

Smoking, Anxiety, and Attention: Support for the Role of Nicotine in Attentionally Mediated Anxiolysis

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Based on J. D. Kassel and S. Shiffman's (1997) study, the hypothesis was tested that cigarette smoking's anxiolytic effects are attentionally mediated and depend on the presence of benign distraction. This study explored whether the attentionally mediated anxiolytic effects of smoking observed in the J. D. Kassel and S. Shiffman (1997) study could be replicated and are attributable to nicotine. The study examined the effect on anxiety of smoking a high- or low-yield nicotine cigarette with or without a current distraction in 67 smokers. As predicted, only those who smoked a high-yield cigarette paired with participation in a distracting activity experienced a significant reduction in anxiety. Those who smoked a high-yield cigarette in the absence of distraction experienced a slight exacerbation of anxiety. These findings suggest that nicotine—not the behavioral or sensory aspects of smoking—interacts with distraction and leads to alleviation of anxiety.

Nicotine is a potent reinforcer (Henningfield & Goldberg, 1983). Smokers describe that cigarette smoking is stimulating at certain times, relaxing at others, and helps to enhance attention and concentration. With such an armament of desirable effects available at their fingertips, it is no wonder that smokers find it difficult to forego this behavior. Virtually all smokers attribute their smoking, at least in part, to its reputed anxiolytic and sedative properties (Frith, 1971; Spielberger, 1986). Moreover, laboratory and field studies alike have shown increases in smoking when the smoker is experiencing subjective stress and anxiety (Conway, Vickers, Ward, & Rahe, 1981; Pomerleau & Pomerleau, 1987). A problem arises, however, with the inferences that are often drawn from these findings. First, the fact that smokers believe that smoking helps to reduce negative affect does not in and of itself validate a pharmacological effect of nicotine on negative affect apart from any expectancy effects. Second, one cannot infer functional significance from the observation that smokers apparently smoke more when experiencing negative mood. The picture is further complicated by the discrepant findings from a number of controlled laboratory studies, some of which have demonstrated smoking-induced anxiolysis (e.g., Perkins, Grobe, Fonte, & Breus, 1992; Pomerleau & Pomerleau, 1987) and others of which have not (e.g., Fleming & Lombardo, 1987; Jarvik, Caskey, Rose, Herskovic, & Sadeghpour, 1989).

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Kassel (1997; Kassel & Shiffman, 1997) recently proposed that cigarette smoking's calming effects are cognitively mediated and, hence, indirect. More specifically, he asserted that, as for alcohol (see Steele & Josephs, 1988), smoking (nicotine) induces a state of attentional narrowing, or reduction in cue utilization (Easterbrook, 1959), such that the smoker cannot attend to as many environmental or interoceptive cues as he or she could when not smoking (see Kassel, 1997). Thus, smoking appears to reduce attention paid to peripheral, irrelevant, or noxious cues (see, e.g., Gilbert, 1995, Chap. 9; Knott, 1978). Furthermore, there is ample evidence to suggest that cholinergic drugs, including nicotine, appear to constrain or narrow an individual's breadth of attention (Callaway, Halliday, & Naylor, 1992). An implication of these assertions is that smoking may reduce anxiety through its ability to constrain smokers' attention to the most immediate and salient stimuli in their environment—when such stimuli are available. This process is believed to result in an automatic reallocation of attention away from the distressing thoughts that would otherwise continue to promote subjective distress. In the absence of benign distraction, however, smoking is believed to have no impact on anxiety because the smoker's narrowed attention remains focused on the stressful cognitions.

The results of a laboratory study (Kassel & Shiffman, 1997) generally confirmed the predictions of this model: After participants were made anxious through an experimental manipulation, those who smoked in the presence of benign distraction experienced a significant reduction in anxiety, whereas those who smoked in the absence of distraction did not. Those who were assigned to a no-smoking condition experienced little change in anxiety, regardless of whether they were in the distraction condition or not. These findings suggest that smoking is not inherently anxiolytic but rather that distraction is an important mediator of smoking's ability to reduce anticipatory anxiety (see also Grobe, Perkins, Goettler-Good, & Wilson, 1998). It is important to note, however, that Kassel and Shiffman (1997) used a smoke/no-smoke design, thus limiting the extent to which it can be presumed that nicotine is responsible for the observed effects. It is conceivable

that the behavioral act of smoking, as well as the associated sensory cues (Levin, Rose, Behm, & Caskey, 1991), interacted with distraction to produce this pattern of findings.

The purpose of the present study was to replicate and extend the findings of Kassel and Shiffman (1997). In lieu of a smoke/no-smoke design, this study manipulated nicotine intake through the use of an ultra-low-yield nicotine cigarette versus a high-yield nicotine cigarette. We assumed that nicotine is the constituent of tobacco smoke that leads to attentional narrowing, and therefore made the following predictions: Those who both smoke a high-yield nicotine cigarette and participate in a distracting activity will evidence the greatest decrease in anxiety, whereas those who smoke a high-yield nicotine cigarette in the absence of distraction should manifest no significant change in anxiety. Smokers in the low-yield nicotine condition should experience minimal changes in anxiety regardless of whether they are distracted or not.

Finally, we were also interested in examining the potential moderating effect of trait anxiety because there is reason to believe that trait anxiety is associated with both susceptibility to distraction and attentional narrowing (Eysenck & Graydon, 1989). We entertained two competing hypotheses:

1. Those high in trait anxiety might be more susceptible to the joint effects of nicotine and distraction because their attention would be more easily diverted to the benign distraction; and conversely,

2. Those high in trait anxiety will be less susceptible to these effects as a result of a threshold effect such that the heightened anxiety is so high as to be resistant to attentionally mediated anxiolysis (cf. Gilbert, 1995, Chap. 9).

Method

Overview

In this study we used the same basic procedure as that used in Kassel and Shiffman (1997), which, in turn, was based on the design used by Steele and colleagues in their studies of alcohol's effect on anxiety (Josephs & Steele, 1990; Steele & Josephs, 1988). We evaluated changes in anxiety following exposure to a stressor (in which participants were asked to prepare a potentially embarrassing, self-disclosing speech). Smokers were randomly allocated to four cells in a 2×2 factorial design independently manipulating whether they smoked a high- or low-yield nicotine cigarette with whether they participated in a benign, distracting activity (viewing art slides). Subjective anxiety was monitored throughout the study, allowing assessment of the extent to which anxiety fluctuated as a function of the stressor and two experimental manipulations.

Participants

Sixty-seven smokers were recruited from the community at large and were paid for their participation in the 1.5-hr study. All participants were at least 18 years old. Smokers had to have smoked at least 10 cigarettes a day for a minimum of 1 year and to have smoked regularly (1 or more cigarettes a day) for at least 2 years. They were randomly assigned to one of four experimental groups: high-yield nicotine cigarette (HN)/distraction ($n = 17$), HN/no distraction ($n = 17$), low-yield nicotine cigarette (LN)/distraction ($n = 17$), and LN/no distraction ($n = 16$).

Measures

State anxiety. The State Anxiety subscale of the State-Trait Anxiety Inventory, Form Y (STAI-S; Spielberger, Gorsuch, Lushene, Vagg, &

Jacobs, 1983) was used to monitor anxiety throughout the experiment and served as the primary dependent variable. The STAI-S is a well-known measure used to evaluate feelings of apprehension, tension, nervousness, and worry from responses to 20 self-descriptive statements. We used a 7-point scale as per Steele and Josephs's (1988) suggestion ($\alpha = .93, .90, .95, \text{ and } .96$ across the four measurement periods, respectively).

Trait anxiety. The Trait Anxiety subscale of the State-Trait Anxiety Inventory, Form Y (STAI-T; Spielberger et al., 1983) was used to assess general propensity to experience anxiety. As in the STAI-S, this measure taps feelings of apprehension, nervousness, and worry from responses to 20 self-descriptive statements ($\alpha = .89$). High- and low-anxiety groups were defined by using a median split of the score distribution.

Procedure

On arriving at the laboratory, all participants smoked one of their own cigarettes in an ad libitum fashion. They subsequently completed an informed-consent form outlining the procedures of the experiment. The consent form stated that this study would examine smokers' "verbal behavior and judgments" and that they would be asked to smoke two research cigarettes later on in the study. After completing several questionnaires (including the STAI-T), participants were told, "One of the things this study is interested in are the variations in mood and stress over time. In order to assess this, we will be asking you to report how you are feeling at several points during the study, the first of which is right now" (cf. Kassel & Shiffman, 1997; Steele & Josephs, 1988). They then completed the first (prefilm) of four administrations of the STAI-S. Participants then spent the balance of the 50-min baseline period viewing a pleasant cartoon film, *The Jungle Book*. The experimenter encouraged them to relax and enjoy the film. The primary purpose of the baseline period was to ensure that all smokers had undergone an equal period of smoking deprivation. All participants in this study were nicotine deprived for 50 min, approximating the typical between-cigarettes interval in pack-a-day smokers.

After the 50-min baseline period, participants completed the second (postfilm) STAI-S. They then provided an expired air breath sample that was assessed for alveolar carbon monoxide (CO) levels by using a Vitalograph EC 50 carbon monoxide monitor. The first experimental manipulation then occurred, during which participants smoked either two LN (0.14 mg nicotine, 26.8 mg tar) or two HN (1.14 mg nicotine, 25.8 mg tar) research cigarettes (University of Kentucky) in the following manner. A paced puffing regimen was used to control for dosing (Perkins, 1995; Schupp, Mucha, & Pauli, 1996). Participants took 6 puffs per cigarette, were asked to hold their inhalation for 2 seconds, and then waited another 10 seconds before taking the next puff. The HN cigarettes were smoked through a Waterpik cigarette filtration system #1 filter (Waterpik/Teledyne Corp.), which cuts the delivery of tar and nicotine by 25%. LN cigarettes were smoked through a #2 filter, which reduces tar and nicotine by 50%, resulting in an extremely low, placebo-like nicotine yield. The experimenters were unaware of the nicotine doses because cigarettes were prepared in advance by the principal investigator. Debriefing revealed no differences in participants' ratings of pleasantness and harshness across the two cigarette types.

Immediately after the nicotine manipulation, we took a second CO reading, and we induced anticipatory anxiety in all participants by informing them that in 10 min they would be asked to give a 3-min speech about what they dislike about their body and physical appearance (cf. Kassel & Shiffman, 1997; Steele & Josephs, 1988). Participants were also told that their speech would be videotaped and evaluated for its openness and defensiveness. At this point, participants were asked to take the next few minutes to think about and prepare their speech. Immediately after these instructions, participants completed the third (prepreparation) STAI-S. After completion of the prepreparation STAI-S, half of the participants were asked to view a series of art slides and answer the same four questions

Table 1
Participants' Anxiety Ratings for the Four Administrations of the State Anxiety Subscale by Condition

Administration of State Anxiety subscale	Low-nicotine cigarette		High-nicotine cigarette		<i>F</i> (3, 63)
	Slides	No slides	Slides	No slides	
Prefilm					
<i>M</i>	44.12	46.65	50.94	49.12	0.42
<i>SD</i>	14.36	20.65	19.53	19.81	
Postfilm					
<i>M</i>	40.65	42.36	46.94	40.88	0.59
<i>SD</i>	12.38	18.28	12.22	17.28	
Prepreparation					
<i>M</i>	54.82	53.47	61.81	58.41	0.45
<i>SD</i>	21.41	23.14	18.66	26.49	
Postpreparation					
<i>M</i>	53.29	54.06	51.44	60.00	0.39
<i>SD</i>	24.72	24.38	14.75	30.26	

Note. All *F* values are nonsignificant.

per slide (e.g., "What do you think of the use of colors in this painting?"). This constituted the distraction condition. The other half of the participants did not rate art slides, representing the no-distraction condition. The rate of slide presentation was determined by the participant, yielding an average of 3.2 slides viewed within the 3½-min time frame.

Three-and-a-half minutes into the distraction/no-distraction period, we administered the (postpreparation) STAI-S to the participants for the fourth and final time. After its completion, the study was over. Participants never actually gave the speech and were fully debriefed as to the study's purposes and intentions.

Results

Sample Characteristics

The sample was mostly Caucasian (91%), 63.6% female, and averaged 28 years of age ($M = 28.17$, $SD = 12.3$). Smokers smoked an average of one pack a day ($M = 19.32$ cigarettes, $SD = 7.8$), had smoked their current amount for an average of 8 years ($M = 8.08$, $SD = 9.5$), and had been smoking with some degree of regularity for over 11 years ($M = 11.88$, $SD = 11.43$). Across the four cells of smokers, no differences were found in age, number of cigarettes smoked per day, how long they had been smoking their current amount, how long they had smoked regularly, trait anxiety, or increase in expired air CO subsequent to smoking the experimental cigarette (all $ps > .10$).

Anxiety Measures

Measures of anxiety were taken at four points in the study: prefilm, postfilm, prepreparation, and postpreparation. Table 1 presents mean STAI-S scores. As a first step in our analytic strategy, we conducted a 2 (high-yield nicotine cigarette, low-yield nicotine cigarette) \times 2 (distraction, no distraction) analysis of variance (ANOVA) on the prefilm STAI-S score to determine whether there were initial group differences in anxiety that would need to be taken into account in subsequent analyses. This analysis failed to yield a significant group effect, $F(1, 66) = 0.01$, $p > .90$.

We then assessed whether the introduction of the speech task was effective at inducing anxiety (prepreparation vs. postfilm

STAI-S scores) as well as whether increases in anxiety in response to hearing about the speech varied by nicotine condition. In particular, we were interested in ascertaining whether there was a differential response to the speech task based on smoking condition (high- vs. low-yield nicotine), as there might be if nicotine exerted a direct anxiolytic effect or impaired appraisal of the stressor (cf. Sayette, 1993). Results from a 2 (nicotine) \times 2 (repeated measures; postfilm to prepreparation) ANOVA showed that, as expected, anxiety rose dramatically in response to the speech instructions, $F(1, 63) = 41.95$, $p < .001$.¹ Findings from the ANOVA revealed no Nicotine \times Repeated Measures interaction. Hence, smokers in both nicotine conditions showed comparable anxiety increases in response to the speech instructions, $F(1, 63) = 0.64$, $p > .40$, indicating that nicotine yield had no effect on anxiety change in response to the speech instructions.

Our primary hypothesis predicts a three-way interaction between nicotine yield (high vs. low), distraction (slides vs. no slides), and repeated measures (pre- and postpreparation STAI-S scores because these were the only two measurement periods during which the experimental manipulations were implemented). A mixed-model repeated measures ANOVA revealed the predicted three-way interaction, $F(1, 59) = 13.05$, $p = .001$. To assess the meaning of this interaction, we conducted separate Distraction \times Repeated Measures ANOVAs on the two nicotine-yield groups. Only in the high-yield condition did a significant interaction effect emerge, $F(1, 31) = 13.64$, $p = .001$. Thus, as can be seen in Figure 1a, the greatest reduction in anxiety occurred in the high-yield nicotine/distraction condition.

Post hoc analyses offered further interpretation of the observed three-way interaction. Specifically, smokers who smoked HN cigarettes and viewed slides had a significantly greater decrease in anxiety than smokers who smoked HN cigarettes but did not view

¹ Unlike our previous study (Kassel & Shiffman, 1997), the present investigation did not yield a significant Gender \times Repeated Measures interaction, $F(1, 58) = .003$, $p > .90$, indicating that women did not become more anxious than men upon hearing about the speech.

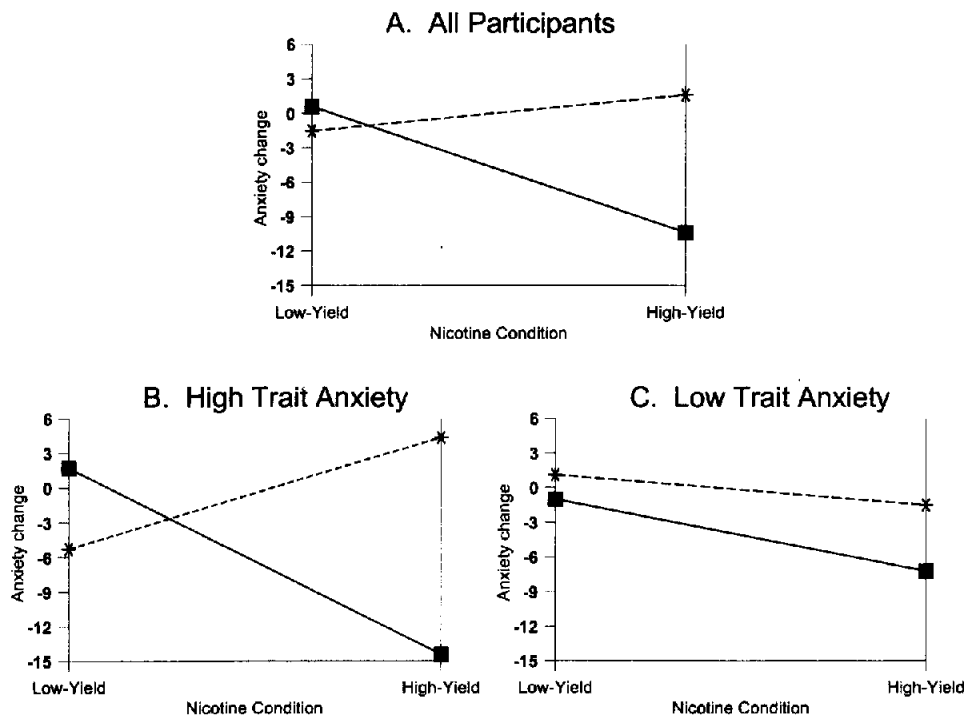


Figure 1. Pre- to postpreparation State-Trait Inventory—State (STAI-S) change scores by nicotine and distraction conditions. Figures 1b and 1c depict STAI-S change scores among high ($n = 34$) and low ($n = 33$) trait anxiety participants (determined by median split), respectively. Asterisks denote the no-slides condition and dark boxes denote the slides condition.

slides, $t(31) = 3.69, p = .001$. Among smokers who did not view slides, anxiety change was comparable regardless of the nicotine content of the cigarette, $t(32) = -1.14, p > .20$. Finally, although participants in the high-yield nicotine/distraction condition experienced a significant reduction in anxiety, $t(15) = 3.83, p = .002$, those in the high-yield nicotine/no-distraction condition did not, $t(17) = -0.86, p > .40$.

The observed three-way interaction was further interpreted within the context of a significant four-way (Trait Anxiety \times Nicotine \times Distraction \times Repeated Measures) interaction, $F(1, 59) = 7.41, p < .01$. This interaction was decomposed by first performing a median split on trait anxiety scores, and assigning participants to a high- or low-trait anxiety group. Results of two separate three-way ANOVAs revealed that whereas a significant Nicotine \times Distraction \times Repeated Measures interaction emerged among those in the high trait anxiety group, $F(1, 29) = 19.38, p < .001$, this three-way interaction was not significant among those low in trait anxiety, $F(1, 30) = 0.41, p > .50$. Among participants in the high-trait anxiety group, further analyses revealed a significant Distraction \times Repeated Measures interaction among those who smoked the high-yield nicotine cigarettes, $F(1, 14) = 21.52, p < .001$, whereas the interaction was not significant among the low-yield nicotine participants, $F(1, 15) = 2.75, p > .10$. Figures 1b and 1c demonstrate the moderating effects of trait anxiety on anxiety change as a function of both distraction and nicotine yield.

Discussion

The primary purpose of this study was to see if the attentionally mediated anxiolytic effects of smoking observed in the Kassel and Shiffman (1997) investigation could be replicated and are attributable to nicotine. The results were consistent with the pattern of findings observed in the earlier study and seem to implicate the role of nicotine: Those who smoked a high-yield nicotine cigarette and were distracted (by rating art slides) experienced the largest reduction in anxiety among all four cells. Those who smoked a high-yield nicotine cigarette in the absence of distraction did not experience a reduction in anxiety. In fact, they experienced a slight exacerbation of anxiety. Participants who smoked low-yield nicotine cigarettes manifested nonsignificant changes in anxiety, regardless of whether they were in the distraction condition or not. Thus, our findings suggest that it is nicotine—not the behavioral or sensory aspects of smoking—that interacts with distraction so as to lead to alleviation of anxiety.²

² In actuality, the critical postpreparation STAI score occurred just after the distraction period had ended. Thus, one could argue that the experimental design does not provide a precise test of the proposed theory given that anxiety is not being measured during the presence of distraction (see Curtin et al., 1998, and Sayette, 1993, for similar comments on Josephs and Steele's studies [Josephs & Steele, 1990; Steele & Josephs, 1988] of alcohol's attentionally mediated effects). Nonetheless, we believe that measurement of anxiety at this time point is justifiable. Participants were

Enthusiasm must be allayed somewhat, however, by the limitations of the study. We used only one measure of anxiety (self-report), which provided only a narrow window into the dynamics of the emotional response system. Future research should use multiple response mode designs (Lang, 1968) that can assess the impact of smoking and distraction on anxiety, as well as on other mood states, across physiological, behavioral, and subjective systems. Unobtrusive measures such as facial coding (Sayette, Smith, Breiner, & Wilson, 1992) or startle eyeblink response (Curtin, Lang, Patrick, & Stritzke, 1998) are well suited in this regard. Independent measures of cognitive (attentional) processing (cf. Kassel & Shiffman, 1997) may also help to elucidate the precise nature of the underlying attentional mechanisms. It is also important to note that although those who smoked the high-yield nicotine cigarettes while viewing art slides experienced the largest reduction in anxiety, their absolute level of anxiety at the study's end (postpreparation STAI-S) was comparable with that of smokers who smoked the low-yield nicotine cigarettes. Given the relatively young sample, the generalizability of our findings to older smokers is as yet unknown. Finally, although we attempted to control for nicotine dosing by paced puffing, more sensitive indices (i.e., blood-nicotine levels) could be used in future studies as a means of corroborating the behavioral manipulation.

Acknowledging the study's limitations, we still believe that the data make a compelling case for the notion that cigarette smoking's ability to reduce anxiety has less to do with direct pharmacological effects than it does with nicotine's propensity to directly impact on attentional processing. As such, our findings impugn the notion that smoking is inherently anxiolytic. Moreover, the use of a double-blind design rules out both experimenter bias and participant expectancies as potential confounding factors. In conjunction with the Kassel and Shiffman (1997) findings, our study points to a critical factor—distraction—whose presence mediates smoking's effect on negative mood.

From an individual-differences perspective, one might postulate that those smokers who are highly anxious might find these attentionally mediated anxiolytic effects particularly reinforcing. Indeed, our results support this contention. The critical Nicotine \times Distraction \times Repeated Measures interaction was evident among those high, but not low, in trait anxiety.³ These findings are consistent with the recently postulated Situation \times Trait Adaptive Response (STAR) model of nicotine reinforcement (Gilbert & Gilbert, 1998), which posits that nicotine has no inherent effects on affective processing but rather exerts its influence through interactions with personality and situational variables. As noted earlier, it may be that those high in trait anxiety are more susceptible to distraction and, hence, more predisposed to the interactive effects of nicotine and benign distraction. This finding perhaps goes some way toward explaining the marked association between nicotine dependence and psychiatric comorbidity, including anxiety disorders (Breslau, 1995).

never told that the slide rating task was over; rather, they were asked to "take a minute to fill out this questionnaire" with the current slide still showing. Thus, from the participants' perspective, they were still in the midst of rating slides and likely expected that they would continue doing so. It is also important to note that postdistraction reductions in negative mood (e.g., dysphoria) have been reported in the literature (e.g., Nolen-Hoeksema & Morrow, 1993).

In the context of the proposed model, the question might arise as to why, in conjunction with smoking a high-yield nicotine cigarette, smokers' attention appears to have been more efficiently captured by the benign distractor than by the speech preparation. Indeed, one could argue that preparation of the speech might represent a more pressing and salient concern. We believe, however, that the behavioral nature and immediacy of the distraction task necessarily demands attention and thus takes precedence over the speech preparation (cf. Rodriguez & Craske's [1993] discussion of distraction and phobic stimuli). Still unanswered, however, is the question of whether nicotine-facilitated attentional narrowing is a passive, automatic response, or rather, a volitional process, executed as an active coping response (see Kassel, 1997, for a discussion of these issues). Given the latter possibility, an alternative explanation for our findings can be entertained: It may be that nicotine promotes attentional focus on that which is more pleasurable rather than more salient or immediate.⁴

Although the precise parameters governing distraction must be left to future research, it seems likely that the effects observed here while using the task of rating art slides generalize to a broad range of activities that accompany real-life cigarette smoking (cf. Steele & Josephs, 1988). As such, our findings begin to shed light on one potential reinforcing mechanism governing this highly destructive, and preventable, behavior.

³ Importantly, those low in trait anxiety who both smoked the HN cigarette and rated art slides did experience a reduction in anxiety from pre- to postpreparation (~7 points). Although the magnitude of this change was not significant, $t(8) = 1.81$, $p = .11$, this was probably due to limited statistical power.

⁴ An initial step toward differentiating these competing explanations might be to reverse the parameters of the present experiment such that smokers who are experiencing *positive affect* and smoke a nicotine cigarette are exposed to a noxious stimulus. According to our model, smoking should reduce positive feelings in such a situation, whereas if nicotine narrows attention to that which is most hedonically pleasant through volitional coping, there should be no reduction in positive mood.

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