Nicotine & Tobacco Research, Volume 11, Number 9 (September 2009) 1047–1054

Original Investigation

Relations between anhedonia and smoking motivation

Adam M. Leventhal, Andrew J. Waters, Christopher W. Kahler, Lara A. Ray, & Steve Sussman

Abstract

Introduction: A growing literature suggests that anhedonia—an affective dimension related to the inability to experience pleasure—is associated with poor smoking cessation outcomes. Despite these findings, research of the motivational mechanisms linking anhedonia and smoking has been limited. Accordingly, the present study examined (a) relationships between anhedonia and motivationally relevant smoking characteristics and (b) whether anhedonia moderated the effects of tobacco deprivation on appetitive and aversive aspects of smoking urges.

Methods: Smokers ($N=212$; ≥5 cigarettes/day) first attended a baseline session during which measures of anhedonia and smoking characteristics were completed. Prior to a subsequent experimental session, a portion of participants were randomized to one of two groups: (a) 12-hr tobacco deprivation before the session ($n=51$) and (b) *ad libitum* smoking ($n=69$).

Results: Smokers with higher levels of anhedonia reported a greater number of past failed quit attempts and a higher proportion of quit attempts that ended in rapid relapse within 24 hr, $rs>.20$, $ps<.05$. Anhedonia did not consistently correlate with smoking heaviness, chronicity, and dependence motives. Anhedonia significantly moderated the influence of tobacco deprivation on appetitive smoking urges, such that deprivation effects on appetitive urges were stronger in high anhedonia smokers ($\beta=.64$) than in low anhedonia smokers ($\beta=.23$). Anhedonia did not moderate deprivation effects on aversive smoking urges. This pattern of results remained robust when controlling for baseline negative affect.

Discussion: These findings elucidate anhedonia's link with smoking relapse and could be useful for developing cessation interventions for anhedonic smokers.

Introduction

Higher levels of precessation depressive symptoms are generally associated with reduced odds of smoking cessation success (Anda et al., 1990; Brown et al., 2001; Cinciripini et al., 2003; Ginsberg, Hall, Reus, & Muñoz, 1995; Haas, Muñoz, Humfleet, Reus, & Hall, 2004; Hitsman et al., 1999; Japuntich et al., 2007; Killen, Fortmann, Davis, Strausberg, & Varady, 1999; Kinnunen, Doherty, Militello, & Garvey, 1996; Leventhal, Ramsey, Brown, LaChance, & Kahler, 2008; Niaura et al., 2001; Rausch, Nichinson, Lamke, & Matloff, 1990; Swan et al., 2003). A common account of this effect is that depressed smokers are more prone to relapse because they have high levels of negative affect (NA) and find it difficult to cope without using cigarettes to alleviate aversive emotions. However, research has not consistently supported this explanation (McChargue, Spring, Cook, & Neumann, 2004; Spring et al., 2008).

It is often overlooked that depressive symptomatology is a multifactorial construct that includes several distinct subdimensions (Shafer, 2006). Most multifactorial models of depressive symptoms include independent dimensions of anhedonia and NA and sometimes retain additional nonaffective dimensions (Shafer, 2006). Anhedonia involves deficient levels of positive emotions (e.g., feelings of joy, interest, and alertness) and a lack of hedonic responsiveness to pleasant stimuli. In contrast, NA is associated with the experience of aversive emotions (e.g., sadness, irritability, anxiety, and agitation) and hyperresponsiveness to aversive stimuli. These two dimensions are psychometrically distinct (Watson & Clark, 1997), associate with different neural underpinnings (Davidson, Ekman, Saron, Senulis, & Friesen, 1990), and have unique psychosocial correlates (Watson & Clark, 1997). Anhedonia is also conceptually and psychometrically distinct from other affective constructs related to low emotional reactivity, including alexithymia (i.e., the inability to identify and describe emotions; Loas, Fremaux,

Adam M. Leventhal, Ph.D., *Center for Alcohol and Addiction Studies, Brown University, Providence, RI*
Andrew J. Waters, Ph.D., *Department of Medical and Clinical Psychology, Uniformed Services University of the Health Sciences, Bethesda, MD*
Christopher W. Kahler, Ph.D., *Center for Alcohol and Addiction Studies, Brown University, Providence, RI*
Lara A. Ray, Ph.D., *Department of Psychology, University of California Los Angeles, CA*
Steve Sussman, Ph.D., *Departments of Preventive Medicine and Psychology, Institute for Health Promotion and Disease Prevention Research, University of Southern California, Alhambra, CA*

Corresponding Author:
Adam M. Leventhal, Ph.D., *Center for Alcohol and Addiction Studies, Brown University, Box G-S121-4, Providence, RI 02912, USA. Telephone: 713-305-4280; Fax: 832-553-7714; E-mail: adam_leventhal@brown.edu*

doi: 10.1093/ntr/ntp098
Advance Access publication on July 1, 2009
Received January 28, 2009; accepted April 13, 2009

& Boyer, 1997) and affective flattening (i.e., blunting of both positive and negative emotions; Loas, Salinas, Pierson, & Guelfi, 1994).

To isolate the domains of affective disturbance that play the strongest role in smoking cessation, we previously studied the influence of empirically distinct subdimensions of depressive symptoms among individuals participating in a cessation treatment study (Leventhal, Ramsey, et al., 2008). Results showed that higher precessation levels of NA, anhedonia, and somatic features (i.e., a dimension indicative of physical symptoms) each predicted lower cessation success, with anhedonia having the strongest influence. However, when the dimensions were considered concomitantly, only anhedonia predicted poorer outcomes incrementally to the other dimensions. Furthermore, anhedonia's effect was incremental to other relevant clinical characteristics, such as tobacco dependence severity, cigarettes per day, and history of major depression. Additional studies have found that anhedonia, or low positive affect, predicts poorer cessation outcomes (Carton, Le Houezec, Lagrue, & Jouvent, 2002; Doran et al., 2006; Japuntich et al., 2007; Niaura et al., 2001) and more persistent tobacco dependence (Leventhal, Kahler, Ray, & Zimmerman, 2009).

Despite the emerging evidence of anhedonia's role in smoking cessation, investigation of the motivational mechanisms linking anhedonia and smoking has been limited. Cook, Spring, McChargue, and Hedeker (2004) conducted a laboratory tobacco deprivation study, which found that anhedonia as measured by the Fawcett–Clark Pleasure Scale (FCPS; Fawcett, Clark, Scheftner, & Gibbons, 1983), predicted greater deprivation-induced increases in cigarette craving. These findings elucidate some of the mechanisms linking anhedonia and smoking and raise several points for additional investigation.

First, the FCPS, as used in Cook et al. (2004), is a 36-item anhedonia questionnaire that asks participants to rate imagined hedonic reactions to hypothetical pleasurable situations. Although the FCPS is considered to have good overall psychometric properties (Leventhal, Chasson, Tapia, Miller, & Pettit, 2006), it contains some items that may not apply to the entire population (e.g., "Your neighbors rave about the way you keep up your house and yard"; "While fishing, you feel a tug on your line and watch a 6-pound fish jump out of the water with your bait in its mouth"). The Snaith–Hamilton Pleasure Scale (SHAPS; Snaith, Hamilton, Morley, & Humayan, 1995) is a shorter (14-item) anhedonia scale that also uses a hypothetical situation format; however, it was constructed to be unaffected by social class, gender, age, dietary habits, and nationality. This is evident in the general content of SHAPS items (e.g., "I would get pleasure from helping others"; "I would enjoy my favorite television or radio program"). We recently found that although both the FCPS and the SHAPS strongly loaded onto a latent dimension of anhedonia, the SHAPS had a stronger loading ($r = .92$) than the FCPS ($r = .68$; Leventhal et al., 2006). Thus, exploring the smoking-related correlates of SHAPS scores may support the usage of a novel anhedonia scale in smoking research.

Second, a unidimensional measure of cigarette craving was utilized in Cook et al. (2004). Extending these findings to multidimensional measures of craving (Cox, Tiffany, & Christen, 2001), which distinguish between appetitive smoking urges (desire to smoke and anticipation of pleasure from smoking) and aversive smoking urges (urgent need to smoke and anticipation of NA relief from smoking), could further elucidate the motivational basis of smoking in anhedonic individuals.

Finally, previous analyses indicate that anhedonia is uncorrelated with several smoking characteristics, including smoking chronicity, cigarettes smoked per day, and Fagerström Test for Nicotine Dependence (FTND) scores (Cook, Spring, & McChargue, 2007). It remains unclear, however, whether anhedonia correlates with other motivationally relevant smoking characteristics. Recent conceptualizations indicate that tobacco dependence motivation is a multidimensional construct involving theoretically distinct domains that can be assessed using trait-based measures such as the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68; Piper et al., 2004). Additional characteristics, including the frequency and duration of previous quit attempts, can also provide clinically useful information about smoking motivation. Thus, exploring whether anhedonia is associated with smoking dependence motives and previous cessation patterns may clarify how and why anhedonia is linked with poor cessation outcomes.

To that end, the current study examined the association between anhedonia (as measured by the SHAPS) and baseline smoking characteristics, spanning constructs relevant to smoking heaviness, quitting history, and smoking dependence motivation. Based on previous findings, we hypothesized that anhedonia would not be associated with smoking heaviness or FTND scores but would be linked to lower success of previous cessation attempts. We did not make any hypotheses regarding the association between anhedonia and WISDM-68 dimensions due to the paucity of extant research in this area. We also evaluated whether anhedonia moderated the effect of experimentally manipulated 12-hr tobacco deprivation on dimensions of smoking urges. Previous evidence indicates that anhedonia predicts deprivation-induced changes in positive but not NA (Cook et al., 2004). Therefore, we hypothesized that anhedonia would predict greater deprivation-induced changes in appetitive smoking urges but would not associate with deprivation-induced changes in aversive smoking urges.

Methods

Participants

Participants were 212 current smokers enrolled at the University of Houston recruited to participate in a larger study on the cognitive effects of acute tobacco deprivation (Leventhal, Waters, et al., 2008). 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. The inclusion criteria were as follows: (a) report normal or corrected-to-normal vision, (b) 18+ years of age, and (c) report smoking 5+ cigarettes/day on average for the past 2 years. Individuals were excluded if they could read or speak Chinese (one of the cognitive tasks in the larger study required participants to rate Chinese ideographs intended to be novel). Smokers were excluded if they (a) planned to quit in the next 30 days, (b) were currently cutting down substantially, or (c) were currently using some form of nicotine replacement therapy. Participants received a $15 voucher redeemable at a department store and course credit for completing the study. The study was approved by the Institutional Review Boards of the University of Texas M. D. Anderson Cancer Center and the University of Houston.

Procedure

At a baseline session, participants completed questionnaires on anhedonia, NA, and smoking characteristics (see Measures section).

Smokers who completed the baseline session were randomized to be either deprived or nondeprived during their experimental session. Deprived participants were asked to abstain from smoking for at least 12 hr before the experimental session. Nondeprived participants were asked to smoke freely before the session and to smoke one cigarette within 30 min of the session. Experimental sessions were conducted within 2 weeks of the baseline session. At the outset of the experimental session, breath carbon monoxide (CO) levels were assessed to determine whether participants complied with instructions either to abstain or to smoke within 30 min of the session (see Analyses of Experimental Session Data section). Participants then completed cognitive tasks for 30 min, after which they completed questionnaires, including a measure of craving.

Measures

At the baseline session, the following questionnaires were administered:

SHAPS (Snaith et al., 1995). The SHAPS is a 14-item questionnaire that measures current capacity to experience pleasure. Participants rate the degree of pleasure they would experience if they engaged in hypothetical activities that are normally rewarding. Each of the items has a set of four response categories: *Definitely Agree* (0), *Agree* (1), *Disagree* (2), and *Definitely Disagree* (3). A higher total score indicates higher levels of anhedonia. In the original scoring algorithm, Snaith et al. (1995) proposed to recode each item as dichotomous (*Definitely Agree or Agree* 0 and *Disagree or Definitely Disagree* 1). However, recent approaches have used an updated scoring algorithm, which codes each of the four response categories as separate scores (ranging 0–3), in order to generate greater dispersion of the data. The psychometric properties of the updated scoring algorithm have been supported (Franken, Rassin, & Muris, 2007; Leventhal et al., 2006). In the present study, the original scoring was used only to identify the proportion of participants that could be diagnosed as anhedonic based on Snaith et al.'s recommended cutoff (original SHAPS score >2). For all other analyses, the updated scoring algorithm was used in which a total score was computed by summing scores across four response categories.

The SHAPS has demonstrated excellent construct validity in a previous study in which it loaded strongly onto a latent dimension of anhedonia ($r = .92$), which was distinct from latent dimensions of dysphoric depression ($r = .12$) and anxiety ($r = .14$; Leventhal et al., 2006). The SHAPS has also demonstrated excellent test–retest reliability (Franken et al., 2007). In this sample, the SHAPS had good internal consistency (Cronbach's $\alpha = .87$) and adequate construct validity as evidenced by a robust inverse correlation with the Positive and Negative Affect Schedule (PANAS)-positive affect scale ($r = -.43$, $p < .0001$) and a modest but significant correlation with the PANAS-NA scale ($r = .19$, $p = .005$).

PANAS (Watson, Clark, & Tellegen, 1988). The 10-item PANAS-NA subscale was used to assess NA during the past week. This scale has evidenced excellent psychometric properties in previous samples (Watson et al., 1998). This scale's α in this sample was .80.

Smoking History Questionnaire. This questionnaire assessed years of smoking, number of cigarettes smoked per day, previous number of serious quit attempts, and number of previous quit attempts in which abstinence was maintained for at least 24 hr. Using these last two measures, a ratio score was computed for the proportion of quit attempts ended in early lapses ([number of total quit attempts − number of cessation attempts with ≥24-hr abstinence]/number of total quit attempts).

FTND (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). The FTND is a widely used and well-validated measure of nicotine dependence.

WISDM-68 (Piper et al., 2004). The WISDM-68 is a 68-item questionnaire that assesses 12 theoretically distinct domains of tobacco dependence motives using a subscale approach (affiliative attachment, automaticity, loss of control, behavioral choice–melioration, cognitive enhancement, craving, cue exposure–associative processes, negative reinforcement, positive reinforcement, social–environmental goads, taste and sensory processes, tolerance, and weight control). WISDM-68 subscales associate with biochemical and other self-report dependence assessments (Piper et al., 2004). A combined overall dependence severity score is also calculated by averaging all items.

At the experimental session, the 10-item *Questionnaire on Smoking Urges-brief* (QSU-brief; Cox et al., 2001) was administered to assess cigarette craving. Participants were asked to respond according to how they felt "right now" on a 6-point scale. In addition to a total craving score, which utilizes all items, the QSU yields two distinct five-item factor scores. Factor 1 captures intention and desire to smoke and anticipation of pleasure from smoking (e.g., "I have a desire for a cigarette," "A cigarette would taste good"). Factor 2 reflects urgent need to smoke and anticipation of relief from NA (e.g., "I would do almost anything for a cigarette," "Smoking would make me less depressed"). This two-factor structure has been supported in previous laboratory samples (Cox et al., 2001). The internal consistency of both subscales in this sample was high (Factor 1: $\alpha = .94$; Factor 2: $\alpha = .90$). The two subscales had 49% overlapping variance, indicating that they were assessing related, but not entirely redundant, constructs.

Data analysis

Analyses of baseline session data. Preliminary analyses examined the distribution of SHAPS scores and the proportion of individuals who scored above the cutoff for a diagnosis of anhedonia using the criterion of Snaith et al. (1995). To assess associations between anhedonia and baseline smoking characteristics, we computed correlations between SHAPS scores and Smoking History Questionnaire measures, WISDM-68 subscales, and FTND scores. Because SHAPS scores demonstrated a small, but significant association with PANAS-NA, any associations demonstrated between the SHAPS and the measures of smoking motivation could potentially be explained by covariance accounted for by affective distress. Accordingly, these correlations were recomputed as partial correlations, which adjusted for PANAS-NA scores, to examine if associations were specific to the appetitive aspect of anhedonia and not explained by any potential overlap with aversive affect. Although the PANAS-positive affect scale was also measured at baseline, analyses do not control for this variable because the constructs of positive affect and anhedonia are strongly overlapping. Similarly, analyses do not control for overall depressive symptoms because measures of depressive symptomatology typically include items assessing anhedonia and positive affect. Thus, covaring for positive affect or depressive symptoms may partial out relevant variance linked with the appetitive aspects of the anhedonia construct. Rather, we control only for NA in order to partial out irrelevant variance overlapping with aversive affect. The above analyses used all participants who completed the baseline session ($N = 212$), with the exception of correlations with number of sustained cessation periods and proportion of early lapses (only participants who made at least one cessation attempt completed the number of sustained cessation periods item; $n = 102$).

Analyses of experimental session data. In the larger study from which this sample was drawn (Leventhal, Waters, et al., 2008), a subset of participants did not complete the experimental session ($n = 50$) or did not meet criteria for biochemical confirmation of either smoking in the nondeprived group ($CO \geq 9$ ppm) or abstinence in the deprived group ($CO < 9$ ppm; $n = 42$) and were therefore excluded from the analyses of experimental session data. The final sample used in the experimental session analyses consisted of 69 nondeprived smokers and 51 deprived smokers. Participants who did not meet biochemical abstinence criteria were more likely to be male and were heavier, more chronic, and more dependent smokers than those who met biochemical abstinence criteria. These two groups were not significantly different on SHAPS and PANAS-NA scores at baseline ($ps > .87$). In addition, the pattern of findings was not substantially altered when both groups were included in the analyses. Therefore, the experimental session analyses presented herein utilize the sample of compliant study completers.

To examine whether anhedonia moderated the effects of deprivation on craving, we ran regression models in which the continuous variable of SHAPS scores, Group (deprived vs. nondeprived), and the SHAPS × Group interaction term were independent variables and craving was the dependent variable. Separate models were run for the dependent variables of QSU-Total, QSU-Factor 1, and QSU-Factor 2. We ran an additional set of three regression models, which included the same independent variables as above, but also added PANAS-NA scores and the PANAS-NA × Group interaction term as covariates to examine the affective specificity of effects. Although the primary analysis utilized the continuous variable of SHAPS scores, interactions were deconstructed in additional analyses by examining the Group effect across two subsamples categorized on a median split of SHAPS scores for graphing and interpretation of results. In all interaction models, the deprivation group variable was coded −0.5 for nondeprived and 0.5 for deprived so that the standardized estimate (β) of each effect could be interpreted.

SHAPS scores were not significantly associated with age, gender, or ethnicity. Therefore, these variables were not included as covariates. Alpha level was set at .05, and all tests were two-tailed. All regression models were tested in SAS using PROC REG (SAS Institute Inc., 2003).

Results

Distribution of SHAPS scores

The mean SHAPS score was 8.2 ($SD = 6.1$, range 0–32), and 43 of 212 (20.3%) participants scored above the cutoff of Snaith et al. (1995) for an anhedonia diagnosis. The distribution of scores is higher than previous samples selected from the general population but lower than samples selected from psychiatric treatment settings (Franken et al. 2007; Leventhal et al. 2006; Snaith et al., 1995). Thus, the range of responses in the present sample indicates adequate distribution across the continuum of anhedonia severity.

Associations between SHAPS scores and smoking characteristics

As illustrated in Table 1, SHAPS scores were significantly correlated with higher numbers of quit attempts but not with number of quit attempts in which abstinence was achieved for at least 24 hr. Consistent with this dissociation, SHAPS scores were correlated with a greater proportion of early lapses. Each of these effects remained significant after controlling for PANAS-NA scores.

Unadjusted analyses indicated that SHAPS scores were significantly correlated with WISDM-68 automaticity, behavioral choice–melioration, cognitive enhancement, and craving subscales (see Table 1). These associations fell below significance when PANAS-NA scores were controlled for, although there was a trend correlation with behavioral choice–melioration ($r = .13$, $p = .06$). SHAPS scores did not significantly correlate with any other WISDM scale, FTND scores, cigarettes smoked per day, age of smoking onset, or duration of smoking.

Anhedonia's moderating influence on the effects of deprivation on craving

As depicted in Table 2, the SHAPS × Group interaction effect was significant in the unadjusted models predicting QSU-Total and QSU-Factor 1, which indexed appetitive urges ($ps < .05$), but nonsignificant for the QSU-Factor 2, which indexed aversive urges ($p = .12$). In the adjusted models, the SHAPS × Group interaction remained significant in the model predicting QSU-Factor 1 ($p < .05$), was reduced below significance in the model predicting QSU-Total ($p = .12$), and eliminated in the model predicting QSU-Factor 2 ($p = .61$; see Table 2). Consistent with the primary findings, additional analyses using scores from the QSU-Factor 1 item most indicative of the rewarding aspects of smoking ["A cigarette would really taste good right now"] as the dependent variable found significant SHAPS × Group interactions in both unadjusted and adjusted models ($\beta s > .17$, $ps < .05$).

To follow-up on the interaction, we categorized participants as high anhedonia if they scored above the median SHAPS score of 8 and as low anhedonia if they scored at or below the median.

Table 1. Associations between anhedonia and smoking characteristics

Variable	M (SD)	Correlations with SHAPS scores: Unadjusted r	Partial r[a]
Age of smoking onset (years)	17.7 (2.7)	.02	.02
Duration of smoking (years)	6.5 (6.0)	−.04	−.01
Cigarettes per day	14.9 (6.2)	.01	.01
Number of previous quit attempts	1.8 (2.6)	.23***	.22***
Number of sustained cessation periods (>24 hr)[b]	1.2 (1.4)	−.09	−.10
Proportion of early lapses[c]	0.40 (.38)	.20*	.20*
FTND	3.9 (2.1)	.09	.05
WISDM-68[d]			
Total	4.0 (1.1)	.11	.04
Affiliative attachment	2.8 (1.6)	.10	.05
Automaticity	4.1 (1.6)	.15*	.11
Locus of control	3.2 (1.1)	.08	.04
Behavioral choice–melioration	3.2 (1.4)	.18**	.13†
Cognitive enhancement	3.9 (1.7)	.14*	.09
Craving	4.4 (1.5)	.14*	.09
Cue exposure	5.0 (1.2)	−.03	−.09
Negative reinforcement	4.5 (1.4)	.03	−.04
Positive reinforcement	4.2 (1.3)	.01	−.05
Social–environmental goads	4.7 (1.8)	.01	−.02
Taste and sensory properties	4.4 (1.3)	−.03	−.06
Tolerance	4.2 (1.6)	.12	.09
Weight control	2.7 (1.7)	.10	.04

Note. $N = 212$. FTND, Fagerström Test for Nicotine Dependence; SHAPS, Snaith–Hamilton Pleasure Scale; and WISDM-68, Wisconsin Inventory of Smoking Dependence Motives.

[a]Adjusted for Positive and Negative Affect Schedule-negative affect.

[b]Analyses run among those with at least one attempt ($n = 102$).

[c]Ratio of number of sustained cessation periods to number of quit attempts.

[d]Average score per item (range 1–7).

†$p = .06$; *$p < .05$; **$p < .01$; ***$p < .002$.

In the high anhedonia participants, the differences between nondeprived ($n = 30$) and deprived ($n = 20$) groups in QSU-Factor 1 scores were robust, $\beta(1, 48) = .64$, $p < .0001$, $R^2 = .42$. In the low anhedonia participants, the differences between nondeprived ($n = 39$) and deprived ($n = 31$) groups in QSU-Factor 1 scores were smaller, $\beta(1, 68) = .23$, $p = .06$, $R^2 = .05$ (see Figure 1). Regression analyses utilizing this SHAPS variable (coded −0.5 for low and 0.5 for high) found a significant Anhedonia Status × Group interaction effect, $\beta(1, 116) = .20$, $p = .02$, which was comparable in size to the interaction effect detected in the primary analyses that utilized the continuous SHAPS variable.

Given the dissociation of effects for the two QSU-Factor scales in the adjusted analyses, we computed an additional post-hoc analysis. This mixed model included the between-subjects variables of SHAPS score and Group, the within-subject variable of Subscale (QSU-Factor 1 vs. QSU-Factor 2), the between-subjects covariate of PANAS-NA scores, and all the interaction terms. This model yielded a trend SHAPS × Group × Subscale three-way interaction, $F(1, 114) = 3.50$, $p = .06$. Thus, there was tentative evidence that the moderating influence of SHAPS scores on the deprivation effect was more pronounced for Factor 1 than for Factor 2 scores.

Discussion

This study explored relations between anhedonia (as measured by the SHAPS) and aspects of smoking motivation. Consistent with previous findings, anhedonia was not associated with cigarettes per day, FTND scores, and smoking chronicity (Cook et al., 2007). However, anhedonia was related with greater frequency of past quit attempts and proportion of quit attempts ending in rapid relapses, in which abstinence could not be maintained for greater than 24 hr. These findings are concordant with a previous study of relapse patterns in self-quitters (Niaura et al., 2001), which found that individuals who endorsed anhedonia on a single-item scale relapsed faster than those who did not endorse anhedonia. Taken together, these findings indicate that although individuals with higher levels of anhedonia may have difficulty sustaining abstinence, they nonetheless appear to be interested in quitting and make more quit attempts.

We also examined the relation between anhedonia and smoking dependence motives. Results showed that anhedonia was significantly correlated with some of the WISDM-68 subscales (automaticity, behavioral choice–melioration, cognitive

Table 2. Summary of regression analyses examining whether anhedonia moderates the effects of deprivation on craving

Independent variables	Unadjusted model: β(1, 116)	p	Adjusted model[a]: β(1, 114)	p
Dependent variable: QSU-Total score				
SHAPS	.09	.30	.01	.91
Group	.42	<.0001	.39	<.0001
SHAPS × Group interaction	.18	.04	.12	.16
Dependent variable: QSU-Factor 1 score				
SHAPS	−.04	.68	.01	.94
Group	.39	<.0001	.37	<.0001
SHAPS × Group interaction	.19	.03	.17	.047
Dependent variable: QSU-Factor 2 score				
SHAPS	.13	.14	.02	.77
Group	.39	<.0001	.36	<.0001
SHAPS × Group interaction	.13	.12	.04	.61

Note. Group variable was coded −0.5 for nondeprived and 0.5 for deprived. SHAPS, Snaith–Hamilton Pleasure Scale; Group, nondeprived ($n = 69$) vs. deprived ($n = 51$); QSU, Questionnaire on Smoking Urges-brief; PANAS-NA scale, and Positive and Negative Affect Schedule-negative affect scale.

[a]Model adjusted for PANAS-NA scores and the PANAS-NA × Group interaction.

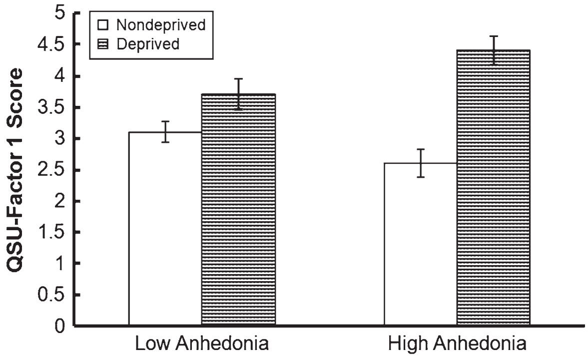

Figure 1. *M* (*SEM*) of QSU-Factor 1 scores (desire to smoke and anticipation of pleasure from smoking), by anhedonia status (high vs. low) and Group (deprived vs. nondeprived). A significant Anhedonia Status × Group interaction was found, $\beta(1, 116) = 270$, $p = .02$, such that the Group effect was a trend in low anhedonia smokers ($\beta = .23$, $p = .06$) and robust in high anhedonia smokers ($\beta = .64$, $p < .0001$). High anhedonia (SHAPS > 8; nondeprived $n = 30$ and deprived $n = 20$); low anhedonia (SHAPS ≤8; nondeprived $n = 39$ and deprived $n = 41$); SHAPS, Snaith–Hamilton Pleasure Scale; and QSU, Questionnaire on Smoking Urges-brief (average score per item, range: 0–5).

enhancement, and craving). However, these associations were reduced below significance after controlling for NA, indicating that these linkages were partially accounted for by overlapping variance in affective disturbance that was not specific to anhedonia. Adjusted analyses indicated a trend-level association between the anhedonia and the behavioral choice–melioration scale (i.e., the tendency to place higher priority on smoking as a reinforcer in comparison to other reinforcers). This relationship could be consistent with the notion that anhedonic smokers come to rely on smoking as a reinforcer because they are insensitive to the hedonic properties of other reinforcers. Nonetheless, this should be interpreted with caution because the association was relatively small and did not reach statistical significance. Although we did not make a priori hypotheses about which WISDM-68 scales would be correlated with anhedonia, the lack of association with the Positive Reinforcement Scale is notable, given that one might expect anhedonic smokers to utilize smoking as a positive reinforcer. This finding could potentially be explained by the limited discriminant validity of this scale. The WISDM Positive and Negative Reinforcement Scales were strongly associated in this sample ($r = .85$) and in a previous sample ($r = .80$; Leventhal, Ramsey, et al., 2008). Thus, future research of the link between anhedonia and other measures of positive reinforcement smoking may be warranted to clarify this relationship.

Concordant with our hypothesis, individuals with higher anhedonia were more sensitive to the effects of tobacco deprivation on appetitive (but not aversive) smoking urges. Even though nearly half the variance in the QSU-Factor 1 and Factor 2 subscales overlapped, the dissociation of findings was prominent, especially in the adjusted analyses, which controlled for influence of baseline NA. Follow-up analyses offered suggestive evidence of a three-way interaction by which the moderating effects of anhedonia on deprivation-induced urges were unique to the QSU-Factor 1, which also supports the appetitive–aversive distinction. These results parallel previous findings indicating that individuals with higher anhedonia are more sensitive to the acute effects of nicotine administration and deprivation on positive (but not negative) affect (Cook et al., 2004, 2007).

Overall, the present results add to the emerging evidence that appetitive processes may underlie anhedonia's relationship with smoking and extend previous work by Cook et al. (2004, 2007) in several ways. First, we demonstrated that the SHAPS may be a useful measure of anhedonia that associates with aspects of smoking motivation. Second, we found that anhedonia's link with deprivation-induced changes in craving was specific to the appetitive facet of smoking urges and robust when controlling for baseline NA. Third, we explored smoking characteristics that had not previously been examined in the anhedonia literature (e.g., the WISDM).

The potential limitations of this study should be noted. Although it supports the utility of the SHAPS as a measure of anhedonia in smoking research, we cannot compare effects found across different anhedonia measures because only the SHAPS was included in this study. Also, the tobacco deprivation was limited to 12 hr; thus, it is unclear whether these findings would generalize to longer periods of abstinence. Additionally, we do not know whether the deprivation effects observed in the study were due to changes in nicotine intake or psychological factors associated with tobacco deprivation (e.g., expectations about nicotine withdrawal). Finally, a sizeable portion of individuals either did not attend the experimental session ($n = 50$) or did not comply with smoking/abstinence instructions ($n = 42$) and were therefore not included in the experimental session analyses. Participants who were excluded from these analyses were different from those who were included on several smoking characteristics. Importantly, however, excluded participants did not differ in anhedonia, and the findings did not change when their data were included in the analysis, suggesting that these factors did not significantly influence the findings. Finally, we did not examine mediators of deprivation-induced changes in smoking urges, which are of considerable interest (Cook et al., 2004). Future research should examine the appetitive motivational processes that might mediate anhedonia's influence on smoking urges and whether urges ultimately precipitate smoking relapse among individuals with high anhedonia.

In sum, the present study indicates that anhedonia is linked with rapid relapses and an appetitive motivational urge to smoke under conditions of tobacco deprivation. These data may explain how and why anhedonia and low positive affect are associated with relapse (Carton et al., 2002; Doran et al., 2006; Japuntich et al., 2007; Leventhal, Ramsey, et al., 2008; Niaura et al., 2001). Continued research on the appetitive motivational pathway linking anhedonia and smoking behavior could potentially inform the development of more effective treatments that mitigate anhedonia's influence on smoking relapse vulnerability. For instance, the current findings suggest that interventions targeting anhedonic smokers should perhaps focus more strongly on coping with appetitive urges during the acute stages of abstinence, which appears especially problematic for this subset of individuals. Further work is necessary to fully translate these findings into treatment applications and recommendations to practicing clinicians. Nevertheless, the potential clinical implications of targeting this treatment-resistant group of smokers are clear and warrant further basic and applied research.

Funding

This research was supported, in part, by grants CA57730 and DA016184 from the National Institutes of Health.

Declaration of Interests

None declared.

Acknowledgments

The authors extend their gratitude to Evelina Tapia and Elizabeth Miller for their role in collecting these data.

References

Anda, R. F., Williamson, D. F., Escobedo, L. G., Mast, E. E., Giovino, G. A., & Remington, P. L. (1990). Depression and the dynamics of smoking. A national perspective. *Journal of the American Medical Association*, *264*, 1541–1545.

Brown, R. A., Kahler, C. W., Niaura, R., Abrams, D. B., Sales, S. D., Ramsey, S. E., et al. (2001). Cognitive-behavioral treatment for depression in smoking cessation. *Journal of Consulting and Clinical Psychology*, *69*, 471–480.

Carton, S., Le Houezec, J., Lagrue, G., & Jouvent, R. (2002). Early emotional disturbances during nicotine patch therapy in subjects with and without a history of depression. *Journal of Affective Disorders*, *72*, 195.

Cinciripini, P. M., Wetter, D. W., Fouladi, R. T., Blalock, J. A., Carter, B. L., Cinciripini, L. G., et al. (2003). The effects of depressed mood on smoking cessation: Mediation by postcessation self-efficacy. *Journal of Consulting and Clinical Psychology*, *71*, 292–301.

Cook, J. W., Spring, B., & McChargue, D. (2007). Influence of nicotine on positive affect in anhedonic smokers. *Psychopharmacology*, *192*, 87–95.

Cook, J. W., Spring, B., McChargue, D., & Hedeker, D. (2004). Hedonic capacity, cigarette craving, and diminished positive mood. *Nicotine & Tobacco Research*, *6*, 39–47.

Cox, L. S., Tiffany, S. T., & Christen, A. G. (2001). Evaluation of the brief questionnaire of smoking urges (QSU-brief) in laboratory and clinical settings. *Nicotine & Tobacco Research*, *3*, 7–16.

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-withdrawal and cerebral asymmetry: Emotional expression and brain physiology. I. *Journal of Personality and Social Psychology*, *58*, 330–341.

Doran, N., Spring, B., Borrelli, B., McChargue, D., Hitsman, B., Niaura, R., et al. (2006). Elevated positive mood: A mixed blessing for abstinence. *Psychology of Addictive Behaviors*, *20*, 36–43.

Fawcett, J., Clark, D. C., Scheftner, W. A., & Gibbons, R. D. (1983). Assessing anhedonia in psychiatric patients: The Pleasure Scale. *Archives of General Psychiatry*, *40*, 79–84.

Franken, I. H. A., Rassin, E., & Muris, P. (2007). The assessment of anhedonia in clinical and non-clinical populations: Further validation of the Snaith-Hamilton Pleasure Scale (SHAPS). *Journal of Affective Disorders*, *99*, 83–89.

Ginsberg, D., Hall, S. M., Reus, V. I., & Muñoz, R. F. (1995). Mood and depression diagnosis in smoking cessation. *Experimental and Clinical Psychopharmacology*, *3*, 389–395.

Haas, A. L., Muñoz, R. F., Humfleet, G. L., Reus, V. I., & Hall, S. M. (2004). Influences of mood, depression history, and treatment modality on outcomes in smoking cessation. *Journal of Consulting and Clinical Psychology*, *72*, 563–570.

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerström, K.-O. (1991). The Fagerström Test for Nicotine Dependence: A revision of the Fagerström Tolerance Questionnaire. *British Journal of Addiction*, *86*, 1119–1127.

Hitsman, B., Pingitore, R., Spring, B., Mahableshwarkar, A., Mizes, J. S., Segraves, K. A., et al. (1999). Antidepressant pharmacotherapy helps some cigarette smokers more than others. *Journal of Consulting and Clinical Psychology*, *67*, 547–554.

Japuntich, S. J., Smith, S. S., Jorenby, D. E., Piper, M. E., Fiore, M. C., & Baker, T. B. (2007). Depression predicts smoking early but not late in a quit attempt. *Nicotine & Tobacco Research*, *9*, 677–686.

Killen, J. D., Fortmann, S. P., Davis, L., Strausberg, L., & Varady, A. (1999). Do heavy smokers benefit from higher dose nicotine patch therapy? *Experimental and Clinical Psychopharmacology*, *7*, 226–233.

Kinnunen, T., Doherty, K., Militello, F. S., & Garvey, A. J. (1996). Depression and smoking cessation: Characteristics of depressed smokers and effects of nicotine replacement. *Journal of Consulting and Clinical Psychology*, *64*, 791–798.

Leventhal, A. M., Chasson, G. S., Tapia, E., Miller, E. K., & Pettit, J. W. (2006). Measuring hedonic capacity in depression: A psychometric analysis of three anhedonia scales. *Journal of Clinical Psychology*, *62*, 1545–1558.

Leventhal, A. M., Kahler, C. W., Ray, L., & Zimmerman, M. (2009). Refining the depression-nicotine dependence link: Patterns of depressive symptoms in psychiatric outpatients with current, past, and no history of nicotine dependence. *Addictive Behaviors*, *34*, 297–303.

Leventhal, A. M., Ramsey, S. E., Brown, R. A., LaChance, H. A., & Kahler, C. W. (2008). Dimensions of depressive symptoms and smoking cessation. *Nicotine & Tobacco Research*, *10*, 507–517.

Leventhal, A. M., Waters, A. J., Breitmeyer, B. G., Tapia, E., Miller, E. K., & Li, Y. (2008). Subliminal processing of smoking-related and affective stimuli in tobacco addiction. *Experimental and Clinical Psychopharmacology*, *16*, 301–312.

Loas, G., Fremaux, D., & Boyer, P. (1997). Anhedonia and alexithymia: Distinct or overlapping constructs. *Perceptual and Motor Skills*, *84*, 415–425.

Loas, G., Salinas, E., Pierson, A., & Guelfi, J. D. (1994). Anhedonia and blunted affect in major depressive disorder. *Comprehensive Psychiatry*, *35*, 366–372.

McChargue, D. E., Spring, B., Cook, J. W., & Neumann, C. A. (2004). Reinforcement expectations explain the relationship between depressive history and smoking status in college students. *Addictive Behaviors*, *29*, 991–994.

Niaura, R., Britt, D. M., Shadel, W. G., Goldstein, M., Abrams, D., & Brown, R. (2001). Symptoms of depression and survival experience among three samples of smokers trying to quit. *Psychology of Addictive Behaviors*, *15*, 13–17.

Piper, M. E., Piasecki, T. M., Federman, E. B., Bolt, D. M., Smith, S. S., Fiore, M. C., et al. (2004). A multiple motives approach to tobacco dependence: The Wisconsin Inventory of Smoking Dependence Motives (WISDM-68). *Journal of Consulting and Clinical Psychology*, *72*, 139–154.

Rausch, J. L., Nichinson, B., Lamke, C., & Matloff, J. (1990). Influence of negative affect on smoking cessation treatment outcome: A pilot study. *British Journal of Addiction*, *85*, 929–933.

SAS Institute Inc. (2003). *The SAS System for Windows (Version 8.2)*. Cary, NC: SAS Institute Inc.

Shafer, A. B. (2006). Meta-analysis of the factor structures of four depression questionnaires: Beck, CES-D, Hamilton, and Zung. *Journal of Clinical Psychology*, *62*, 123–146.

Snaith, R. P., Hamilton, M., Morley, S., & Humayan, A. (1995). A scale for the assessment of the hedonic tone: The Snaith-Hamilton Pleasure Scale. *British Journal of Psychiatry*, *167*, 99–103.

Spring, B., Cook, J. W., Appelhans, B., Maloney, A., Richmond, M., Vaughn, J., et al. (2008). Nicotine effects on affective response in depression-prone smokers. *Psychopharmacology*, *196*, 461–471.

Swan, G. E., Jack, L. M., Curry, S., Chorost, M., Javitz, H., McAfee, T., et al. (2003). Bupropion SR and counseling for smoking cessation in actual practice: Predictors of outcome. *Nicotine & Tobacco Research*, *5*, 911–921.

Watson, D., & Clark, L. A. (1997). Measurement and mismeasurement of mood: Recurrent and emergent issues. *Journal of Personality Assessment*, *68*, 267–296.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063–1070.