Association of Frequency of Perceived Exposure to Discrimination with Tobacco Withdrawal Symptoms and Smoking Lapse Behavior in African Americans

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Abstract

BACKGROUND AND AIMS: Frequent experiences of discrimination could increase vulnerability to tobacco withdrawal and smoking lapse in populations subject to tobacco-related health disparities. This laboratory study (2013–2017) examined whether individual differences in perceived exposure to discrimination in one's daily life predicted tobacco withdrawal symptoms and smoking lapse behavior following acute tobacco deprivation in African American smokers.

DESIGN: Mixed design with the between-subjects continuous variable of perceived discrimination crossed with the within-subject variable of tobacco deprivation status (deprived vs. non-deprived).

SETTING: Academic medical center in Los Angeles, California, USA.

PARTICIPANTS: African American non-treatment seeking daily cigarette smokers (*N*=607, 10 cig/day).

MEASUREMENTS: At a baseline visit, self-reported frequency of perceived exposure to discrimination in one's daily life was measured (EDDS). At two subsequent counterbalanced experimental visits (16-hour tobacco deprivation vs. *ad libitum* smoking), self-report assessments of various tobacco withdrawal symptom domains (Brief-QSU, WSWS, POMS, SHAPS, and CIS) and a behavioral smoking lapse analogue task were measured.

FINDINGS: Adjusted models demonstrated that greater frequency of perceived exposure to discrimination was associated with larger deprivation-induced increases in acute urges to smoke to alleviate negative mood, several negative mood states, and subjective cognitive functioning—effect

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sizes were small in magnitude (βs=.09-.13; ps<.02). Data were inconclusive for associations between perceived exposure to discrimination and deprivation-induced changes in cravings, urges to smoke for pleasure, positive mood reduction, other symptoms, or smoking reinstatement behavior.

CONCLUSIONS: Frequency of perceived exposure to discrimination appears to be modestly associated with increased severity of some deprivation-induced tobacco withdrawal symptoms in African American smokers.

Keywords

African American smokers; discrimination; smoking; cigarette; tobacco withdrawal; mood; cognition

African Americans experience a disproportionate burden of tobacco-related morbidity and mortality relative to several other racial/ethnic populations in the United States (1). While African American cigarette smokers report higher levels of motivation to quit smoking and smoke less frequently compared to several other racial/ethnic groups (1–3), they are also at increased risk of relapsing back to smoking following a quit attempt (4). Thus, it is possible that the certain etiological influences that contribute to the vulnerability to persistent, relapsing patterns of cigarette smoking in African Americans are unique to this group, and are not merely explained by smoking patterns, greater motivation to quit, and other universal determinants of tobacco addiction.

Discrimination—unequal or unfair treatment by individuals and/or social institutions on the basis of gender, race, ethnic or national origin, sexual orientation, social class, or other factors—is disproportionately experienced by African Americans (5, 6) and predicts risk of relapse during cessation attempts (7, 8). African American smokers who experience perceived discrimination more frequently are at greater risk of being a smoker (9), higher tobacco dependence severity (10), and greater motivation to smoke to enhance cognitive functioning and mood (10). One study reported that associations between perceived frequency of discrimination and cigarette smoking status and smoking frequency were amplified among African Americans relative to Latinos (11). More recently, a 2019 study demonstrated that African American low-income smokers who reported a greater frequency of exposure to discrimination were less likely to achieve smoking abstinence at week 26 upon receiving interventions that included varenicline for 12 weeks and six guideline-based smoking cessation counseling sessions relative to African Americans who reported experiencing discrimination less frequently (8). Furthermore, a 2020 study tested the causal relationship between acute interpersonal discrimination and smoking motivation (i.e., urges to smoke cigarettes, cessation self-efficacy, and smoking behavior) among African American smokers who engaged in a virtual ball-playing game where they were randomly assigned to 4 groups (i.e., included/ingroup, included/outgroup, excluded/ingroup [ostracism], and excluded/outgroup [acute discrimination] (12). Findings demonstrated that participants in the excluded (vs. included) conditions reported lower cessation self-efficacy and those within the excluded/outgroup conditions had reduced latency to smoke relative to those in the ingroup conditions, further suggesting that discrimination may be a potential

contributing factor to persistent tobacco use and difficulty quitting smoking among African American smokers (12).

While the existing evidence described above suggests that discrimination may be implicated in the etiology of tobacco use in African Americans, proximal mechanisms that may underlie persistent smoking in African Americans are unclear. We propose that discrimination may perpetuate smoking in African Americans by augmenting tobacco withdrawal symptoms—a strong determinant of failed quit attempts and core driver of dependence (13, 14). Nicotine has attention-filtering and mood-modulating effects, whereby aversive environmental stimuli are less distracting and emotionally distressing after acute exposure to nicotine (15–17). For African Americans who frequently experience discrimination in their daily lives (18, 19), nicotine-related buffering against the attention-disrupting and emotionally distressing effects of exposure to discrimination may be of high functional value that perpetuates smoking behavior. When deprived from smoking (either due to temporary deprivation [e.g., at workplace with smoking restrictions or waking after overnight deprivation] or as part of a quit attempt), the absence of nicotine may increase vulnerability to the distressing and distracting effects of stressors, including exposure to discriminatory events. Such vulnerability in discrimination-prone smokers could be expressed as a constellation of tobacco withdrawal symptoms during smoking abstinence, including heightened urges to smoke (20, 21).

The distribution of discrimination varies amongst African Americans, with some experiencing frequent and severe discrimination while others experiencing discrimination less frequently (22). Thus, it is plausible that African American smokers who experience discrimination on a more (vs. less) frequent basis would be more liable to experience several tobacco withdrawal symptoms during tobacco deprivation, such as worse negative mood states (e.g., anger, irritability, anxiety, sadness) and subjective cognitive impairment (e.g., difficulty concentration, confusion), as well as greater smoking lapse behavior. Moreover, African women (vs. men) and individuals living in poverty are susceptible to experiencing greater levels of discrimination (23, 24), thus, it is possible that associations of perceived discrimination and tobacco withdrawal may differ by race and income. No previous study has examined associations between perceived frequency of discrimination and tobacco withdrawal.

Primary analyses of this study investigated whether reported frequency of perceived exposure to discrimination in one's daily life predicted smoking urges, positive and negative mood states, self-reported cognitive functioning, other tobacco withdrawal symptoms, and smoking lapse behavior on an analogue behavior task following experimentally-manipulated overnight tobacco deprivation challenge in African American daily cigarette smokers. Based on the premise above (25), we hypothesized that frequency of perceived exposure to discrimination would predict greater deprivation-induced increases in smoking lapse behavior, negative mood, and subjective cognitive functioning and would not predict variability in other expressions of tobacco withdrawal (e.g., hunger, diminished positive mood).

Methods

Participants

This study analyzes data from the Southern California Tobacco Addiction Phenotype Project (2013–2017), a laboratory study of individual differences in tobacco withdrawal phenotypes amongst African American smokers in Los Angeles, CA, USA metropolitan area (26, 27). Participants were 607 non-treatment seeking adult cigarette smokers ($M = 50.05$ years old, $SD = 10.6$; see descriptive statistics in Table 1) who self-reported having Non-Hispanic African American ancestry in both biological parents. Inclusion criteria were smoked cigarettes daily for at least 2 years, smoked   10 cigarettes per day, and were fluent in English. We excluded participants who: 1) met *DSM-IV* criteria for non-nicotine substance dependence (to prevent non-nicotine intoxication or withdrawal effects during study sessions); 2) breath carbon monoxide (CO) levels < 10 parts per million (ppm) at baseline; 3) had a desire to substantially cut down or quit smoking in the next 30 days; 4) currently used psychiatric medications, which may modulate tobacco withdrawal effects; 5) pregnant or breastfeeding; and/or 6) used non-cigarette tobacco products or nicotine replacement therapy daily. All participants completed informed consent and were compensated approximately $200 for completing the study. Of the 776 participants who attended a baseline visit, 684 were eligible for the study. Of these, 61 and 16 completed zero or one experimental visits, respectively, and were excluded. The total analytic sample with complete data included 607 participants. The University of Southern California Internal Review Board approved all study procedures.

Procedures

After a baseline in-person screening, participants attended two counterbalanced experimental visits both beginning at noon: 1) non-deprivation after *ad libitum* smoking and 2) 16-hour tobacco deprivation. Experimental procedures across both visits were identical except that: (a) during the tobacco deprivation condition, participants were instructed to abstain from smoking after 8 pm the night before their visit and for the non-deprivation condition to smoke normally prior to visit; and (b) upon arrival, participants smoked a cigarette of their preferred brand in the lab during the non-deprivation condition only. Participants were also instructed to avoid using non-cigarette tobacco or nicotine products and other psychoactive substances within 24 hours of each session. Compliance with instructions was biologically verified via assessing breath alcohol (BrAC = 0.000 required for all visits) and CO (< 10 ppm required for tobacco deprivation visits) at the beginning of each visit. Both tests have been shown to be highly sensitive to heavy cigarette smoking and alcohol use and are not affected by concurrent use of nicotine replacement products and other psychoactive substances (28, 29). After breath alcohol and CO assessments, participants then completed self-report measures of tobacco withdrawal at a single time point followed by a smoking lapse analogue task to assess the motivational value of initiating smoking (described below). Detailed study procedures have been described in prior investigations (26, 27).

Baseline Visit Measures

Perceived Discrimination (Independent Variable).—The 9-item Everyday Discrimination Scale (EDDS) is a self-report measure administered only at the baseline session to determine the frequency of perceived exposure to day-to-day experiences of interpersonal discrimination in one's daily life. Each item includes an exemplary type of discriminative experience, the frequency of which is rated on 6-point Likert-type scales (e.g., "You are threatened or harassed."; 0 = *Never*, 1 = *Less than once a year*, 2 = *A few times a year*, 3 = *A few times a month*, 4 = *At least once a week*, and 5 = *Almost every day* (30). The total score based on the summed rating across the nine items served as the primary exposure variable, with higher scores indicating higher frequency of perceived exposure to discrimination. The EDDS has been demonstrated to have sufficient internal consistency and test-retest reliability (31), and has been validated across diverse racial/ethnic and cultural groups in the United States (i.e., African Americans, Hispanics/Latinos, and Asians (32).

Covariates.—We administered the following measures to describe the sample and include as covariates that may confound associations between discrimination and withdrawal. This included a demographic and smoking characteristics survey (i.e., age, gender [female vs. male], educational attainment [1 = *Less than high school*, 2 = *High school diploma or GED*, 3 = *Some college completed or currently enrolled in college*, 4 = *College degree or higher*], employment status [i.e., "Indicate your employment status as of TODAY."; 1 = *Full time*, 2 = *Part time*, 3 = *Retired or Disability*, 4 = *Unemployed*, 5 = *Summer only*], annual income [i.e., "Which category best describes your total PRE-TAX HOUSEHOLD income last year?"; 1 = *Less than $15,000*, 2 = *At least $15,000, but less than $30,000*, 3 = *At least $30,000, but less than $45,000*, 4 = *At least $45,000, but less than $60,000*, 5 = *At least $60,000, but less than $75,000*, 6 = *At least $75,000, but less than $90,000*, 7 = *At least $90,000, but less than $105,000*, 8 = *At least $105,000, but less than $120,000*, 9 = *Greater than $120,000*], cigarettes/day, menthol preference [yes vs. no], baseline CO levels, and age of onset of regular smoking), the Fagerström Test of Nicotine Dependence (FTND (33)—a 6-item self-report measure of nicotine dependence severity (range 0–10), and the Inventory of Depression and Anxiety Symptoms 20-item general depression subscale (IDAS-GD; (34), which instructs respondents to rate the extent of experienced depressive symptoms (e.g., "I had little interest in my usual hobbies or activities.") during the past two weeks on a 5-point scale (1 = *Not at all* to 5 = *Extremely*) and yields a mean response per symptom composite score. Based on prior work (26, 35, 36), we dichotomized the following variables: educational attainment (never attended college vs. some college attendance or higher education level), employment status (unemployed vs. employed), and annual income (Less than $15,000 vs. $15,000 or greater) due to smaller cell sizes across response options and to characterize the sample of participants who were unemployed, had lower education, and who were living in poverty.

Experimental Visit Measures (Dependent Variables)

The following measures described below have demonstrated sufficient psychometric properties and sensitivity to overnight tobacco deprivation challenges (37, 38).

Smoking Urges.—The Brief Questionnaire of Smoking Urges (QSU) is a 10-item measure that includes statements assessing desire to smoke for pleasure and intention to smoke (Factor 1; e.g., "I have an urge for a cigarette."; five items) and desire to smoke to alleviate negative mood (Factor 2; e.g., "I would control things better if I could smoke."; five items (37). Participants were instructed to rate the extent of agreement based on how they felt "right now" on 6-point Likert scales (0 = *Strongly disagree* to 5 = *Strongly agree*). Each subscale (Factor 1 and Factor 2) is computed based on mean rating per item within each respective subscale, with Factors 1 and 2 reflecting appetitive and aversive urges, respectively.

Tobacco Withdrawal Symptoms.—The 28-item Wisconsin Smoking Withdrawal Scale (WSWS) measures 6 distinct symptom dimensions of tobacco withdrawal (39). Participants were instructed to rate withdrawal symptoms on 5-point Likert scales based on how they have felt "so far today" (0 = *Strongly disagree* to 4 = *Strongly agree*). The mean symptom item response from the respective subscales (i.e., anger, anxiety, sadness, concentration, hunger, cravings) were computed for each subscale.

Mood States.—The Profile of Mood States (POMS) instructed participants to rate 72 adjectives of varying mood states (e.g., agreeable, relaxed, uneasy, anxious) based on how they were feeling "right now" on 5-point Likert scales (0 = *Not at all* to 4 = *Extremely* (40). As in a prior investigation (41), we computed negative mood subscales (Anger [12 items], Anxiety [8 items], Confusion [7 items], and Depression [15 items]) based on mean rating per item within respective subscale items, and overall scores for negative mood valence (NM; mean of five negative mood subscale scores) and positive mood valence (PM; mean of six positive mood subscales).

Anhedonia.—The Snaith-Hamilton Pleasure Scale (SHAPS) is a 14-item self-report measure of anhedonia (i.e., inability to experience pleasure; (42) that instructs participants to agree or disagree with statements of hedonic response in pleasurable situations (e.g., "I would enjoy being with my family or close friends.") experienced "right now, in the current moment" on 4-point Likert scales (1 = *Strongly disagree* to 4 = *Strongly agree*). A composite index was computed based on mean response across all items and reverse-coded with higher SHAPS scores indicating greater anhedonia (i.e., lower hedonic capacity).

Current Impulsivity.—The 19-item Current Impulsivity Scale (CIS (43) instructs were participants to rate a set of statements reflecting state impulsive tendencies (e.g., "Having a hard time controlling what I do or say.") based on how they felt "right now" on 5-point Likert scales (0 = *Not at all* to 4 = *Extremely*) and yields a composite index based on mean response across all items.

Smoking Lapse Analogue Task.—This behavioral task measures the motivation to smoke under conditions in which avoiding smoking is monetarily rewarded (44, 45). Participants received a tray containing eight cigarettes of their preferred brand, a lighter, and ashtray. The task begins with the delay portion during which participants were instructed that they could smoke at any point within the next 50 minutes, but for each 5 minutes that they delayed smoking, they would earn $0.20 for a maximum of $2.00 (monetary values

were selected based on prior piloting among smokers from the local population in order to maximize variability in delay time and smoking choices and to ensure sufficient deprivation effects and inter-individual variance in smoking motivation (13, 46, 47). The delay period ended once the 50 minutes had elapsed or when the participant decided that they would like to smoke. After the delay period, participants began the self-administration portion of the task where they were instructed that they could smoke as little or as many cigarettes as they wished for the next 60 minutes. Participants were instructed that they had a $1.60 credit and each cigarette they lit would cost $0.20. Participants were informed that they would not have another opportunity to smoke again until the end of the session to prevent the influence of the impending opportunity to smoke on choices made during the task. The latency to smoking initiation during the delay portion (range: 0–50 minutes) and number of cigarettes purchased during the self-administration portion (range: 0–8) were outcomes, reflecting the motivation to start smoking (lapse) and motivation to continue smoking once provided the opportunity, respectively. Following the self-administration period, participants entered a rest period for the remainder of the session, during which they were not allowed to smoke. This served to standardize session length for participants who chose not to fully delay, as well as to minimize the influence of participants' impending ability to smoke following session completion on lapse behaviors during the task (rest time range: 60–110 minutes). Previous studies support the validity of this task as an analogue model of smoking lapse behavior, reliably showing changes in task performance due to deprivation (46), stress (48), and cessation medication (48) in expected directions.

Analysis Plan

Preliminary analyses.—We first calculated descriptive statistics and tested correlations between all baseline variables and the EDDS score. We then utilized paired sample *t*-tests as a manipulation check to assess whether tobacco deprivation affected each study outcome and reported internal consistency estimates by deprivation condition (Cronbach's α; Table 2). Deprivation-induced change scores were calculated for each study outcome (i.e., difference score in tobacco deprivation condition – score in non-deprivation condition after *ad libitum* smoking). We also conducted ANOVA analyses to determine whether there were order effects on deprivation-induced changes in tobacco withdrawal outcomes and smoking lapse behavior as a result of the counterbalanced experimental design.

Primary Analyses.—We conducted 16 separate linear regression models to examine associations of baseline frequency of perceived exposure to discrimination (EDDS) with deprivation-induced change scores in each experimental session outcome. We utilized simultaneous regressors and entered variables in two phases—one model without adjustment and one fully adjusted model. Covariates were additional regressors that were simultaneously included in the fully adjusted model. Unadjusted models included each outcome variable's respective non-deprivation condition score as the sole covariate. Adjusted models simultaneously controlled for covariates that were significantly associated with frequency of perceived exposure to discrimination and withdrawal outcomes of interest in preliminary analysis (i.e., gender, annual income, and IDAS general depression). All variables utilized in analyses were continuous and all model assumptions were met in this study.

Results for the various outcomes were grouped into conceptually-distinct phenotypic expressions of withdrawal: *Urge/Craving* (WSWS-Craving, QSU Factor 1 [Appetitive Urge], QSU Factor 2 [Aversive Urge]), *Negative Mood* (POMS-Negative Mood, WSWS-Anger, POMS-Anger, WSWS-Anxiety, POMS-Anxiety, WSWS-Sadness, POMS-Depression), *Low Positive Mood* (POMS-Positive Mood, SHAPS-Anhedonia), *Cognition* (POMS-Confusion, WSWS-Concentration, CIS-Impulsivity), *Other Withdrawal Symptoms* (WSWS-Hunger), and *Smoking Lapse Behavior* (Time Delayed [min], Cigarettes Smoked). Associations are reported as standardized regression coefficients (β) with 95% confidence intervals (CIs) and all statistical analyses were two-tailed. To correct for multiple tests, the Benjamini-Hochberg procedure was used to maintain a study-wise false discovery rate of .05 (49). Missing data were accounted for using complete case analysis, whereby all cases with missing outcomes were excluded from the statistical analyses ($n = 16$). Post-hoc power analyses were also conducted using the G*Power software (50) and results from power analyses suggested that a sample of 600 subjects was 95% powered to detect differences with an effect size of .05. Additional supplementary analyses were conducted to examine the robustness of the results and are detailed below. Data were analyzed using IBM SPSS Version 24 (51) and analyses were not pre-registered, thus, results should be considered exploratory.

Results

Study Sample and Check of Tobacco Deprivation Manipulation

Descriptive statistics for frequency of perceived exposure to discrimination, depression, and demographic and smoking characteristics are reported in Table 1. We found significant correlations between frequency of perceived exposure to discrimination and gender, low annual income, and depression ($rs = -.08$-.29, $ps < .04$; see Table 1). Table 2 illustrates M (SD) for study outcomes by deprivation condition. Tobacco deprivation significantly affected all outcomes in the expected direction and effect magnitudes ranged from small to large as evidenced by Cohen's d statistics (see Table 2). Positive change scores indicate tobacco deprivation-induced increases in key withdrawal outcomes whereas negative change scores denote deprivation-induced decreases in key outcomes. We found no significant order effects on deprivation-provoked changes in tobacco withdrawal and smoking lapse behavior (ps .10).

Association of Frequency of Perceived Exposure to Discrimination with Deprivation-Induced Changes in Tobacco Withdrawal and Smoking Lapse Behavior

Table 3 reports results of both unadjusted and adjusted models controlling for covariates and the respective non-deprivation visit score. In models adjusting for only the non-deprivation visit score, there were statistically significant associations between greater frequency of perceived exposure to discrimination with greater deprivation-induced increases in 1 of 3 *Urge/Craving* outcomes (i.e., urges to smoke to relieve negative mood; $\beta = .10$), all 7 *Negative Mood* outcomes ($\beta s = .10$-.16), and all 3 *Cognition* outcomes ($\beta s = .09$-.15). After additionally adjusting for three covariates, associations between frequency of perceived exposure to discrimination and deprivation-induced increases in urge to smoke to alleviate negative mood, 6 of 7 negative mood state measures, and the confusion measure of subjective cognitive functioning remained statistically significant. In the adjusted models,

sadness and the other 2 measures of subjective cognitive functioning (i.e., concentration problems and impulsivity) were no longer statistically significant. Data were inconclusive for associations between frequency of perceived exposure to discrimination and *Low Positive Mood*, *Other Withdrawal Symptoms*, and the *Smoking Lapse Behavior* measures in unadjusted or adjusted models. Fully adjusted models controlling for all covariates showed a similar pattern of association (Supplementary Table 2).

Supplementary Analyses

Association of Frequency of Perceived Exposure to Discrimination with Deprivation Values of Tobacco Withdrawal and Smoking Lapse Behavior— Given that using deprivation-induced change scores for study outcomes may reduce reliability, we retested the regression models of the effects of frequency of perceived exposure to discrimination using the tobacco withdrawal and smoking lapse behavior scores during tobacco deprivation as the outcome after adjusting for the respective non-deprived variable to determine the robustness of the findings across different outcomes (see Supplementary Table 1). Adjusted models controlling for three covariates and the respective non-deprived variable demonstrated that greater frequency of perceived exposure to discrimination significantly predicted increases in urge to smoke to alleviate negative mood (β = .09), 6 of 7 negative mood state measures (βs = .09-.12), and the confusion measure of subjective cognitive functioning (β = .09) during tobacco deprivation. Data were inconclusive for associations between frequency of perceived exposure to discrimination and *Low Positive Mood*, *Other Withdrawal Symptoms*, and the *Smoking Lapse Behavior* measures in unadjusted or adjusted models.

Interactive Effects of Frequency of Perceived Exposure to Discrimination and Gender and Income on Deprivation-Induced Changes in Tobacco Withdrawal and Smoking Lapse Behavior—Given that women (vs. men) and individuals living in poverty are vulnerable to experiencing greater levels of discrimination (23, 24), we also tested whether gender and income levels moderated the relationship between frequency of perceived exposure to discrimination and tobacco withdrawal and smoking lapse behavior. We found non-significant interactions between frequency of perceived exposure to discrimination with gender or income predicting deprivation-induced changes in tobacco withdrawal and smoking lapse behavior.

Discussion

Consistent with our hypotheses, this study found that African American smokers who report greater frequency of perceived exposure to discrimination in their daily life experienced greater exacerbations across several negative mood and cognitive states during an acute tobacco deprivation challenge. Perceived discrimination was not associated with deprivation-induced changes in other symptoms of withdrawal or smoking lapse behavior on an analogue task. While the results suggest that discrimination may play some role in tobacco withdrawal, associations were modest and not consistent across all outcomes, which implies that discrimination may not be a *primary* cause of withdrawal in African Americans. Furthermore, these findings indicate that previously-reported positive associations between

frequency of discrimination experienced and smoking relapse (7) may not be primarily driven by withdrawal among African Americans.

Outside of the tobacco literature, prior studies have found that increased anger, anxiety, depression, and difficulty concentrating are all common and pronounced emotional responses to perceived experiences of discrimination or racism (52–54). Correspondingly, the majority of the perceived discrimination-withdrawal associations observed within our sample clustered around distress-related symptoms, including cognitive symptoms, such as confusion—which can be distressing. These findings coupled with results indicating an association between perceived discrimination and urge to smoke to alleviate negative affect concord with literature showing that African American cigarette smokers who encounter discrimination on a more frequent basis are more likely to smoke for mood-regulation motives (10). The current results highlight that one reason for greater negative mood regulation smoking motives may be that they tend to experience slightly worse negative mood when they are deprived from smoking.

Why might discrimination subtly increase vulnerability to withdrawal-related affective and cognitive distress? Consider a smoker who experiences frequent discrimination on a day-to-day basis and has adverse appraisals of such discriminatory experiences. Such a smoker may be more likely to find nicotine's distress-alleviating and mood- and cognitive-enhancing pharmacological effects appealing. Nicotine could help to offset the spike in negative mood states and corresponding cognitive resources that accompany exposure to and appraisal of discriminatory experiences. Over years of smoking and experiencing discrimination, many instances of 'learning trials' in which smoking occurs in close temporal proximity to discrimination experiences may accrue, resulting in a specific conditioned association between discrimination-induced distress, smoking, and distress alleviation. Thus, in the absence of the ability to rely on such smoking reinforcement-mediated coping strategies during acute tobacco deprivation, adverse mood reactions or cognitive disruptions to acute deprivation may be perceived as especially aversive. It is plausible that smokers who report more frequent experience of discrimination may have been discriminated against in the 18 hours prior to experimental sessions, the effects of which on distress and cognition may have been more robust leading up to the deprived visit.

Notably, we did not observe significant associations between exposure to discrimination and deprivation-induced increases in withdrawal-related hunger, concentration, impulsivity, or specific withdrawal symptoms in the *Urge/Craving* domain (i.e., craving, appetitive smoking urge). Thus, the adverse impact of experiencing a greater frequency of perceived experience of day-to-day discrimination on tobacco withdrawal symptoms during acute deprivation may not generalize to motivational or physiological aspects of tobacco withdrawal, but rather may be specific to mood- and cognition-based manifestations of tobacco withdrawal.

The current study did not have a sample of non-African American smokers to conduct analytic comparisons of discrimination-withdrawal associations across other racial/ethnic groups of smokers. Thus, it remains unclear whether greater exposure to discrimination may confer generalized risk for tobacco withdrawal severity among other diverse smoker populations, or alternatively, may represent a distinct risk factor for heightened tobacco

withdrawal specifically among African American smokers. Given that there are many marginalized sociocultural identities beyond lines of race/ethnicity that are subject to discrimination (e.g., gender, sexual orientation, religion) and that there is extensive evidence of adverse tobacco-related outcomes as a function of discrimination among non-racial/ethnic minority groups (55), it is likely that the sociopharmacological mechanism linking discrimination with exacerbated withdrawal severity among African American smokers may also be at play for smokers of any marginalized group that experiences disproportionate socially-determined stress. However, we did not observe significant interactions between gender and frequency of perceived exposure to discrimination in predicting deprivation-induced changes in tobacco withdrawal and smoking lapse behavior, suggesting that the negative impact of perceived exposure to discrimination on tobacco withdrawal might generalize across African American smokers, regardless of gender. Prior evidence suggests that African Americans report higher levels of perceived discrimination (52, 56–58) and are victims of racially-motivated hate crimes at a considerably higher rate than other racial/ethnic minority groups (59). Future work examining the relation between sociocultural stressors such as discrimination and tobacco withdrawal severity in multi-racial samples is warranted.

Several additional limitations are worth noting. First, the current study utilized a non-treatment seeking sample of African American smokers. Hence, future work should continue exploration of these effects in clinical populations to determine whether these tobacco deprivation effects generalize to treatment-seeking African American smokers. Second, tobacco deprivation was experimentally-manipulated over a short duration of time (16 hours) and not part of a self-motivated quit attempt, thus, our findings may not generalize to minority smokers who attempt to quit smoking. However, recent work demonstrated that tobacco withdrawal during experimentally-manipulated tobacco deprivation may be representative of withdrawal after self-motivated smoking cessation, which suggests some potential generalizability of our findings (60). Third, we utilized a single self-report measure to assess several types of perceived discrimination. Thus, the inclusion of additional assessments to measure specific types of discrimination (i.e., racial discrimination) or objective cognitive tasks in addition to self-reported data may aid in a more precise assessment of the effects of perceived discrimination among African Americans smokers. Fourth, the time frames for covariates included in this study varied during baseline assessment (e.g., depression measure assessed for symptoms within past two weeks) relative to the discrimination measure, which assessed for frequency of perceived exposure to day-to-day experiences of interpersonal discrimination in one's lifetime. Hence, the varying time frame for covariates may not have sufficiently addressed confounding factors since these covariates may not have overlapped with the time frame for discrimination. Fifth, a recent study suggests that recent vs. lifetime exposure to discrimination may differentially impact negative mood symptoms (61), yet we only assessed perceived discrimination at a single time point during the baseline session. Thus, it is plausible that deprivation-induced changes in mood states and other tobacco withdrawal outcomes observed in this study may have differed by perceived exposure to recent (e.g., past 24 hours) vs. lifetime discrimination, which we did not sufficiently capture during the experimental sessions. Sixth, price values utilized in the behavioral smoking lapse analogue task were developed to assess the relative

reward value of smoking and to maximize a participant's willingness and motivation to smoke (vs. delaying smoking) and were not reflective of price values of cigarettes in the current market. Given that this task is limited in ecological validity, it is plausible that participant decisions on this task may have been influenced by the appealing nature of the lower price values of delaying smoking and purchasing cigarettes since majority of smokers in our study were significantly disadvantaged (i.e., 50% were unemployed and 64% earned less than $15,000/year). Seventh, while participants were advised to avoid using all tobacco and nicotine products prior to the deprivation session, it is possible that some might have not followed instructions and used e-cigarettes or other non-combustible nicotine and tobacco products during the deprivation condition, as CO is a biochemical verification of abstinence that is insensitive to non-combustible product exposure (62). Lastly, we took a conservative approach to covariate selection. Some of these covariates, such as depression, nicotine dependence, education, income, and cigarettes smoked per day, may not merely be confounds of an association between discrimination and withdrawal. Depression and dependence are known correlates and consequences of frequent experiences of discrimination. Thus, some of these covariates may perhaps be mediators between discrimination and withdrawal, raising the possibility that the adjusted results may actually underestimate the true potential risk of discrimination and withdrawal.

Conclusions

In summary, the current study provides initial evidence that exposure to sociocultural stressors, such as discrimination, may confer risk for experiencing certain tobacco withdrawal symptoms and that these effects can be detected using controlled behavioral pharmacology paradigms, such as the smoking lapse analogue task. Given that discrimination has been shown to hinder smoking cessation efforts (7) and declines in smoking rates (6, 9, 63), one clinical implication of this work is that increased experience of perceived discrimination during the early stages of a quit attempt may exacerbate the stress of quitting smoking. No association was observed with motivation to reinstate smoking, which does not provide evidence that discrimination-related exacerbation of mood and cognitive translates into lapse propensity, at least within the context of a short abstinence period in this laboratory study of African American smokers. Further, if extended to clinical samples, these results could raise the possibility that tailoring of smoking cessation interventions to account for assessment of sociocultural stressors or tobacco deprivation-induced amplification to inform conceptualization and treatment of tobacco withdrawal symptomatology may be warranted, especially among African American smokers endorsing higher rates of experiencing discrimination. Future studies may also be important to provide a scientific agenda for health equity promotion in minority smokers by addressing both individual-level factors (i.e., depressive symptomatology, tobacco addiction) and sociocultural determinants that disproportionately contribute to pervasive disparities facing African Americans who smoke and experience frequent discrimination.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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Table 1.

Descriptive Statistics

Key Variables	Correlation with EDDS	p-value	M (SD) or n (%)
Demographics			
Age	−.06	.13	50.05 (10.61)
Female Gender	**.16**	.0001	227 (37.6%)
Low Education (Never attended college)	−.02	.58	319 (53.8%)
Low Annual Income (Less than $15,000)	**−.08**	.04	386 (64.7%)
Unemployed	−.02	.63	302 (50.5%)
Depressive symptoms (IDAS-General Depression)	**.29**	<.0001	1.96 (0.68)
Smoking Characteristics			
Age of onset regular smoking (years)	−.05	.25	19.70 (5.91)
Cigarettes/day	.04	.31	15.08 (7.26)
Menthol Cigarette Preference	−.06	.17	374 (61.8%)
Nicotine Dependence (FTND)	.03	.42	5.53 (1.96)
Baseline CO level (parts per million)	−.04	.33	17.97 (7.56)
Perceived Exposure to Discrimination (EDDS)	-	-	14.71 (11.31)

Note: N = 607. IDAS = Inventory of Depression and Anxiety Symptoms (range 1–5); FTND = Fagerström Test for Nicotine Dependence (range 0–10); CO = Carbon Monoxide; EDDS = Everyday Discrimination Scale (range 0–45); Education Level (Never attended college vs. College degree or higher); Annual Income (Less than $15,000 vs. $15,000 or more); Employment (Unemployment or Retired/Disability vs. Employed); Mentholated cigarette preference (vs. non-mentholated cigarette). Cronbach's α for EDDS = 0.92. Significant values are bolded.

Table 2.

Deprivation Effects for Study Outcomes

Key Withdrawal Outcomes	Non-Deprivation Condition		Tobacco Deprivation Condition		Deprivation-Induced Change Score	Deprivation Effect			Available Data for Both Conditions (N)
	M (SD)	α	M (SD)	α	M (SD)	t	d	p-value	
CO (ppm)	18.06 (9.58)	-	4.87 (2.55)	-	−13.15 (9.03)	−35.90	−1.46†	< .0001	607
Urge/Craving									
WSWS-Craving	1.65 (0.98)	0.82	2.56 (0.98)	0.86	0.93 (1.02)	22.32	0.91†	< .0001	599
QSU-Factor 1(Appetitive Urge)	1.55 (1.49)	0.94	3.80 (1.32)	0.91	2.27 (1.68)	33.11	1.35†	< .0001	598
QSU Factor 2 (Aversive Urge)	0.90 (1.18)	0.90	2.20 (1.51)	0.88	1.31 (1.38)	23.18	0.95†	< .0001	601
Negative Mood									
POMS-Negative Mood	0.54 (0.53)	0.96	0.68 (0.62)	0.97	0.14 (0.51)	6.81	0.27†	< .0001	598
WSWS-Anger	0.93 (1.00)	0.85	1.59 (1.15)	0.88	0.66 (1.15)	14.04	0.57†	< .0001	599
POMS-Anger	0.35 (0.53)	0.83	0.52 (0.67)	0.89	0.17 (0.59)	7.06	0.29†	< .0001	598
WSWS-Anxiety	1.45 (0.90)	0.73	1.92 (0.88)	0.71	0.47 (0.93)	12.46	0.51†	< .0001	598
POMS-Anxiety	0.64 (0.61)	0.84	0.93 (0.76)	0.87	0.29 (0.70)	10.02	0.41†	< .0001	598
WSWS-Sadness	1.18 (0.75)	0.62	1.50 (0.74)	0.64	0.33 (0.75)	10.67	0.44†	< .0001	599
POMS-Depression	0.37 (0.56)	0.92	0.44 (0.62)	0.92	0.07 (0.52)	3.09	0.13*	.002	598
Low Positive Mood									
POMS-Positive Mood	2.16 (0.85)	0.95	1.73 (0.89)	0.96	−0.42 (0.75)	−13.80	−0.56†	< .0001	596
SHAPS-Anhedonia	1.72 (0.47)	0.91	1.89 (0.53)	0.93	0.16 (0.51)	7.73	0.31†	< .0001	602
Cognition									
POMS-Confusion	0.71 (0.56)	0.71	0.85 (0.63)	0.74	0.14 (0.56)	6.10	0.25†	< .0001	597
WSWS-Concentration	1.04 (0.81)	0.66	1.50 (0.92)	0.77	0.47 (0.88)	12.91	0.53†	< .0001	599
CIS-Impulsivity	1.29 (0.44)	0.68	1.48 (0.48)	0.72	0.20 (0.42)	11.78	0.48†	< .0001	601
Other Withdrawal Symptoms									
WSWS-Hunger	1.87 (0.83)	0.72	2.21 (0.85)	0.76	0.35 (0.88)	9.56	0.40†	< .0001	598
Smoking Lapse Analogue Task									

Key Withdrawal Outcomes	Non-Deprivation Condition		Tobacco Deprivation Condition		Deprivation-Induced Change Score	Deprivation Effect			Available Data for Both Conditions (N)
	M (SD)	α	M (SD)	α	M (SD)	t	d	p-value	
Time Delayed (min)	36.04 (19.91)	-	18.46 (22.56)	-	−17.58 (23.56)	−18.31	−0.75†	<.0001	602
Cigarettes Smoked	1.04 (0.97)	-	1.26 (1.06)	-	0.22 (1.02)	5.20	0.22†	<.0001	582

Note: CO = Carbon Monoxide; WSWS = Wisconsin Severity of Withdrawal Scale (range 0–4); QSU = Questionnaire of Smoking Urges (range 0–5); POMS = Profile of Mood States (range 0–5); CIS = Current Impulsivity Scale (range 1–4); Time Delayed = Time to smoking initiation (range 0–50 minutes); Cigarettes smoked = Number of cigarettes smoked (range 0–8). α = Cronbach's alpha for internal consistency estimates. t = t-value for paired samples t-test. d = Cohen's d effect size. Deprivation-Induced Change Score = Score in Tobacco Deprivation Condition – Score in Non-Deprivation Condition.

*
p< .01

†
p< .0001.

Table 3.

Association of Frequency of Perceived Exposure to Discrimination with Deprivation-Induced Changes in Tobacco Withdrawal Outcomes

Tobacco Withdrawal Outcome	Parameter Estimate for Association of Frequency of Perceived Exposure to Discrimination with Respective Outcome			
	Unadjusted Models[a] β (95% CI)	p-value	Adjusted Models[b] β (95% CI)	p-value
Urge/Craving				
WSWS-Craving	.04 (−.002, .01)	.23	.02 (−.005, .01)	.65
QSU-Appetitive Urge	.04 (−.003, .01)	.22	.03 (−.005, .01)	.36
QSU-Aversive Urge	.10 (.002, .02)†	.01	.10 (.002, .02)†	.02
Negative Mood				
POMS-Negative Mood	.13 (.003, .01)†	.001	.11 (.001, .01)†	.008
WSWS-Anger	.12 (.005, .02)†	.002	.09 (.002, .02)†	.02
POMS-Anger	.16 (.004, .01)†	.0001	.13 (.003, .01)†	.002
WSWS-Anxiety	.12 (.004, .02)†	.001	.11 (.003, .02)†	.002
POMS-Anxiety	.13 (.003, .01)†	.001	.11 (.002, .01)†	.006
WSWS-Sadness	.10 (.002, .01)†	.004	.07 (−.0001, .01)	.06
POMS-Depression	.14 (.003, .01)†	.0002	.11 (.001, .01)†	.008
Low Positive Mood				
POMS-Positive Mood	−.06 (−.009, .001)	.11	−.09 (−.01, −.001)	.03
SHAPS-Anhedonia	.02 (−.002, .004)	.64	.02 (−.003, .004)	.71
Cognition				
POMS-Confusion	.15 (.003, .01)†	.0001	.11 (.001, .01)†	.008
WSWS-Concentration	.09 (.001, .01)†	.01	.06 (−.001, .01)	.12
CIS-Impulsivity	.10 (.001, .01)†	.01	.08 (−.0001, .01)	.06
Other Withdrawal Symptoms				
WSWS-Hunger	−.01 (−.006, .01)	.86	−.04 (−.01, .003)	.27
Smoking Lapse Behavior				
Time Delayed (min)	.03 (−.09, .21)	.41	.03 (−.11, .22)	.50
Cigarettes Smoked	−.04 (−.01, .002)	.22	−.05 (−.01, .002)	.15

Note. Sample size varies across analyses (*N*s = 582–607 due to missing data; see Table 2). WSWS = Wisconsin Severity of Withdrawal Scale; QSU = Questionnaire of Smoking Urges; POMS = Profile of Mood States; CIS = Current Impulsivity Scale; Time Delayed = Time to smoking initiation; Cigarettes smoked = Number of cigarettes smoked.

*a*Unadjusted models controlled for non-deprivation value for respective outcome variable.

*b*Adjusted models additionally controlled for gender, annual income, and IDAS general depression.

*†*Statistically significant after Benjamini-Hochberg correction to maintain study-wise false discovery rate at .05.