# Hostility as a Predictor of Affective Changes During Acute Tobacco Withdrawal

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## ABSTRACT

**Introduction:** Hostility—a personality trait reflective of cynical attitudes and a general mistrust of others—is associated with smoking status and relapse risk. Yet, the mechanisms linking hostility and smoking are not entirely clear. In this lab study, we tested a socioaffective model that purports that high-hostility individuals smoke to cope with maladaptive social mood states (i.e., anger and low friendliness), which become expressed and exacerbated during acute tobacco withdrawal.

**Methods:** Following a baseline visit at which trait hostility was assessed, adult smokers ($n = 153$, ≥10 cig/day) attended two counterbalanced lab visits: a deprived session following 16 hr of deprivation, and a nondeprived session. At both lab visits, affect and withdrawal symptoms were assessed at a single time point.

**Results:** Higher trait hostility predicted larger deprivation-induced increases in several forms of negative affect (anxiety, depression, confusion; $\beta s \geq .20$, $p s \leq .01$) and a composite tobacco withdrawal symptom index ($\beta = .16$, $p = .04$) but did not predict changes in positive emotions. These effects persisted after statistically controlling for gender, nicotine dependence, and depression. Other aspects of trait aggression (i.e., verbal aggression, physical aggression, anger) did not predict deprivation-induced changes in affect and withdrawal other than state anger.

**Discussion:** High-hostility individuals appear to experience generalized exacerbations in several negative affective states during acute tobacco withdrawal. Increases in negative affect during tobacco withdrawal may motivate negative reinforcement-mediated smoking and could underlie tobacco addiction in high-hostility smokers.

## INTRODUCTION

Individual differences in personality traits may be important factors that underlie the development and maintenance of tobacco addiction (Kahler et al., 2010; Leventhal et al., 2012). Understanding the mechanisms through which personality traits increase vulnerability to persistent smoking behavior can lead to the development of novel smoking cessation treatments tailored to personality profiles. In addition, such information may advance theoretical models of tobacco addiction in psychologically vulnerable populations.

Of the traits currently under investigation in smoking research, hostility is particularly important to study because it consistently associates with smoking characteristics and is a robust risk factor for cardiovascular disease and a number of health damaging behaviors. (Miller, Smith, Turner, Guijarro, & Hallet, 1996; Whiteman, Fowkes, Deary, & Lee, 1997). Individual differences in hostility lie on a continuum characterized by cynical attitudes and a general mistrust of others and often relates to emotional and behavioral expressions of aggression (Miller et al., 1996). In addition to associating with smoking status (Kahler, Daughters, et al., 2009; Lipkus, Barefoot, Williams, & Siegler, 1994; Whiteman, et al., 1997), hostility and its related traits also associate with characteristics indicative of persistent forms of tobacco dependence, including risk of relapse following cessation. (Kahler, Spillane, et al., 2009; Kahler, Strong, Niaura, & Brown, 2004). Importantly, the relation between hostility and smoking status and relapse risk remains even after controlling for other measures of negative affect (Kahler, Daughters, et al., 2009; Kahler, Spillane, et al., 2009; Kahler, et al., 2004), which suggests that hostility is not solely a proxy for trait affect disturbance but rather a unique predictor of smoking characteristics. Despite consistent evidence of the association between hostility and smoking, the mechanisms underlying this relation are poorly understood.

## Hostility and tobacco withdrawal

The Situation × Trait Adaptive Response (STAR) model of smoking is relevant to understanding how maladaptive psychological traits, such as hostility, might increase vulnerability to tobacco addiction (Gilbert, 1995). The STAR model hypothesizes that (a) smoking is commonly mediated by anticipation of improved affective and cognitive states and (b) motivation to smoke is determined by the interaction of trait dispositions and state-specific circumstances. Based on this notion, individuals who carry certain psychological traits may be more sensitive to the affect-modulatory properties of smoking, which could enhance addiction risk in such individuals. Following from the STAR model and tenets put forth by Kahler, Leventhal, et al. (2009), we propose a socioaffective model of the mechanisms linking hostility and persistent smoking. This model purports that smokers with higher levels of hostility smoke in order to modulate maladaptive socioaffective mood states characteristic of hostility, such as low friendliness and high anger. That is, high-hostility smokers may experience particularly pronounced reductions in anger following smoking and may also experience a greater boost in feelings of friendless when smoking, such that smoking may potentially modifying these specific mood states to the point that they reach levels similar to low-hostility individuals. However, during abstinence, preexisting mood levels may be expressed and magnified by nicotine withdrawal (i.e., pronounced increases in anger and decreases in friendliness). In other words, during tobacco withdrawal states, the aversive mood state of anger may be experienced at particularly heightened levels, while the appetitive mood state of friendless may be experienced at particularly deficient levels among high-hostility smokers. These withdrawal-related affective changes could underlie motivation to resume smoking in order to modify this undesired mood profile to alleviate the aversive social mood state (i.e., anger) and enhance the deficient appetitive social mood state (i.e., friendliness). Altogether, these processes could explain hostility's influence on persistent and relapsing forms of tobacco dependence (Kahler, Spillane, et al., 2009; Kahler, et al., 2004).

There is preliminary support for this socioaffective model of hostility and persistent smoking. Nicotine appears to have anger-reducing effects in high-hostile, but not in low-hostile, individuals (Jamner, Shapiro, & Jarvik, 1999), which indicates that smoking may counteract maladaptive socially relevant emotions associated with hostility. A separate study showed that immediate (vs. delayed) smoking offset increasing negative mood following a laboratory-based social stressor, particularly among smokers with high levels of hostility (Kahler, Leventhal, et al., 2009). Further, a study of treatment-seeking smokers showed that higher hostility predicted higher levels on a composite measure of withdrawal symptoms when assessed 1 week after quit date (Kahler, Spillane, et al., 2009).

Despite preliminary evidence in support of the model, several aspects of the mechanisms underlying hostility's link with persistent smoking remain unclear. For one, there has been no systematic evaluation of the various affective changes that occur during tobacco abstinence as a function of hostility. Extant research has explored composite measures of withdrawal symptoms or negative affect (Kahler, Leventhal, et al., 2009; Kahler, Spillane, et al., 2009). Illustrating that social mood states particularly characteristic of hostility (i.e., low friendliness, high anger) are disproportionately exacerbated by tobacco abstinence as a function of hostility would clarify if smoking cessation treatment for high-hostile individuals

should target socially relevant mood states in particular, or affective disturbance more broadly. Another gap in the mechanisms literature is the discriminant validity of hostility per se in comparison to other personality constructs related to aggression. Prior smoking cessation outcome data illustrates that the sociocognitive construct of hostility may be a more robust predictor of smoking cessation outcome than other verbal, behavioral, and emotional aggressive traits (Kahler, Spillane, et al., 2009). Illustrating that hostility but not other components of aggression are related to particular affective changes during acute tobacco abstinence would further refine knowledge of the role of personality traits in tobacco addiction and could narrow the target for developing smoking cessation treatments tailored to personality.

To this end, this study tested elements of the socioaffective model of hostility and persistent smoking among adult nontreatment-seeking daily smokers taking part in a laboratory study of experimentally manipulated acute tobacco deprivation effects. Following prior work (Leventhal et al., 2007), we utilized a within-subjects method to study mood on deprived and nondeprived days in order to measure abstinence-induced changes from baseline (nondeprived) levels. We hypothesized that increased trait hostility would predict greater deprivation-induced increases in anger and reductions in friendliness but would not associate with deprivation-induced changes in other mood states. We further hypothesized that hostility and affective changes during tobacco deprivation would more robustly relate than other corresponding aggressive traits (verbal, physical, and emotional aggression) and deprivation-induced changes in emotion.

## METHODS

### Participants

Participants were 230 community-dwelling nontreatment-seeking smokers who responded to postings and advertisements offering the opportunity to participate in a study on personality and smoking. Inclusion criteria were (a) ≥18 years of age; (b) regular cigarette smoker for ≥2 years; (c) currently smoking ≥10 cigarettes daily; (d) normal or corrected-to-normal vision; and (c) fluent in English. Exclusion criteria were (a) current *DSM-IV* nonnicotine substance dependence; (b) current *DSM-IV* mood disorder or psychotic symptoms; (c) breath carbon monoxide (CO) levels <10 ppm at intake to screen out individuals who might be over-reporting their smoking; (d) use of noncigarette forms of tobacco or nicotine products; (e) current use of psychiatric or psychoactive medications; and (f) currently pregnant. Participants were paid approximately $200 for completing the study. Participants who were ineligible (*n* = 57), dropped out (*n* = 18), or twice failed to meet abstinence criteria at the deprived session (*n* = 2; see below for more details) were excluded from analyses, leaving a final sample of 153 participants. The Institutional Review Board of the University of Southern California approved the protocol.

### Procedure

After completing a telephone screen, participants attended an in-person baseline study session and completed informed

consent; breath CO analysis; a psychiatric interview; and measures of personality, psychopathology, and smoking.

Eligible participants then completed two counterbalanced experimental sessions. One was a deprived session in which participants were asked not to smoke 16 hr before the start of the session. For the nondeprived visit, participants were instructed to smoke normally. These two sessions occurred within 3–7 days of each other.

Participants completed a breath alcohol analysis at the beginning of each session. If the reading was positive (Breath Alcohol Content at the appropriate line > .000 g/dl), the session was terminated and rescheduled for a different day. The procedures were identical for the two experimental sessions except that participants smoked a cigarette of their preferred brand in the laboratory at the beginning of the nondeprived session prior to providing an exhaled CO reading in order to standardize deprivation level. The deprived session began with a CO assessment. Previous studies (Leventhal, Waters, Moolchan, Heishman, & Pickworth, 2010; SRNT, 2002) indicate that "recent smoking" is indicated by a CO measurement of 10 ppm or greater. Participants with CO indicating that they were nondeprived (≥ 10 ppm) at their deprived session could return later that week for a second attempt to complete their deprived session (*n* = 9). Those with CO ≥10 ppm on their second attempt were disqualified from completing the study (*n* = 2). Following the CO assessment, participants were administered measures of nicotine withdrawal and affect at a single time point, which served as the primary outcome in this study.

**Measures—Baseline Session**

*Structured Clinical Interview for DSM-IV Nonpatient Edition*
Psychiatric eligibility was established using the mood disorder, psychotic screen, and substance use disorder modules from the Structured Clinical Interview for DSM-IV Nonpatient Edition (SCID-NP; First, Spitzer, Gibbon, & Williams, 2002).

*Demographic and Smoking History Questionnaire*
This author-constructed survey was used to obtain demographic and smoking characteristics (e.g., cigarettes smoked per day, age of smoking onset).

*Fagerström Test of Nicotine Dependence*
The Fagerström Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) is a widely used and well-validated 6-item self-report measure of nicotine dependence severity.

*Brief Aggression Questionnaire*
The brief Aggression Questionnaire (AQ; Bryant & Smith, 2001) is a 12-item reduced version of the standard 29-item AQ (Buss & Perry, 1992). The brief AQ measures four components of aggression using separate subscales: physical aggression (3 items; e.g., "Given enough provocation, I may hit another person"), verbal aggression (3 items; e.g., "My friends say that I am somewhat argumentative"), anger (3 items; e.g., "I have trouble controlling my temper"), and hostility (3 items; e.g., "At times I feel I have gotten a raw deal out of life"). All items are rated on a 0 (extremely uncharacteristic of me) to 5 (extremely characteristic of me) Likert-type scale, with each subscale reflecting the mean rating for the respective 3 items. The AQ-hostility subscale was our primary measure, which taps a construct indicative of general cynicism about life, with item content relating to having bad luck, getting a raw deal out of life, and not getting the same breaks that others get. The other subscales of the AQ were examined for discriminant validity purposes to shed light on whether the sociocognitive construct of hostility per se is particularly predictive of the affective changes that occur upon tobacco withdrawal or whether aggression more generally and its various behavioral and affective manifestations are predictive of withdrawal-induced affective disturbance. Prior work has illustrated that, despite each scale containing only 3 items, subscales on the brief AQ exhibit good psychometric properties in general population samples as well as samples of smokers (Bryant & Smith, 2001; Kahler, Spillane et al., 2009). Specifically, Bryant and Smith (2001) showed that the reduced item version outperformed the initial version in factorial validity and construct validity by exhibiting greater structural fit to the data consistent with the 4-factor model across three separate samples (goodness of fit [GFI] 29-item version: .76–.81; GFI 12-item version: .93–.94). Further, Kahler, Spillaine, et al. (2009) illustrated that the 3-item AQ-hostility scale exhibited adequate internal consistency (α = .73) and convergent validity with another measure of hostility (*r* = .44) among smokers. Similarly, the internal consistency (α = .73) and discriminant validity from the other AQ scales and the Center for Epidemiologic Studies Depression Scale (CES-D) were adequate in the current sample (see Table 1).

**Table 1.** Associations Between AQ Subscales and CESD Baseline Characteristics

| | *M* (*SD*) | Intercorrelations (*r*s) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1. AQ-hostility | 2.15[a] (1.06) | (.74) | | | | |
| 2. AQ-verbal aggression | 2.24[a] (0.99) | .51 | (.75) | | | |
| 3. AQ-physical aggression | 1.68[a] (0.90) | .51 | .47 | (.70) | | |
| 4. AQ-anger | 1.80[a] (0.97) | .53 | .66 | .58 | (.77) | |
| 5. CES-D | 10.35 (8.07) | .52 | .29 | .32 | .38 | (.84) |

*Note.* Variables on the diagonal in parenthases reflect Cronbach's alpha coefficients. All *p*s < .0002. *N* = 153. AQ = Aggression Questionnaire—Brief; CES-D = Center for Epidemiologic Studies Depression Scale total scale.
[a]Data based on average response per item (possible range: 1–6).

*Center for Epidemiologic Studies Depression Scale*
The 20-item CES-D (Radloff, 1977) was administered to assess depressive symptom severity and was used to explore whether the effect of hostility on withdrawal-related affective changes is incremental to the effects of depression, which is a known correlate of both smoking and hostility (Weiss et al., 2005).

**Measures—Experimental Sessions**

*Profile of Mood States*
The profile of mood states (POMS; McNair, Lorr, & Droppleman, 1971) measures affect on a multidimensional scale and serves as the primary outcome of the affective changes induced by tobacco deprivation. This study used a 72-item version in which participants rated their affect "right now" using a 5-item Likert scale with affect adjectives (0: not at all; 4: extremely). The POMS generated 8 affect scales (anxiety, friendliness, vigor, depression, fatigue, confusion, anger, and elation), which were computed by taking the mean score per item within each scale.

*Minnesota Nicotine Withdrawal Scale*
This study used an 11-item Minnesota Nicotine Withdrawal Scale (MNWS; Hughes & Hatsukami, 1986) variant to measure withdrawal symptoms experienced "so far today." This questionnaire served as a supplemental outcome to compare the current findings to past hostility research using this scale (e.g., Kahler, Leventhal, et al., 2009). A composite mean score across the 11 symptoms (range 0–5) is reported.

*Analytic Plan*. For preliminary analyses, we report descriptive statistics on smoking and demographic characteristics of the sample, as well as descriptive statistics, Cronbach's alpha coefficients, and intercorrelations among the AQ subscales and CES-D. To test the main effects of deprivation on CO (manipulation check) and our primary outcomes, we report $M$ ($SD$) by condition and conduct paired sample $t$ tests.

We then used linear regression models to test associations of AQ scales to deprivation-induced changes in mood (POMS) and withdrawal (MNWS) outcome measures. Separate models were tested for each outcome. In order to control for nondeprived ratings, the corresponding nondeprived outcome measure was included as a predictor in each model. For each significant relation, follow-up models adjusted for the effects of depressive symptoms (CES-D), nicotine dependence (FTND), and gender to explore whether the effects of hostility were incremental to these important cofactors, which have been shown to covary with hostility in prior work (Kahler, Spillane, et al., 2009; Kahler et al., 2004). The primary analyses focused on the effects of AQ-hostility subscale on POMS-anger and POMS-friendliness, as these were our primary hypothesis. Supplemental adjusted analyses paralleling those described above examined the effects of AQ-hostility on other POMS scale outcomes and the other AQ subscales as predictors of deprivation-induced changes in affect and withdrawal.

Prior to fitting regression models, the AQ and outcome data were initially examined for outliers and distribution normality, and no transformations were required. Primary results of the regression models are reported as standardized regression weights ($\beta$s). Significance was set at $p < .05$ (two-tailed) for analyses.

# RESULTS

**Preliminary Analyses**

*Demographic and Smoking Characteristics*
Descriptive statistics for age, gender, ethnicity, race, age of onset of regular smoking, number of cigarettes smoked per day, and FTND scores of the sample are reported in Table 2.

*AQ Subscales and CES-D*
The means, standard deviations, Cronbach alpha internal consistency coefficients, and intercorrelations of the AQ subscales and CES-D baseline characteristic scores are presented in Table 1. There was a moderate, but not considerably high, degree of intercorrelation between the hostility subscale and the other AQ subscales and CES-D scores ($r$s .51–.53), suggesting that hostility was associated, but not redundant, with other forms of aggression and affective distress.

*Effects of Deprivation*
Manipulation check analyses illustrated that CO values were significantly lower during the deprived than the nondeprived session [$M$ ($SD$) = 5.57 (2.09) vs. 27.51 (14.12) ppm, $t = -6.93$, $d = -2.09$, $p < .0001$]. The means and standard deviations of each outcome measured by deprivation status are reported in Table 3. The deprivation effect in the overall sample was statistically significant for all outcomes, except for fatigue, which has shown modest deprivation effects in previous research (Leventhal et al., 2010).

**Primary and Supplemental Analyses of Hostility and Other Components of Aggression Predicting Affective Changes Induced by Tobacco Deprivation**

*Hostility*
The results for regression models testing the relation between hostility and deprivation-induced changes in affect (POMS) and withdrawal symptoms (MNWS) are reported in Table 4. Results from our primary hypotheses indicated that higher

**Table 2. Sample Demographics and Smoking Characteristics**

| Demographics | |
| --- | --- |
| Gender, % | |
| Male | 66.0 |
| Female | 34.0 |
| Ethnicity, % | |
| Non-Hispanic | 83.9 |
| Hispanic | 16.1 |
| Race, % | |
| Black | 52.8 |
| White | 39.4 |
| Multi-racial | 4.2 |
| Other | 3.5 |
| Age, $M$ ($SD$) | 43.76 (10.14) |
| Age started regular smoking, $M$ ($SD$) | 19.56 (5.61) |
| Number of cigarettes smoked per day | 16.83 (6.41) |
| FTND, $M$ (SD) | 5.31 (1.89) |

*Note. N* = 153. FTND = Fagerström Test of Nicotine Dependence score.

**Table 3.** Effects of Deprivation Status on Primary Outcomes

| | Nondeprived | Deprived | Deprivation-induced change score[a] | Effect of deprivation status | |
|---|---|---|---|---|---|
| | M (SD) | M (SD) | M (SD) | d[b] | p value |
| POMS subscales | | | | | |
| Anger | 0.41 (0.68) | 0.76 (0.86) | 0.35 (0.78) | 0.45 | <.0001 |
| Anxiety | 0.76 (0.75) | 1.27 (0.99) | 0.51 (0.95) | 0.54 | <.0001 |
| Confusion | 0.81 (0.68) | 1.02 (0.80) | 0.22 (0.81) | 0.27 | .001 |
| Depression | 0.44 (0.63) | 0.58 (0.72) | 0.14 (0.66) | 0.22 | .008 |
| Elation | 1.93 (0.91) | 1.38 (0.81) | −0.56 (0.84) | −0.66 | <.0001 |
| Fatigue | 0.87 (0.93) | 0.93 (0.95) | 0.061 (0.87) | 0.070 | .39 |
| Friendliness | 2.62 (0.95) | 2.07 (0.96) | −0.55 (0.84) | −0.65 | <.0001 |
| Vigor | 2.20 (1.02) | 1.74 (0.98) | −0.46 (0.85) | −0.54 | <.0001 |
| MNWS-total scale | 1.10 (1.00) | 2.02 (1.11) | 0.92 (1.09) | 0.85 | <.0001 |

*Note.* N = 153. POMS = Profile of Mood States; MNWS = Minnesota Nicotine Withdrawal Scale.
[a]Score while deprived—scored while nondeprived.
[b]Cohen's d statistic for within-subjects deprivation effect.

**Table 4.** Results of Regression Models in Which Hostility Is Predicting Deprivation-Induced Changes in Affect and Withdrawal

| | Unadjusted[a] | | Adjusted[b] | |
|---|---|---|---|---|
| | $\beta$[c] | p value | $\beta$[c] | p value |
| POMS subscales | | | | |
| Anger | .25 | .002 | .25 | .007 |
| Anxiety | .20 | .01 | .22 | .01 |
| Confusion | .27 | .0005 | .26 | .002 |
| Elation | −.06 | .40 | − | − |
| Depression | .28 | .0004 | .23 | .01 |
| Fatigue | .07 | .38 | − | − |
| Friendliness | −.06 | .46 | − | − |
| Vigor | .03 | .66 | − | − |
| MNWS-Total scale | .16 | .04 | .20 | .02 |

*Note.* N = 153. POMS = Profile of Mood States; MNWS = Minnesota Nicotine Withdrawal Scale. [a]Models were constructed to include hostility as the primary predictor and nondeprived ratings corresponding to each scale as covariates. [b]Models were constructed to include hostility and the primary predictor and gender, FTND, depressive symptoms, and nondeprived ratings. [c]Stadardized regression parameter for the predictive effect of hostility. Dash indicates that model was not tested because effect was not significant in unadjusted model.

hostility predicted greater deprivation-induced changes in anger but did not predict deprivation-induced changes in friendliness. Supplemental analyses of hostility as a predictor of other deprivation-induced changes indicated significant effects for other negative affect indictors (POMS-anxiety, depression, confusion) and overall withdrawal (MNWS). Each of the abovementioned relations remained significant after controlling for depressive symptoms, gender, and nicotine dependence severity. Hostility did not significantly predict deprivation-induced changes in fatigue or any of the positive affect indicators (Table 4).

*Other Aggression Constructs*
Models examining the relation between each of the other AQ scales (anger, physical aggression, verbal aggression) and deprivation-induced changes in affect and withdrawal after adjusting for covariates were mostly not significant. The sole exceptions were that deprivation-induced increases in

POMS-anger were predicted by AQ-anger, $\beta$ = .18, p = .02 and AQ-physical Aggression, $\beta$ = .17, p = .04.

## DISCUSSION

Relative to smokers with lower trait hostility, those with higher hostility exhibited a larger worsening change in withdrawal symptoms and negative affect induced by tobacco deprivation. Hostility did not predict deprivation-induced changes in positive affect. The current results are consistent with some past work on hostility and tobacco withdrawal. Two studies examining clinical trials showed that hostility predicted greater postquit scores on a composite measure of nicotine withdrawal (Kahler, Spillane, et al., 2009; Kahler, et al., 2004). By contrast, one lab study showed that high- versus low-hostility smokers reported higher composite withdrawal symptoms but did not significantly differ in response to tobacco deprivation on these

measures (Kahler, Leventhal, et al., 2009). The current study extends the literature in several important ways.

In contrast with prior work that utilized composite measures of negative affect or nicotine withdrawal (Kahler, Leventhal, et al., 2009; Kahler, Spillane, et al., 2009; Kahler, et al., 2004), we examined how hostility moderated the effects of tobacco deprivation on multiple subtypes of both positive affect and negative affect. This approach allowed us to test an emotion-specific socioaffective model, which purports that hostility would specifically predict greater deprivation-induced changes in socially relevant mood states (i.e., friendliness and anger). Results showed all negative mood states were differentially exacerbated during tobacco deprivation as a function of hostility, which was not the hypothesized pattern. Hostility did not modulate the dampening of positive mood states during tobacco deprivation. These findings align with a general negative reinforcement model (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004), as opposed to a socioaffective model, in which hostility exacerbates all negative affective states during tobacco withdrawal. This process could lead to strong motivation to resume smoking in order to suppress multiple forms of negative affect, which ultimately could account for the increased risk of persistent, relapsing nicotine dependence previously demonstrated in high-hostility smokers (Kahler, Spillane, et al., 2009; Kahler, et al., 2004).

We also illustrated the specificity of this negative reinforcement pathway to trait hostility in particular. Other aggression-related constructs (verbal aggression, physical aggression, and anger), which moderately associated with hostility in this sample, generally did not predict affective changes during withdrawal. However, trait anger and physical aggression was associated with deprivation-induced increases in anger but not withdrawal symptoms or other affective states. Hence, hostility may have broader effects on various forms of negative affect during tobacco abstinence, whereas some other aggression-related traits may have more narrow influences specific to state anger. These results are generally consistent with a prior study illustrating that hostility (but not other aggression-related constructs) increased odds of smoking cessation failure (Kahler, Spillane, et al., 2009) and suggest a potential mechanism for this risk pathway (i.e., increased levels of various forms of negative affect during withdrawal). These findings are consistent with the STAR model (Gilbert, 1995) and suggest a possible functional diathesis in between the trait disposition of hostility and the acute effects of tobacco administration and withdrawal, in which hostility may enhance the negative reinforcing properties of smoking. Furthermore, hostility predicted affective changes during tobacco deprivation over and above gender and baseline measures of depressive symptom level and nicotine dependence severity. Although previous findings indicate that hostility and depression covary (Felsten, 1996; Kahler, et al., 2004; Weiss, et al., 2005), the results of this investigation illustrate that hostility is not associated with withdrawal-related negative affect solely because it is a marker for baseline affective distress or more heavy smoking.

This study has several limitations. First, given the nature of the deprivation manipulation, we cannot attribute observed deprivation effects to either nicotine withdrawal effects, nicotine offset effects, or the loss of tobacco self-administration ritual (Baker, Japuntich, Hogle, McCarthy, & Curtin, 2006; Hughes, 1991). It is possible that the relations observed here were impacted by each of these deprivation-related processes.

Second, all assessment was self-report, which has limitations. Ideally, it would be useful to incorporate behavioral measures of hostility (e.g., response to a social stressor; Kahler, Leventhal, et al., 2009) and objective indicators of affective tobacco withdrawal effects (Acri & Grunberg, 1992) to explore if findings generalize across multiple modes of assessment. Because this is a laboratory study, the gathering of self-report friendliness and other socioemotional constructs is limited. Future research could utilize ecological momentary assessment techniques, allowing researchers to gather real-time mood of participants, and the context of any changes, allowing for more accurate measures of social mood states. Finally, this study was limited to individuals who smoked at least 10 cigarettes per day and were not attempting to quit smoking. Therefore, we are unable to determine whether these findings will generalize to tobacco smokers who smoke less frequently and those who may be attempting to quit. Relatedly, because this study examined outcomes based on only 16 hr of deprivation, future work should also examine these results in clinical samples involving prolonged smoking abstinence and within the context of smoking cessation.

Given that smokers with higher hostility exhibited greater deprivation-induced exacerbations across all negative affect states, the current findings raise the possibility that assessing and treating all types of negative affect withdrawal symptoms may be important in reducing relapse risk for high-hostility individuals. Similarly, reducing hostility in smokers could preemptively reduce exacerbations to negative mood and consequently decrease relapse risk. Modulating trait hostility may be possible via psychotherapy and pharmaceutical approaches (Deffenbacher, Filetti, Lynch, Dahlen, & Oetting, 2002; Lorr, McNair, Weinstein, Michaux, & Raskin, 1961) and could be a future avenue for smoking cessation research. Hence, these results may be applied in a clinical setting as a resource for tailored smoking cessation treatments that include behavioral or pharmacotherapy that either alleviate negative affect exacerbation occurring during quit attempts or buffer their effects on smoking relapse risk. From a theoretical perspective, the current findings can be taken in the context of smoking research on other personality traits indicative of psychological disturbance, including neuroticism, impulsivity, novelty seeking, harm avoidance, and anxiety sensitivity, each of which have been linked to heightened negative affect during tobacco abstinence (Gilbert et al., 1998; Langdon et al., 2013; Leventhal et al., 2007; VanderVeen, Cohen, Cukrowicz, & Trotter, 2007). Hostility may represent one of several traits that individually contribute to a common mechanism underlying tobacco dependence—affect-mediated negative reinforcement. Additional work clarifying how hostility and other personality traits impact tobacco dependence may advance both addiction theory and practice for psychologically vulnerable populations.

## FUNDING

## DECLARATION OF INTERESTS

*None declared.*

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