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Original Investigation

Generalized craving, self-report of arousal, and cue reactivity after brief abstinence

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Abstract

Introduction: Numerous studies report smokers' increased craving and physiological arousal when exposed to cigarette stimuli. These responses are attributed to learning processes (e.g., classical conditioning) and are associated with motivational factors that maintain nicotine dependence. However, much less is known about the degree to which these responses are maintained or diminished during quitting.

Methods: Treatment-seeking smokers (N = 104) were randomly assigned to continue smoking or to enter a 2-week treatment program. Abstainers (n = 25) were continuously abstinent for 14–17 days at the time of testing. Control subjects (n = 38) continued to smoke at their usual rate. Participants who were assigned to treatment but resumed smoking during the study (n = 41) were considered to be relapsers. Approximately 2 weeks after baseline measurements, abstainers and controls viewed a series of neutral (n = 12) and cigarette (n = 12) pictures, rating them for craving and arousal (feelings of calm vs. excitement).

Results: Non-cued craving (measured during exposure to neutral cues) was diminished in abstaining smokers. However, cigarette cues produced craving increases of the same magnitude in both abstainers and controls, showing that these cues still had evocative power for both groups. Abstaining smokers, who were not physiologically monitored, had lower self-reports of arousal to cigarette pictures than did controls, but the groups did not differ in arousal to neutral pictures.

Discussion: These findings suggest that the foundations of cue-induced craving, generalized craving, and physiological arousal associated with craving may arise from separate processes.

Introduction

In numerous laboratory studies, smokers have shown increased craving and physiological arousal when exposed to cigarette stimuli (Carter & Tiffany, 1999). In these experiments, the gold standard of reactivity to cigarette cues is calculated as the difference in reactivity to cigarette cues compared with neutral cues. These reactions are believed to be established through learning processes. For example, a classical conditioning model suggests that during a smoker's individual history of cigarette use, certain stimuli, such as environmental contexts or cigarette paraphernalia, reliably accompany nicotine administration. It is assumed that these stimuli, by virtue of their pairing with the unconditioned drug stimulus, become conditioned stimuli capable of eliciting conditioned responses in the form of reactions such as increased craving and skin conductance (Tiffany, 1995). Other learning-based theories include negative reinforcement (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004), automatized behaviors (Tiffany, 1990), and the incentive salience of the cues (Robinson & Berridge, 1993). Although these models posit different mechanisms for producing cue responses, they are in general agreement that the cue responses reflect behaviors supported by a learning process.

Presumably, these cue-specific reactions reflect motivational processes responsible for continuing smoking in nicotine-dependent people as well as relapse in smokers attempting to remain abstinent (Tiffany, 1995). Indeed, a number of naturalistic studies have shown that craving is associated with smoking and relapse (Bagot, Heishman, & Moolchan, 2007; Carter et al., 2008; Shiffman et al., 2002). Not surprisingly, self-report of craving is perhaps the most studied of cue responses. However,

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evidence suggests that a distinction exists between cue-induced craving and non-cue–induced craving. In cue-reactivity research, smokers exposed to neutral cues do not report zero craving; rather, they report a low level of craving, in contrast to the higher level of craving experienced when exposed to cigarette cues (Carter & Tiffany, 1999). For the purposes of the present study, reports of low levels of craving in response to non-cigarette cues are operationalized as a generalized form of craving. Although direct empirical evidence is lacking, these laboratory findings suggest that smokers may experience some level of generalized craving throughout the day that is punctuated with higher spikes in craving level when they are exposed to smoking cues such as cigarettes or other people smoking.

Previous research by Tiffany, Cox, and Elash (2000) has shown that these two forms of craving appear to combine additively rather than interactively (Burton & Tiffany, 1997; Cern, Bailey, & Tiffany, 2002; Maude-Griffin & Tiffany, 1996; Tiffany & Drobes, 1990). For example, evidence shows that generalized craving is more easily reduced through treatment (Tiffany et al., 2000), whereas cue reactivity, defined as the difference between neutral- and cigarette-cue–induced craving, appears highly stable, suggesting that these two forms of craving may be controlled by different processes. That is, experimental manipulations (e.g., nicotine patch and short-term deprivation) that decrease or increase generalized craving do not otherwise interact with or alter cue-induced craving.

Most investigations that have studied abstinence as a potential influence on both generalized and cue-induced craving have examined only short-term abstinence (e.g., 24 hr; Tiffany et al., 2000). To date, no studies have looked at longer periods of abstinence to determine whether, over time, generalized craving remains an additive or interactive influence on cue-induced craving. The present study compared cue reactivity to neutral and cigarette stimuli in continuing smokers versus smokers who have been abstinent for 14–17 days. If craving ratings to neutral- and cigarette-related stimuli change in concert in abstinent smokers, compared with continuing smokers, it would suggest an additive relationship. In contrast, if craving in response to one type of stimuli changes more significantly from baseline than the other, it would suggest that longer periods of abstinence (e.g., 14–17 days vs. 24 hr) produce an interactive effect between generalized and cigarette-cue–induced craving.

Methods

Treatment-seeking smokers ($N = 104$) were taken from a four-session laboratory study investigating the psychophysiological effects of nicotine withdrawal. Some 52% of participants were male; 48% were White; 34% were Black; and 19% were Asian, Hispanic, or other. Participants were on average 38.7 years old (*SD* 10.7); they smoked an average of 21 cigarettes/day (*SD* 7.9), had a mean baseline expired carbon monoxide (CO) level of 25.1 ppm (*SD* 10.6), and had a baseline Fagerström Test for Nicotine Dependence (FTND; Fagerström, 1978) score of 4.65 (*SD* 2.1). The FTND is a 10-item instrument that asks questions such as, "How soon after you wake up do you smoke your first cigarette?" It is scored on a single-point scale (range = 0–10), with higher scores indicating greater nicotine dependence. Participants were assigned to a control group (members of this group continued smoking their usual amount) or to a treatment group (members of this group entered treatment immediately after the baseline laboratory session); the control–treatment ratio was 1 to 2. That is, twice as many participants were randomly assigned to the treatment group to account for relapse and dropouts.

At the baseline laboratory session, participants were randomly assigned to continue smoking for 2 weeks or to enter a 2-week behavioral treatment program, which involved a counseling session at each visit that covered topics such as dealing with cravings, how to spot risky situations, management of the environment (avoiding smoking cues), and relaxation techniques. Because of the demands of the primary study, use of nicotine replacement was not allowed. Immediately before the baseline laboratory session, participants completed the Questionnaire on Smoking Urges (QSU)-brief (Cox, Tiffany, & Christen, 2001) while they smoked a cigarette and completed other study questionnaires. The QSU-brief is a craving questionnaire that asks respondents to rate 10 items (e.g., "I have a desire for a cigarette right now") on a scale of 0 (*not at all agree*) to 100 (*strongly agree*). Participants were scheduled for three additional laboratory sessions 3–4 days apart.

Abstainers ($n = 25$) were continuously abstinent for 14–17 days at the time of cue-reactivity testing. Relapsers ($n = 41$) were assigned to the treatment condition but had resumed smoking by self-report, had dropped out, or had an expired CO of 10 ppm or greater before the end of the study. Controls ($n = 38$) were assigned to smoke at their usual rate until after the study ended.

After the completion of the final laboratory session for the nicotine withdrawal study (approximately 90 min; controls smoked 1 cigarette at the beginning of the study), participants viewed a series of neutral pictures ($n = 12$; e.g., household objects) and a series of cigarette pictures ($n = 12$; e.g., lit cigarette in an ashtray; Carter et al., 2006) displayed in random order. A Pentium III PC using Psychology Tools' E-prime software (Pittsburgh, PA) was used to project a 91.5 × 122–cm image of the slides through an In-Focus LCD projector on a screen positioned approximately 1.5 m from the participant. Each picture was displayed for 6 s, and participants were instructed to look at the picture the entire time it was on the screen. After viewing the picture, participants rated their craving and arousal on two scales from 1 to 9 (*no craving* to *extreme craving* and *very calm* to *very excited*). After participants completed the ratings, the next picture was displayed.

Results

A series of parametric and nonparametric tests was performed to detect differences among smoker groups (controls, relapsers, and abstainers) on demographic variables (e.g., age and race), baseline QSU ratings, and smoking characteristics (number of cigarettes smoked, FTND scores, CO, and cotinine). The salient difference, naturally, was the abstainers' ability to abstain from smoking for 14–17 days, for reasons that remain as yet unexplored. No other significant differences emerged. Because this report is an examination of the craving and arousal differences between absolute abstainers and continuing smokers, data from the relapsers were removed from the analysis. Although the relapsers had resumed smoking or dropped out and were presumed

to have returned to smoking by the end of the study, their partial participation in a treatment program distinguishes them from assigned controls; thus, they were not combined with controls in our analyses.

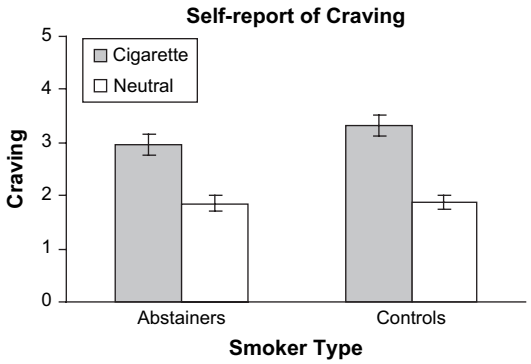
Confirming the accuracy of group membership, abstainers and controls were significantly different on two biochemical markers of smoking activity at the time of picture rating: expired CO (abstainers, $M = 3.6$ ppm, SD 3.8; controls, $M = 24.1$ ppm, SD 13.5) and salivary cotinine (abstainers, $M = 40.4$ ng/ml, SD 53.8; controls, $M = 265.0$ ng/ml, SD 223.0).

A 2 × 2 analysis of variance was conducted with smoker type (abstainer vs. control) as a between-subject factor and picture type (neutral vs. cigarette) as a within-subject factor. There was a main effect of picture type, $F(1, 65) = 386.8$, $p < .0001$, with participants across both groups reporting higher craving after viewing cigarette pictures compared with neutral pictures. There also was a main effect of smoker group, $F(1, 64) = 57.3$, $p < .01$, on craving ratings, with controls reporting higher craving than abstaining smokers to both cigarette stimuli, $F(1, 65) = 44.9$, $p < .0001$, and neutral stimuli, $F(1, 65) = 47.7$, $p < .0001$ (Figure 1). We found no significant interactions.

On self-report of arousal, we found a significant interaction, $F(1, 64) = 4.5$, $p < .05$, with controls reporting higher arousal after viewing cigarette pictures compared with abstainers, $F(1, 64) = 3.9$, $p < .05$. We found no significant difference in arousal ratings between groups after viewing neutral pictures (Figure 2). A correlational analysis revealed no significant correlation between arousal and craving.

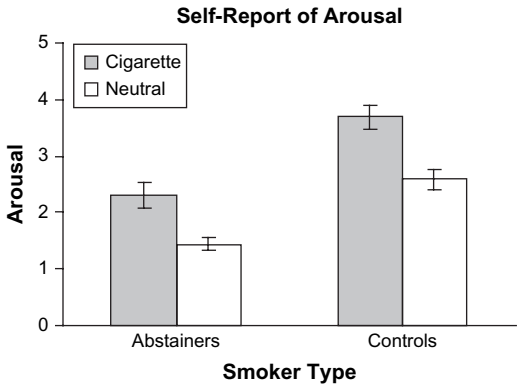
Discussion

These findings suggest that smokers abstinent for 2 weeks display a decrement in generalized craving (i.e., craving measured during exposure to neutral cues), but their smoking-cue–related craving declined at the same rate. That is, both abstainers and controls had the same craving rating difference between cigarette and neutral cues, although abstainers' profiles were lower. This finding supports the proposition that generalized craving and cue-induced craving are additive rather than interactive. This finding also suggests that cue-induced reactivity, if it is a learned behavior, is highly resistant to change. Considering a classical conditioning model, one would expect abstainers, who surely must have experienced numerous unreinforced exposures to specific cues during their 2 weeks of abstinence, to show extra abatement of cue-induced craving compared with controls. However, smoking cues still evoked craving increases among abstainers in the present study.



Note: Figure bars represent 95% confidence intervals

Figure 1. Self-report of craving by picture type.



Note: Figure bars represent 95% confidence intervals.

Figure 2. Self-report of arousal by picture type.

Self-report of arousal showed a different pattern. In abstaining smokers, cue-induced arousal to cigarette pictures declined after 14–17 days of abstinence. The significant drop in self-reported arousal suggests some weakening in the learning processes that may support physiological responding. In this case, the classical conditioning model is supported if one assumes that this decline is the result of numerous unreinforced exposures to cues. In the present study, these smokers were not assessed for objective data (e.g., heart rate and skin conductance) that would show a decline in physiological responding to cigarette cues. However, self-report of arousal is strongly associated with physiological measures of arousal in many cases (Bradley, Codispoti, Cuthbert, & Lang, 2001).

Research on cue reactivity with ex-smokers, who have been abstinent for much longer periods of time, has yet to be investigated fully. Decrements in cue reactivity may be seen after longer periods of abstinence. For example, some cognitive features of nicotine dependence (e.g., cognitive processing bias for cigarette-related cues) have been shown to decay completely in ex-smokers to the level of never-smokers. Munafò, Mogg, Roberts, Bradley, and Murphy (2003) used a modified smoking Stroop task (i.e., smoking-related and neutral words in different colors) to test cue-processing bias (i.e., greater latency to name the correct color) and found no difference between ex-smokers and never-smokers, whereas current smokers retained the bias. Assuming that this bias is a learned phenomenon, as Robinson and Berridge (1993) suggest, then this finding indicates that some smoking-related learning can weaken over time. However, the findings from the present study are based on self-report, which raises the possibility that the decrements in craving and arousal may be restricted to self-report methodology. A larger more controlled study using multiple reactivity measures is needed to clarify this possibility.

Had we conducted a cue-reactivity assessment for these smokers at baseline, a more direct comparison could be made between baseline and end-of-session cue reactivity. We did conduct a baseline measure of craving with the QSU while the participant smoked a cigarette. Although it is difficult to

interpret this baseline craving rating in terms of cue reactivity, it does serve as a prerandomization, global craving rating on which the eventual smoker groups (abstainers, relapsers, and controls) did not differ at baseline.

The results of the present study suggest several factors that may influence learned nicotine dependence. First, generalized craving and cue reactivity appear to be controlled by separate processes, given the unequal rates of decline among groups. In the case of cue reactivity, there was no decline at all. Second, the decline in generalized craving could be due to the behavioral treatment effects, which included relaxation techniques. Therefore, it is possible that both types of craving are the result of learning but are controlled by different processes.

Several limitations of this preliminary study need to be kept in mind when interpreting the results. The study was constrained by the parameters of a larger study, of which it is a part. It would have been more desirable to have assessed smokers at a more traditional 1-, 3-, 6-, or 12-month follow-up. However, this was a preliminary study on the short-term effects of abstinence on cue reactivity. We were limited by the design of the main study, which did not allow for extensive follow-up. It also would have been fruitful to have collected physiological data (e.g., heart rate and skin conductance) during the cue-reactivity phase to supplement the self-report of arousal.

Most current research efforts, and current nicotine dependence models on cue-induced reactivity, are focused on how the cue-response association is established and maintained, whereas the decrement of these responses in ex-smokers remains largely unstudied. This area of study, how or whether the cue-response association decays over time in ex-smokers, should help shed light on the potential learning and other factors that may be involved in the basic mechanisms of nicotine dependence.

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Declaration of Interests

None declared.

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