td>
<td>0.34</td>
<td></td>
<td>−0.33</td>
<td>†</td>
<td>(.86)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. CESD-PA</td>
<td>2.09</td>
<td>0.74</td>
<td>−0.27</td>
<td>†</td>
<td>0.65</td>
<td>†</td>
<td>−0.50</td>
<td>†</td>
<td>(.82)</td>
</tr>
<tr>
<td>5. CESD-NA</td>
<td>0.63</td>
<td>0.61</td>
<td>0.34</td>
<td>†</td>
<td>−0.46</td>
<td>†</td>
<td>0.68</td>
<td>†</td>
<td>−0.62</td>
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<tr>
<td>6. WISDM-Reinforcement Smoking</td>
<td>3.96</td>
<td>1.50</td>
<td>0.59</td>
<td>†</td>
<td>−0.07</td>
<td>0.29</td>
<td>†</td>
<td>−0.13</td>
<td>0.27†</td>
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<tr>
<td>7. WISDM-Heavy Smoking</td>
<td>4.42</td>
<td>1.57</td>
<td>0.43</td>
<td>†</td>
<td>0.01</td>
<td>0.16†</td>
<td>−0.03</td>
<td>0.10</td>
<td>0.45†</td>
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</table>

*Note. N = 212. Values on the diagonal in parentheses are Cronbach $\alpha$ for each measure.

*aValues based on average score per item. QSU = Questionnaire of Smoking Urges—Brief (range 0–5); PANAS = Positive and Negative Affect Schedule (range 1–5), PA = Positive Affect, NA = Negative Affect; CESD = Center for Epidemiologic Studies Depression Scale (range 0–3), PA = Positive Affect, NA = Negative Affect; WISDM = Wisconsin Inventory of Smoking Dependence Motives (range 1–7).

$^b$Interaction effect controlling for predictor variable and moderator variable.

$^c$Interaction effect controlling for predictor variable, moderator variable, age, sex, FTND, cig/day, and years smoking. QSU = Questionnaire of Smoking Urges—Brief; PANAS = Positive and Negative Affect Schedule, PA = Positive Affect, NA = Negative Affect; CESD = Center for Epidemiologic Studies Depression Scale, PA = Positive Affect, NA = Negative Affect.
study, Brandon et al. examined the moderational role of smoking outcome expectancies—a cognitive construct indicative of beliefs about the expected reinforcing effects of smoking. Smokers were randomly assigned to either a positive or negative experimental mood induction and were either deprived or nondeprived from tobacco. Current state-level smoking reinforcement expectancies, affect, and urge were measured after the mood induction. Among tobacco-deprived smokers, positive reinforcement expectancies moderated the relationship between PA and post–mood induction urge when controlling for pre-induction urge. This interaction effect was not found in nondeprived smokers (results were not reported separately by mood induction condition). The direction of the interaction was such that deprived smokers with both high positive reinforcement expectancies and high PA reported the highest urge to smoke after the mood induction. This study’s interaction was in a different direction (i.e., participants with both low PA and high RS reported the highest urge). There are several differences between Brandon et al. and this study that could explain the incongruent findings. First, Brandon et al. measured current expectancies using a state-level questionnaire assessed at post–mood induction, whereas the current report used the WISDM-RS scale, which measures motivation to smoke for mood modulation at the trait-level. Second, the interaction found in Brandon et al. was evident only among deprived smokers following a mood induction. In this study, there was no mood manipulation, and participants were assessed after smoking ad libitum to approximate their daily experience. Thus, it is possible that moderational pathways involving PA, RS-related constructs, and urge operate in a unique fashion when smokers are in an affectively charged state (i.e., after a mood induction and during nicotine withdrawal). To address this question, it would be informative for future studies to examine whether trait-level differences in RS moderate the influence of experimentally-induced poor mood on smoking urge.

RS did not moderate the relationship between NA and smoking urge. Although it was predicted that both aspects of poor mood would have a moderational effect, evidence that PA and NA display disparate effects is consistent with previous research in the tobacco literature. For example, McChargue et al. found that the effect of low PA on severity of nicotine dependence was mediated by neuroticism, whereas the effect of NA on nicotine dependence was not mediated by neuroticism. The univariate analyses in this report indicate robust associations between NA and urges in the entire sample. The lack of moderation by NA indicates that the relationship between NA and urge to smoke remained consistent across smokers with differing levels of RS. This finding is concordant with the notion that NA is the predominant motive for addictive drug use across individuals. By contrast, the potential influence of PA on motivation to smoke may be more substantial only for certain groups of smokers (e.g., smokers who are high in RS).

Although not a primary aim, this study also examined correlations between RS and affect. According to the STAR model, individuals with higher NA and lower PA should exhibit a greater tendency to engage in RS to overcome their affective disturbance. Indeed, a previous study found that neuroticism, a trait closely linked to NA, was associated with a tendency to smoke to alleviate negative affect; no PA-related trait was reported. In this investigation, a global measure of RS was significantly correlated with NA, but not with PA. It is unclear why the findings with NA were consistent with prior theory and research, whereas findings with PA were not. Potentially, a scale that specifically measures the tendency to smoke to enhance pleasure may demonstrate stronger relations with PA than the more general WISDM-RS scale used in this study demonstrated.

This investigation had some limitations. A cross-sectional, correlational design was used, which precludes causal and temporal interpretations and the relationships exhibited herein. The sample was generally limited to young adult smokers with moderate levels of nicotine dependence, and it is unclear whether these findings will generalize to older smokers with more severe nicotine dependence. Similarly, participants in the study did not report substantial levels of affective distress, leaving uncertain whether these results will extend to smokers with more severe affective dysregulation, who represent a sizeable portion of the population of smokers. The primary measure of RS was the consolidated 3-item WISDM-RS scale calculated using the updated scoring algorithm. Supplemental analyses using the original WISDM positive and negative reinforcement scales found that both scales moderated the PA-urge association. However, as in previous samples, these 2 scales were highly correlated with each other, leaving unclear whether distinct subfacets of RS display different patterns of moderational effects. Accordingly, further examination of these moderational pathways using a measure that distinguishes different subfacets of RS would be informative.

Limitations notwithstanding, this study provides initial evidence that RS moderates the link between low PA and urge to smoke such that high-RS smokers may experience the strongest smoking urge under conditions of low PA. If these findings were replicated and extended, one could speculate that smoking cessation treatments that raise PA may perhaps attenuate the urge to smoke among individuals who sit higher on the RS continuum, which could have a positive impact on cessation outcomes in this group of smokers. Continued investigation of these moderational pathways could identify which smokers may benefit most from treatments that target mood during smoking cessation.

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