ORIGINAL INVESTIGATION

Direct and Indirect Associations Between Social Anxiety and Nicotine Dependence and Cessation Problems: Multiple Mediator Analyses

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Received October 1, 2013; accepted December 20, 2013

ABSTRACT

Introduction: Little empirical work has evaluated why socially anxious smokers are especially vulnerable to more severe nicotine dependence and cessation failure. Presumably, these smokers rely on cigarettes to help them manage their chronically elevated negative affect elicited by a wide array of social contexts.

Methods: The current study examined the direct and indirect effects of social anxiety cross-sectionally in regard to a range of smoking processes among 466 treatment-seeking smokers. Negative affect and negative affect reduction motives were examined as mediators of the relations of social anxiety with nicotine dependence and cessation problems.

Results: Social anxiety was directly and robustly associated with perceived barriers to smoking cessation and problems experienced during past quit attempts. Social anxiety was also associated with greater nicotine dependence and smoking inflexibility indirectly through negative affect and negative affect smoking motives. Negative affect and smoking to reduce negative affect mediated these relations.

Conclusions: These findings document the important role of negative affect and negative affect reduction motives in the relationships of social anxiety with nicotine dependence and cessation problems.

INTRODUCTION

Social anxiety is related to nicotine dependence and cessation failures. To illustrate, persons with social anxiety disorder (SAD) demonstrate greater likelihood of nicotine dependence and heavy smoking relative to those without SAD after controlling for other anxiety disorders, depression, and other substance use disorders (Cougle, Zvolensky, Fitch, & Sachs-Ericsson, 2010). Additionally, one third of people with SAD suffer from nicotine dependence (Grant et al., 2005). Among treatment-seeking smokers, those with SAD reported higher levels of nicotine dependence and greater quit-day negative affect than those with no anxiety disorder history (Piper, Cook, Schlam, Jorenby, & Baker, 2011). SAD is also associated with a greater number of failed quit attempts (Cougle et al., 2010). Notably, SAD tends to onset prior to nicotine dependence (Cougle et al., 2010; Sonntag, Wittchen, Höfler, Kessler, & Stein, 2000) and elevated social anxiety is prospectively related to more severe nicotine dependence after controlling for depression (Sonntag et al., 2000). In fact, social anxiety may be unique among the anxiety disorders as a risk factor for nicotine

dependence given that SAD tends to onset prior to smoking, whereas smoking tends to onset prior to other anxiety disorders (Cougle et al., 2010). Yet, strikingly little empirical work has identified mechanisms underlying the relations of social anxiety to nicotine dependence and cessation problems. Such information could inform personalized treatment development efforts (see National Institute of Drug Abuse, 2013).

In line with negative reinforcement models of drug use (e.g., Baker, Piper, McCarthy, Majeskie, & Fiore, 2004), socially anxious persons may rely on smoking to cope with their chronically elevated negative affect elicited by a wide array of social contexts. In line with this perspective, social anxiety is related to smoking to cope in social situations (N. L. Watson, VanderVeen, Cohen, DeMarree, & Morrell, 2012). Also, affiliative attachment motives (viewing cigarettes as a friend and as having some of the same characteristics as social stimuli; Piper et al., 2004) mediated the relation between social anxiety and nicotine dependence severity (Buckner & Vinci, 2013). These data suggest socially anxious smokers may use cigarettes to manage negative affective states, such as loneliness (resulting from social avoidance), which may at least partially

doi:10.1093/ntr/ntt285

Advance Access publication February 3, 2014

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account for greater nicotine dependence. Further, treatment-seeking smokers with SAD have been found to have greater quit-day negative affect compared with smokers without anxiety disorders (Piper et al., 2011). Together, a growing, albeit still limited, corpus of work suggests that negative affect and smoking to cope with negative affect may play important roles in nicotine dependence and cessation problems (e.g., perceived barriers to cessation, problems associated with quitting) among socially anxious smokers. However, no studies have directly evaluated mechanisms that may account for the high rates of nicotine dependence and cessation problems among socially anxious persons. In line with theoretical models of anxiety and smoking (Zvolensky & Bernstein, 2005), social anxiety may be related to of nicotine dependence and cessation problems because socially anxious persons experience greater negative affect and then engage in more negative reinforcement-based smoking motivation; that is, the indirect effects of the proposed mechanisms (negative affect and smoking motives) are theorized to sequentially impact smoking processes.

Overall, using cross-sectional data from a sample of treatment-seeking smokers, the current study tested the hypothesis that the sequential effects of negative affect and then smoking to cope with negative affect would mediate the relations of social anxiety with nicotine dependence and the following cessation problems: perceived barriers to cessation, problems associated with quitting in past quit attempts, and smoking-related avoidance/inflexibility (i.e., the tendency to respond inflexibly or with avoidance by smoking in response to difficult thoughts, feelings, and sensations). These relations were expected to be evident above and beyond the variance accounted for by gender and cooccurring alcohol and cannabis use, given that these variables are related to social anxiety (e.g., Buckner et al., 2008; Grant et al., 2005) and smoking (e.g., Bonn-Miller, Zvolensky, & Johnson, 2010; Hendricks, Delucchi, Humfleet, & Hall, 2012).

METHODS

Participants and Procedures

Participants ($N = 466$) were adult daily tobacco smokers ($M_{\text{age}} = 36.6$, $SD = 13.58$; 48.5% female) who were recruited as part of a larger smoking cessation treatment trial. Participants were recruited from the community (via flyers, newspaper ads, radio announcements) to participate in a large randomized controlled trial examining the efficacy of two smoking cessation interventions, which took place at two sites (University of Vermont and Florida State University). The current study is based on secondary analyses of pretreatment cross-sectional data. Only cases with complete data on all studies variables were included from the full sample of recruited participants ($N = 725$). Inclusion criteria included daily cigarette use (average ≥ 8 cigarettes/day for at least 1 year), ages 18–65, and reported motivation to quit smoking of ≥ 5 on a 10-point scale. Exclusion criteria included inability to give informed consent, current use of smoking cessation products or treatment, past month suicidality, and history of psychotic spectrum disorders.

The racial/ethnic composition of the current sample was White (85.8%), Black (8.3%), Hispanic (2.4%), Asian (1.1%), and Other (2.4%). Participants tended to be well educated, with 77.4% indicating that they completed at least part of college.

The average daily smoking rate was 16.6 ($SD = 9.92$), and on average, participants reported daily smoking for 18.3 years ($SD = 13.35$). Of the sample, 44.3% met criteria for at least one current (past year) psychological disorder. Rates of relevant primary diagnoses were as follows: SAD (10.3%), generalized anxiety disorder (4.9%), major depressive disorder (4.5%), dysthymia (1.9%), alcohol use disorder (4.6%), and cannabis use disorder (1.9%).

The study protocol was approved by the respective Institutional Review Boards. Individuals responding to study advertisements were scheduled for an in-person, pretreatment assessment. After providing written informed consent, participants underwent a clinical interview and completed an online survey.

Measures

Predictor

Social anxiety was assessed with the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998), a 20-item self-report assessment of anxiety related to social situations rated from 0 (*not at all*) to 4 (*extremely*) scale. Items are summed (range 0–80), with higher scores reflecting higher levels of anxiety in social situations. The SIAS has adequate internal consistency, test–retest reliability, and concurrent and discriminant validity (e.g., E. J. Brown et al., 1997; Heimberg, Mueller, Holt, Hope, & Liebowitz, 1992; Mattick & Clarke, 1998). In the present study, internal consistency was adequate ($\alpha = .87$). A score of 34 is suggestive of SAD (Heimberg et al., 1992) and 26% of the sample scored in this range.

Criterion Variables

Severity of nicotine dependence as assessed with the Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991), a 6-item scale on which scores range from 0 to 10, with higher scores reflecting high levels of physiological dependence on nicotine. The FTND has adequate internal consistency, positive relations with key smoking variables (e.g., saliva cotinine), and high test–retest reliability (Heatherton et al., 1991; Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994). Internal consistency in the current study was $\alpha = .60$.

The Barriers to Cessation Scale (BCS; Macnee & Talsma, 1995) is a 19-item self-report assessment of perceived barriers associated with quitting smoking. Participants rate from 0 (*not a barrier or not applicable*) to 3 (*large barrier*) the degree to which they identify with each listed barriers (e.g., “Weight gain,” “Friends encouraging you to smoke,” “Fear of failing to quit”). Scores are summed. The BCS has strong psychometric properties, including content and predictive validity, internal consistency, and reliability (Macnee & Talsma, 1995). Internal consistency in the current study was acceptable ($\alpha = .89$).

The Acceptance and Inflexibility Scale (AIS; Gifford, Ritsher, McKellar, & Moos, 2006) is a 13-item self-reported measure that assesses the link between internal (affective) triggers and smoking. Items are rated from 1 (*not at all*) to 5 (*very much*), with higher scores reflecting more smoking inflexibility in the presence of difficult thoughts, feelings, and sensations, and lower scores reflecting one’s ability to accept difficult thoughts and feelings without allowing these states to trigger smoking. The AIS has displayed good reliability and validity (Gifford et al., 2004, 2006). Internal consistency of the AIS total score in the current study was acceptable ($\alpha = .93$).

The Smoking History Questionnaire (SHQ; R. A. Brown, Lejuez, Kahler, & Strong, 2002) is a self-report questionnaire used to assess smoking history (e.g., onset of regular daily smoking) and pattern (e.g., number of cigarettes per day), and problematic symptoms experienced during prior quitting attempts (e.g., weight gain, nausea, irritability, and anxiety; R. A. Brown et al., 2002; Zvolensky et al., 2004). In the present study, the SHQ was used to first describe the sample on smoking history and patterns of use (e.g., smoking rate), and then to create a mean composite score of problem symptoms experienced during past quit attempts (Y_4).

Proposed Mediators

Negative affect was assessed with the negative affect subscale of the Positive and Negative Affect Scale (PANAS; D. Watson, Clark, & Tellegen, 1988), a self-report measure that asks participants to rate the extent to which they experience each of 10 different feelings and emotions (e.g., nervous) from 1 (*very slightly or not at all*) to 5 (*extremely*). In the present study, internal consistency of the negative affect subscale was excellent ($\alpha = .90$).

The negative affect reduction motives (RFS-NA; e.g., “When I feel uncomfortable or upset about something, I light up a cigarette”) were assessed via the Reasons for Smoking (RFS; Ikard, Green, & Horn, 1969). Participants are asked to rate their tendency to smoke in each of the circumstances listed, rated from 1 (*never*) to 5 (*always*). The psychometric properties of this scale, including measures of factor structure, internal consistency, and test-retest reliability, are well established (Shiffman, 1993). In the present study, internal consistency for the RFS-NA subscale was good ($\alpha = .89$).

Covariates

Alcohol problems were assessed with the Alcohol Use Disorders Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001), a 10-item self-report measure developed to identify individuals with alcohol problems. Total scores range from 0 to 30, with higher scores reflecting more hazardous drinking. Internal consistency in the present sample was good ($\alpha = .84$).

Cannabis use status was determined via the Marijuana Smoking History Questionnaire (Bonn-Miller & Zvolensky, 2009), a 40-item measure that assesses cannabis use history and patterns of use. One item was used in the current study to determine status of cannabis use in the past 30 days: “Please rate your marijuana use in the past 30 days” from 0 (*no use*) to 8 (*more than once a day*). This item was dichotomously coded to reflect a cannabis use status variable (0 = *no use*; 1 = *past 30-day use*).

Sample Descriptives

Axis I diagnoses were assessed using the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID; First, Spitzer, Gibbon, & Williams, 1994). The SCID was administered by trained advanced doctoral students under the supervision of a licensed psychologist. The rate of agreement between clinical interviewers during the course of this study has been found to be more than 80% with a kappa value of .77 (Timpano & Schmidt, 2013).

Data Analytic Strategy

Analyses were conducted in PASW Statistics 21.0 (IBM SPSS Inc.). First, zero-order correlations among predictor (SIAS [X]), proposed mediators (PANAS-NA [M_1] and RFS-NA [M_2]), and criterion variables (FTND [Y_1], BCS [Y_2], AIS [Y_3], and quit problems [Y_4]) were examined. Next, a serial multiple mediator model was conducted to examine the impact of RFS-NA through PANAS-NA as mediators of the relation between SIAS (X) and criterion outcomes (FTND, BCS, AIS, and quit problems). These conceptual path models are presented in Figure 1. This analytic approach allows for examination of two mediators, in sequential fashion, while simultaneously testing the indirect effects of each mediator independently (Hayes, 2013). In a simple mediation model, the impact of X on Y is considered a *total effect* (path c), interpreted as the expected amount by which two cases that differ by one unit on X are expected to differ on Y, which may occur directly or indirectly. The *direct effect* of X (path c')

Figure 1. Conceptual path model for the effect of social anxiety on nicotine dependence, barriers to smoking cessation, affective inflexibility, and quit problems. *Four separate models were conducted for each criterion outcome; a_1 and a_2 = specific indirect effects of X on M_1 and M_2 ; a_3 = specific indirect effect of M_1 on M_2 ; b_1 and b_2 = specific indirect effects of M_1 and M_2 on Y_i ; c' = direct effect of X on Y_i controlling for M_1 and M_2 ; a_1*b_1 and a_2*b_2 = specific indirect effects of M_1 and M_2 ; $a_1*a_3*b_2$ = conditional indirect effect of M_1 and M_2 .

is interpreted as the part of the effect of X on Y that is independent of the pathway through M. The *indirect effect* ($a*b$) is interpreted as the amount by which two cases who differ by one unit on X are expected to differ on Y through X's effect on M, which in turn affects Y. This is the test of mediation (the effect of X on Y through M) or the difference between the total and direct effects ($a*b = c - c'$). Our statistical strategy (as recommended by Hayes, 2009; Preacher & Hayes, 2004) allows for estimation and significance testing of the indirect effect, through bootstrapping, which generates an empirical representation of the sampling distribution of the indirect effect, from which a CI can be generated. Specifically, each model estimated each specific indirect effect (a^1*b^1 and a^2*b^2); however, to test for sequential mediation effects, the indirect effect of $a^1*a^3*b^2$ was also estimated and tested for statistical significance. Gender, alcohol problems (AUDIT), and cannabis use status (per MHQ) were included as covariates in the model. All analyses were conducted using PROCESS, a conditional process modeling program that utilizes an ordinary least squares-based path analytical framework to test for both direct and indirect effects (Hayes, 2013). The CIs for R^2 indices are obtained analytically. All specific and conditional indirect effects were subjected to follow up bootstrap analyses with 10,000 resamples from which a 95-percentile CI was estimated (Hayes, 2009; Preacher & Hayes, 2004, 2008).

RESULTS

Descriptive information and correlational results are presented in Table 1. Social anxiety was significantly correlated with negative affect, negative affect reduction smoking motives, perceived barriers to smoking cessation, smoking inflexibility, greater number of problems experienced while quitting, and alcohol-related problems. Both proposed mediators (negative affectivity and negative affect reduction) were significantly intercorrelated, and all criterion variables were significantly related. Additionally, male gender was significantly associated with higher AUDIT scores, whereas female gender was related

to greater number of quit problems and higher scores on the PANAS-NA, RFS-NA, BCS, and AIS.

Four path models were constructed to tests each criterion variable. Results for paths a, b, c, and c' are presented in Table 2, which correspond to each of the four models. The estimates of the specific and conditional indirect effects were the paths tested for mediation, which are presented in Table 3. Each model is described below.

Nicotine Dependence

When FTND scores were entered as the criterion (Y_1), the total effect model was significant ($R^2_{y1,x} = .021$, $df = 4, 461$, $F = 2.524$, $p = .040$; path c). The full model with the mediators was also significant ($R^2_{M1,2,x} = .162$, $df = 6, 459$, $F = 14.753$, $p < .0001$). The direct effect (path c') of social anxiety on nicotine dependence severity (controlling for the mediators) was nonsignificant. Regarding the test of the indirect (mediational) effects (as shown in Table 3, Model 1), greater social anxiety was predictive of more severe nicotine dependence indirectly through negative affect and negative affect reduction smoking motives (effect $a_1*a_3*b_2$). Additionally, social anxiety was predictive of nicotine dependence indirectly through negative affect reduction smoking motives (effect a_2*b_2), but not indirectly through negative affect alone (effect a_1*b_1). The sequential effect of the mediators was stronger than the effect of RFS-NA alone, as indicated by the higher regression coefficient for the indirect effect of $a_1*a_3*b_2$.

Barriers to Smoking Cessation

When BSC scores were the criterion (Y_2), both the total effect model ($R^2_{y2,x} = .147$, $df = 4, 461$, $F = 19.923$, $p < .0001$) and the full model with mediators accounted for significant variance ($R^2_{M1,2,x} = .344$, $df = 6, 459$, $F = 40.053$, $p < .0001$). Additionally, the direct effect of social anxiety on barriers to cessation (controlling for the mediators) was significant (see Table 2, BCS path c'). Regarding the test of the indirect effects (Table 3, Model 2), greater social anxiety was predictive of more barriers to cessation indirectly through negative affect and negative

Table 1. Descriptive Statistics and Correlations for Predictor, Mediating, and Criterion Variables ($N = 466$)

Variable	1	2	3	4	5	6	7	8	9	10
1. Gender (% female) ^a		-.10*	-.06	.06	.14**	.25**	-.01	.22**	.18**	.28**
2. AUDIT total ^a			.19**	.12*	.24**	.08	-.11*	.09	.04	.05
3. Cannabis (% current users) ^a				-.04	.08	-.01	-.07	-.00	-.07	-.11*
4. Social anxiety ^b					.58**	.28**	.08	.32**	.17**	.35**
5. Negative affect ^c						.38**	.05	.37**	.24**	.37**
6. Smoking to cope ^c							.35**	.55**	.48**	.46**
7. Nicotine dependence ^d								.19**	.25**	.18**
8. Barriers to cessation ^d									.58**	.51**
9. Smoking inflexibility ^d										.41**
10. Quit problems ^d										
<i>M (SD) or n (%)</i>	226 (48.5)	6.2 (6.02)	260 (55.8)	22.4 (14.3)	19.1 (7.1)	3.5 (0.8)	5.2 (2.3)	24.9 (11.0)	45.0 (10.7)	2.0 (0.67)

Note. AUDIT = Alcohol Use Disorders Identification Test.

^aCovariates.

^bPredictor.

^cMediators.

^dCriterion variables.

* $p < .05$; ** $p < .01$.

Table 2. Regression Results for 5 Mediation Models

Y	Path	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i> value
Nicotine dependence severity	<i>a</i> ₁	0.254	0.017	15.05	<.0001
	<i>a</i> ₂	0.005	0.003	1.859	.064
	<i>a</i> ₃	0.033	0.006	5.44	<.0001
	<i>b</i> ₁	−0.021	0.018	−1.16	.247
	<i>b</i> ₂	1.182	0.136	8.704	<.0001
	<i>c</i> '	0.003	0.008	0.334	.739
	<i>c</i>	0.013	0.007	1.892	.059
Barriers to cessation ^a	<i>b</i> ₁	0.186	0.078	2.386	.018
	<i>b</i> ₂	6.105	0.580	10.531	<.0001
	<i>c</i> '	0.082	0.034	2.434	.015
	<i>c</i>	0.211	0.031	6.766	<.0001
Smoking inflexibility ^a	<i>b</i> ₁	0.114	0.081	1.400	.162
	<i>b</i> ₂	5.890	0.604	9.757	<.0001
	<i>c</i> '	−0.002	0.035	−0.047	.963
	<i>c</i>	0.106	0.032	3.349	.0009
Quit-related problems ^a	<i>b</i> ₁	0.014	0.005	2.762	.006
	<i>b</i> ₂	0.262	0.036	7.241	<.0001
	<i>c</i> '	0.007	0.002	3.315	.001
	<i>c</i>	0.014	0.002	7.544	<.0001

Note. ^aPaths *a*₁, *a*₂, and *a*₃ do not change across criterion outcomes. To eliminate redundancy, these paths are only presented for Model 1.

Table 3. Bootstrap Estimates of the SEs and 95% CIs for the Indirect Effects

Indirect effects	<i>B</i>	<i>SE</i>	Confidence interval (lower)	Confidence interval (upper)
Model 1: FTND				
SIAS → PANAS → FTND (<i>a</i> ₁ * <i>b</i> ₁)	−0.005	0.005	−0.015	0.004
SIAS → RFS-NA → FTND (<i>a</i> ₂ * <i>b</i> ₂)	0.006	0.003	0.001	0.012
SIAS → PANAS → RFS-NA → FTND (<i>a</i> ₁ * <i>a</i> ₃ * <i>b</i> ₂)	0.010	0.002	0.006	0.015
Model 2: BCS				
SIAS → PANAS → BCS (<i>a</i> ₁ * <i>b</i> ₁)	0.047	0.019	0.009	0.085
SIAS → RFS-NA → BCS (<i>a</i> ₂ * <i>b</i> ₂)	0.031	0.017	0.001	0.065
SIAS → PANAS → RFS-NA → BCS (<i>a</i> ₁ * <i>a</i> ₃ * <i>b</i> ₂)	0.051	0.012	0.031	0.078
Model 3: AIS				
SIAS → PANAS → AIS (<i>a</i> ₁ * <i>b</i> ₁)	0.029	0.019	−0.008	0.065
SIAS → RFS-NA → AIS (<i>a</i> ₂ * <i>b</i> ₂)	0.030	0.016	−0.001	0.063
SIAS → PANAS → RFS-NA → AIS (<i>a</i> ₁ * <i>a</i> ₃ * <i>b</i> ₂)	0.050	0.011	0.032	0.073
Model 5: Quit problems				
SIAS → PANAS → PROB (<i>a</i> ₁ * <i>b</i> ₁)	0.004	0.002	0.001	0.006
SIAS → RFS-NA → PROB (<i>a</i> ₂ * <i>b</i> ₂)	0.001	0.001	0.001	0.003
SIAS → PANAS → RFS-NA → PROB (<i>a</i> ₁ * <i>a</i> ₃ * <i>b</i> ₂)	0.002	0.001	0.002	0.004

Note. SIAS is the independent variable (*X*), PANAS (PANAS-negative affect; *M*₁) and RFS-NA (RFS-negative affect reduction subscale; *M*₂) are the mediators, and FTND (nicotine dependence; *Y*₁), BCS (barriers to smoking cessation total score; *Y*₂), AIS (affective inflexibility; *Y*₃); and PROB (number of quit problems experienced; *Y*₄) are the outcomes. *a*₁**b*₁ and *a*₂**b*₂ = specific indirect effects of *M*₁ and *M*₂; *a*₁**a*₃**b*₂ = conditional indirect effect of *M*₁ and *M*₂. The 95% confidence intervals for indirect effects were obtained by bootstrapping with 10,000 resamples. Confidence interval (lower) = lower bound of a 95% confidence interval; confidence interval (upper) = upper bound; → = affects; bold values indicate significant confidence intervals.

affect reduction smoking motives (effect *a*₁**a*₃**b*₂), and indirectly through negative affect (effect *a*₁**b*₁) as well as negative affect reduction smoking motives (effect *a*₂**b*₂). A comparison of the unstandardized regression coefficients reveal that effect of *a*₁**a*₃**b*₂ was stronger than either individual mediator path alone.

Smoking Inflexibility

With *Y*₃, the total effects model accounted for significant variance in AIS (*R*²_{*y*_{3,*x*} = .064, *df* = 4, 461, *F* = 7.881, *p* < .0001), as}

did the full model with both mediators (*R*²_{*M*_{1,2,*x*} = .246, *df* = 6, 459, *F* = 24.917, *p* < .0001); however, there was a nonsignificant direct effect of social anxiety on smoking inflexibility after controlling for the mediators (see Table 2, path *c*'). To test mediation, the indirect effects were estimated (see Table 3, Model 3); social anxiety was predictive of greater smoking inflexibility indirectly through negative affect and negative affect reduction smoking motives (effect *a*₁**a*₃**b*₂), but not indirectly through either specific mediator alone (effects *a*₁**b*₁ or *a*₂**b*₂).}

Quit Problems Reported During Past Attempts

With Y_4 , the total effects model accounted for significant variance in number to problems experienced while quitting in the past ($R^2_{y4,x} = .197$, $df = 4, 461$, $F = 28.311$, $p < .0001$). The full model with the mediators predicted significant variance in quit problems ($R^2_{M1.2,x} = .309$, $df = 6, 459$, $F = 34.235$, $p < .0001$), and there was a significant direct effect of social anxiety on quit problems after controlling for the mediators (see Table 2, problems, path c'). To test mediation, the indirect effects were estimated (see Table 3, Model 4); greater social anxiety was predictive of more problems experienced while quitting indirectly through negative affect and negative affect reduction smoking motives (effect $a_1 * a_3 * b_2$) and indirectly through negative affect (effect $a_1 * b_1$) as well as negative affect reduction smoking motives (effect $a_2 * b_2$). A comparison of the unstandardized regression coefficients reveal that indirect effect of negative affect ($a_1 * b_1$) is stronger than RFS-NA alone, or the sequential effect of PANAS-NA and RFS-NA.

Social Anxiety Disorder

Mediation models were conducted with SAD diagnosis (present vs. absent) as the predictor (x). Results mirrored those from the models with SIAS as the predictor. SAD significantly predicted all four smoking-related criterion variables, as a function of the sequential effect of negative affect and negative affect reduction smoking motives. Full results of these alternative models are available from the second author upon request.

DISCUSSION

Despite emerging research suggesting a robust relations of social anxiety with nicotine dependence and cessation problems (for review see Buckner, Heimberg, Ecker, & Vinci, 2013), little research has examined the impact of social anxiety on smoking processes. Although tension reduction-based models (e.g., Baker et al., 2004) suggest that socially anxious smokers may have difficulty quitting if they smoke to manage negative affect, this is the first known study to explicitly examine whether social anxiety is related to nicotine dependence and cessation problems indirectly via negative affect and negative affect reduction smoking motives. Results suggest that social anxiety is differentially related directly and indirectly to several smoking processes.

Regarding direct effects, social anxiety was directly related to a greater number of perceived barriers to cessation after controlling for negative affect and negative affect reduction motives. Greater social anxiety was also predictive of more barriers to cessation indirectly through negative affect and negative affect reduction smoking motives, and the combined effect of negative affect and negative affect reduction motives was stronger than either factor alone. Given that perceived barriers to cessation are often highly predictive of poorer cessation outcomes (Macnee & Talsma, 1995), this finding suggests that socially anxious smokers may have more failed quit attempts (Cougle et al., 2010) at least partially as a result of beliefs that cessation will be especially difficult. This may be particularly true for socially anxious smokers who are highly motivated to smoke to manage negative affect. These data suggest that smoking cessation interventions for socially anxious smokers

may benefit from assessing perceived barriers to quitting, challenging maladaptive cognitions regarding these perceived barriers, and the development of problem-solving skills to cope with actual barriers to cessation.

Social anxiety was directly related to quit problems reported during past quit attempts. Greater social anxiety was also predictive of more problems experienced while quitting indirectly through negative affect and negative affect reduction smoking motives. Unlike social anxiety's relation to cessation barriers, however, the mediational impact of negative affect was greater than that of negative affect reduction motives or the combination of mediators. This finding suggests that socially anxious individuals who experience negative affect broadly (i.e., not only experience elevated social anxiety but also other negative affective states such as anger, loneliness, and depression) may be especially vulnerable to experiencing quit-related problems such as weight gain, nausea, irritability, and anxiety. This finding is consistent with data indicating that other anxious smokers (those with elevated anxiety sensitivity or fear of anxiety-related sensations and consequences; Zvolensky et al., 2004) report more severe withdrawal and negative mood symptoms when quitting. It is possible that these socially anxious smokers have less ability to tolerate cessation-related internal states or experience greater negative affect.

Greater social anxiety was predictive of more severe nicotine dependence indirectly through negative affect and negative affect reduction smoking motives. Notably, social anxiety was predictive of greater nicotine dependence indirectly through negative affect reduction smoking motives, but not indirectly through negative affect alone, although the sequential effect of the mediators was stronger than the effect of negative affect reduction smoking motives alone. This finding suggests that socially anxious smokers who experience elevated negative affectivity broadly, and who smoke to manage this negative affect, are especially vulnerable to more severe nicotine dependence. In fact, socially anxious persons have been found to suffer from a range of negative affect states such as depression (Stein et al., 2001; Van Ameringen, Mancini, Styan, & Donison, 1991) and hostility (DeWall, Buckner, Lambert, Cohen, & Fincham, 2010). When considered in light of the current findings, these data suggest that personalized smoking cessation efforts may benefit from teaching patients skills to manage not only their social anxiety and smoking cravings but other negative emotional states.

Social anxiety was also indirectly related to smoking inflexibility/avoidance through the sequential effect of negative affect and negative affect reduction motives, but neither mediator alone, suggesting that socially anxious smokers who experience elevated negative affectivity broadly and who smoke to manage this negative affect may be more likely to inflexibly seek out opportunities to escape, avoid, or reduce distressing states through smoking (e.g., Gifford & Lillis, 2009). Similar to other forms of escape/avoidance behavior, AIS is thought to be a negative reinforcement process that is rooted in the dopaminergic reward system, which governs the dopamine release in the mesolimbic pathway (Trafton & Gifford, 2008, 2011). Notably, research on smoking cessation treatments that specifically cultivate greater willingness for emotional distress tolerance/acceptance to address AIS suggests such interventions generally produce better clinical outcomes compared with standard care (e.g., Bricker, Mann, Marek, Liu, & Peterson, 2010; Hernández-López, Luciano, Bricker, Roales-Nieto, &

Montesinos, 2009). Thus, future work may examine whether such interventions aid in cessation for socially anxious smokers.

Results should be considered in light of limitations that suggest additional avenues for work in this area. First, the analyses are correlational, which precludes interpretations regarding the causal or temporal relations between social anxiety, negative affect, smoking motives, and smoking processes. Prospective and experimental work will be an important next step. Second, data relied on self-report and future work could benefit from examining physiological arousal associated with negative affective states. Third, we examined social anxiety as a continuous construct in light of data suggesting that greater social anxiety, regardless of whether those fears meet clinical standards for SAD, are related to greater nicotine dependence (e.g., Buckner & Vinci, 2013; Sonntag et al., 2000). However, some data suggest that individuals with clinically elevated social anxiety are especially vulnerable to substance-related problems (e.g., Buckner, Heimberg, Matthews, & Silgado, 2012). Thus, replication in a sample with a greater number of patients with SAD would be advisable. Fourth, participants were seeking smoking cessation treatment and replication with nontreatment seekers will be an important next step to test generalizability.

Limitations notwithstanding, the current study produced several novel findings and documents the important role of social anxiety in smoking-related behaviors as well as the impact of negative affect and smoking for negative affect reduction motives in the relation of social anxiety with nicotine dependence and cessation problems.

FUNDING

This work was supported by National Institute of Mental Health grants awarded to MJZ and NBS (R01-MH076629-01A1) and to JDB (R21DA029811-02, R34DA031937-01A1). Ms. SGF is supported by a cancer prevention fellowship through the University of Texas MD Anderson Cancer Center funded by the National Cancer Institute (R25T-CA057730) and a predoctoral National Research Service Award from the National Institute of Drug Abuse (F31-DA035564-01). The National Institutes of Health had no further role in study design; in the collection, analysis, and interpretation of data; in the writing of the manuscript; or in the decision to submit the manuscript for publication.

DECLARATION OF INTERESTS

None declared.

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