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Cue-induced cigarette and food craving: A common effect?

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Abstract

Cue-induced cravings may hinder behavior change efforts such as smoking cessation. Correlation of cue-induced cravings across multiple stimuli would provide evidence for a cue-reactive phenotype that may have implications for behavior change therapies. The purpose of this study was to examine relationships between cue-induced cravings for cigarettes and cue-induced cravings for a highly preferred food (chocolate) in a sample of smokers not subjected to lengthy deprivation for either of these two appetitive outcomes. Adult smokers (N=164) were assessed for chocolate cravings before and after exposure to chocolate cues and cigarette cravings before and after exposure to smoking cues. Consistent with previous reports, cigarette cravings increased significantly post-cue exposure and chocolate cravings increased significantly post-cue exposure ($p < .0001$). Consistent with study hypotheses, the magnitude of the increase in chocolate cravings after cue-exposure was significantly related to the increase in post-cue cigarette cravings ($r = 0.38$; $p < .0001$), and was significantly related to scores on a retrospective, self-report, measure of cue-induced food cravings in daily life. These findings are consistent with the idea of a general “cue-reactive” phenotype that varies across individuals, a conceptualization of risk that may point the way toward improved interventions for a variety of hedonically mediated behaviors with negative health outcomes.

Keywords

Tobacco use disorder; cigarette cravings; food cravings; self-reported cravings; cue-reactivity; cue-induced craving

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Contributors Drs. Erblich and Bovbjerg designed the study and wrote the protocol. Ms. Lipsky participated in data collection and analysis. Dr. Styn conceptualized and wrote the manuscript in collaboration with the other authors. All authors contributed and have approved the final manuscript.

Conflict of Interest All authors declare they have no conflict of interest.

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Introduction

Strong cravings for cigarettes are a common problem for individuals attempting to quit smoking, and high craving intensity predicts low cessation success (Ferguson & Shiffman, 2009; Fidler, Shahab, & West, 2011; Fidler & West, 2011; Waters et al., 2004). In addition to cigarette cravings associated with reductions in circulating nicotine levels, it is increasingly recognized that exposure to cues associated with cigarette smoking can trigger intense cravings, as well as generate changes in physiologic parameters, and activation of reward pathways in the brain that mediate motivated behaviors (Balfour, 2009; Brody et al., 2002; Carter & Tiffany, 1999; Erblich, Bovbjerg, & Sloan, 2011; Miranda, Rohsenow, Monti, Tidey, & Ray, 2008). Though not undisputed, cue-induced cravings for cigarettes are thought to be a key factor in relapse to smoking even after long periods of abstinence (Ferguson & Shiffman, 2009; Perkins, 2009; Shiffman, 2009). Yet to receive research attention is the possibility that smokers with higher levels of cue-induced craving for cigarettes may also be vulnerable to other cue-induced cravings, such as for highly palatable foods.

A growing body of empirical evidence and recent theorizing supports the view that cue-induced cravings for food and drugs of abuse, including cigarettes, may share the same neurobiological pathways (Blumenthal & Gold, 2010; Kenny, 2011; Pelchat, 2009). Similar to smoking-cue exposure, food-cue exposure elicits intense cravings, as well as generate changes in physiological responses, and activation of brain reward regions involved in motivated behaviors, even among individuals who have recently eaten (Alsene, Li, Chaverneff, & de Wit, 2003; Cornier, 2009; Ferriday & Brunstrom, 2008, 2011). To date however, only one small study has assessed cue-induced cravings for food and cigarettes in the same individuals, and this study found correlations between the two when participants were under 18 hour selective deprivation (Mahler & de Wit, 2010). Evidence of strong correlations between cue-induced cravings for preferred foods and cigarettes would not only provide behavioral support for shared brain mechanisms, it would also point the way toward an experimental protocol with which to explore common and unique aspects of these conditioned cravings. The results of such research would have implications for optimizing treatment interventions for individuals with a propensity for multiple cue-induced behaviors (a cue-reactive phenotype) that might have negative health implications.

The purpose of this study was to examine relationships between cue-induced cravings for cigarettes and cue-induced cravings for chocolate (one of the most highly craved food items (Polivy, Coleman, & Herman, 2005)) in a sample of smokers in the absence of lengthy concurrent deprivation.

Methods

A subgroup of 164 healthy smokers (all participants who completed the food craving assessment which was added to the protocol in mid-recruitment) induced cigarette craving the parent study, participants had to report smoking at least 10 cigarettes per day for at least from a larger study of cue-induced cigarette craving (Erblich & Bovbjerg, 2004) was included in this study. To be eligible for 5 years and qualify for a current diagnosis of nicotine dependence per the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 1994). Exclusion criteria were: (1) current treatment for smoking cessation, (2) current or past substance abuse (other than nicotine), (3) history of hospitalization for mental illness, (4) history of smoking-related illness, (5) below the age of 23, and (6) current pregnancy. To be eligible for this sub-study, participants had to complete the parent study and be willing to complete the food craving assessment.

Basic demographic information (age, gender, education, income, ethnicity, marital status) and smoking history data (age at initiation, cigarettes per day, years having smoked) were obtained via self-administered questionnaires. The 6-item Fagerstrom Test of Nicotine Dependence (FTND) was used to measure the severity of participants' dependence on nicotine (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). Finally, participants completed the Situational Appetite Measures-Urges scale (SAM-U) and Efficacy scale (SAM-E). These instruments assess "trait" level of food cue-induced craving in daily life. Each scale has 5 factors with 6 items each related to food cravings in response to specific internal and/or external stimuli: relaxation, presence of food, hunger, reward and negative feelings. Questions asked on the SAM-U and SAM-E are identical and both use a 5-point response scale; however, the SAM-U assesses urge to eat, whereas the SAM-E assesses confidence in resisting the urge to eat. Reliability coefficients for the two factors range from .74 to .95 (Stanton, Garcia, & Green, 1990).

Self-reported craving in response to the experimental cue exposures was assessed via a brief, five-item, 0–100 instrument designed specifically to make rapid assessments of craving during experimental manipulations that has been used in multiple studies (Erblich & Bovbjerg, 2004; Erblich, Boyarsky, Spring, Niaura, & Bovbjerg, 2003; Hutchison, Niaura, & Swift, 1999). Pre- and post-cue versions of the instrument separately assessed cravings for cigarettes and chocolate "right now" and "during the scene," respectively.

Procedures

To avoid ceiling effects in cigarette craving, participants were instructed to smoke one cigarette immediately before beginning the study procedures. Participants then turned in their package of cigarettes (used for in vivo exposure; see below) and were given a carbon monoxide (CO) breath test using a MicroCO monitor (MicroDirect, Lewiston, ME). To be conservative, we explored CO levels as a potential covariate in the analyses (see below).

Following a classic cue-reactivity paradigm, participants were exposed to neutral, food-related, and smoking-related cues. The neutral cue was a stapler, the food cue was a bar of the participant's preferred brand of chocolate, and the smoking cue was a cigarette from the participant's own pack. To avoid possible carryover effects (Sayette, Griffin, & Sayers, 2010), the neutral cue was always presented first, followed by the chocolate cue and then the smoking cue. Self-reported chocolate and cigarette cravings were assessed immediately before and after each cue exposure using the face-valid craving questionnaire. To reduce the possibility of carryover, participants viewed a brief nature video (Hannan, 1999) between each of the three cue exposures. During each exposure, participants held and sniffed the stimulus for 90 s.

Data Analysis

To measure reactivity, we calculated raw pre- and post-change scores on the craving scale for each of the three exposures (neutral, chocolate, cigarette). To control for initial levels, we always analyzed change scores with pre-exposure craving entered as a covariate, yielding indices of baseline-adjusted change (theoretical range = -100– 100). This approach resolves the frequently discussed problem of poor change score reliability (Pedhazur, 1997). To address the study hypotheses, we conducted partial correlation analyses between: 1) smoking-cue-induced cigarette craving and chocolate-cue-induced chocolate cravings, and 2) specific cue-induced cravings and SAM scores. These analyses controlled for demographics, time since last cigarette, CO levels, BMI, FTND, and craving responses to the neutral stimulus. It should be noted that results were comparable with or without partialling out these factors. Finally, we explored the possibility that gender and ethnicity

would moderate the relationships between cigarette and food cravings by comparing subgroup correlations with a Fisher's r to Z transformation.

Results

Participants had a mean age of 37.3 ± 10.9 years of age. The sample was 49% female, 37% African American, 29% Caucasian, and 25% Hispanic and smoked an average of 18.0 cigarettes per day (FTND=5.4). Mean BMI was 27.6 ± 7.0 . Mean time since last cigarette was 32.1 ± 4.2 minutes. Annual household incomes were less than \$20,000 per year for 40% of the participants, and 70% had completed at least some college.

As shown in Table 1, the participants' cigarette cravings increased significantly post-smoking cue exposure ($p < .0001$). Similarly, participants' chocolate cravings increased significantly post-chocolate cue exposure ($p < .0001$). Consistent with the study hypothesis, there was a significant correlation between smoking-cue-induced cigarette craving and chocolate-cue-induced chocolate craving; ($r = 0.38$; $p < .0001$). To better illustrate this relationship, we performed a two-group median split on cigarette craving scores and compared chocolate craving scores between the two groups. As depicted in Figure 1, smokers with above-median scores in smoking cue-induced cigarette cravings had significantly higher chocolate cue-induced chocolate cravings under laboratory conditions.

We also examined the relationship between laboratory cue-induced cravings and SAM scores (i.e., measures of "real world" cue-induced food urges). Findings revealed that laboratory cigarette craving responses were significantly correlated with both the SAM-E and SAM-U ($r^2 = 0.22$, $p < .005$). As expected, experimentally-induced cue-induced chocolate cravings were also associated with elevated SAM-E ($r = 0.20$, $p < .01$) and SAM-U ($r = 0.22$, $p < .005$) scores. Separate analyses by gender and ethnicity yielded statistically comparable correlations using Fisher's r to Z transformation ($p > .3$), suggesting that effects were not moderated by gender or ethnicity. Finally, demographic factors, BMI, FTND, time since last cigarette, and CO levels were not related to any of the craving outcomes ($p > .20$).

Discussion

The present study explored the extent to which cue-induced cravings for cigarettes are related to cue-induced cravings for chocolate. Consistent with the study hypotheses, we found a significant relationship between the intensities of cravings induced by smoking cues and those induced by chocolate cues in a community sample ($n = 164$) of nicotine-dependent smokers under controlled laboratory conditions. The intensities of these experimentally induced cravings were also found to be related to participants' scores on a well-validated measure of cue-induced cravings for food in daily life. We found no evidence that the strength of these relationships were related to either gender or ethnicity.

Our findings provide additional support for the existence of a general "cue-reactive" phenotype, as proposed by Mahler and de Wit (2010). In a study of 15 college age smokers, Mahler and de Wit (2010) found a strong correlation ($r = .57$) between cue-induced cigarette craving and cue-induced food craving after 18 hours of abstinence from smoking and/or eating. They found no association between cue-induced cravings when participants were permitted to smoke and eat during study procedures. Although we did not allow participants to smoke or eat during study procedures, prior abstinence was not required. Indeed, participants were instructed to smoke immediately before initiating study procedures. Our results thus indicate that substantial deprivation periods are not necessary to see significant correlations in the intensity of craving responses elicited across different appetitive cues.

The somewhat lower correlation between different types of cue-induced cravings in our study ($r=.38$) compared to that found in the Malhler and de Wit study ($r=.57$), may reflect the effects of deprivation status, but could also be due to a variety of other methodological differences between the two studies (e.g., their use of a set of food cues vs. a specific chocolate cue). Additional research will be required to determine the extent to which deprivation state influences the detection of a cue-reactive phenotype. Future research should also confirm correlations across additional types of cue-induced cravings (e.g., cocaine) to establish the generalizability of individual differences in cue-reactivity, as suggested by analogous studies of cues with incentive motivational value in animal models (Saunders & Robinson, 2011).

Recent theorizing suggests that the neurobiological pathways underlying cue-induced cravings for food, include the same mesolimbic dopamine reward circuitry involved in cue-induced craving for drugs of abuse, including nicotine, alcohol, and cocaine (Berridge, 2007; Blum, Liu, Shriner, & Gold, 2011; Blumenthal & Gold, 2010; Kenny, 2011; Pelchat, 2009). The mechanisms responsible for individual differences in the intensity of cue-induced cravings across these modalities have yet to be determined. However, accumulating evidence from animal studies and initial research with humans increasingly implicates genetic differences in dopamine pathways activated by such incentive stimuli (Blum et al., 2011; Erblich, Lerman, Self, Diaz, & Bovbjerg, 2005; Flagel, Akil, & Robinson, 2009; Flagel et al., 2011; Flagel et al., 2010).

The clinical implications of the possibility that some individuals may have a propensity for particularly intense cue-induced cravings (a high cue-reactive phenotype) have yet to be realized, but may be profound. For example, weight gain is a common side-effect of smoking cessation, but little attention has been paid to the possible role of a shared phenotype for cue reactivity. Evidence suggests that there are significant short-term benefits and no risks of combining smoking treatment and behavioral weight control (B. Spring et al., 2009); however, not all reports are supportive of dual-treatment (Parsons, Lycett, & Aveyard, 2009; Perkins et al., 2001; B. Spring, McFadden, Rademaker, & Hitsman, 2011). Individuals who are highly cue reactive may be more likely to have difficulty changing both their eating and smoking behaviors together, or they may be more particularly responsive to tailored interventions. More research to explore possible synergistic benefits would now seem to be warranted.

Key strengths of the research reported here include the large, community recruited sample ($n=164$) and diverse ethnic representation. Moreover, the research design included both experimental and survey based assessments to explore possible relationships between cue-induced urges for chocolate and cigarettes under controlled laboratory conditions and urges for foods in daily life. A lack of survey-based assessments of smoking cue-induced cravings in daily life is a weakness, as is the lack of data regarding time of last eating episode and, more specifically, length of abstinence from chocolate. It is also important to note that while we found increases in self-reported cravings, it is not clear whether these cravings would result in increased eating or smoking in response to the cues. Future studies should take this line of research one step further and examine to what extent specific cues elicit alterations in behavior as well as increased urges.

In summary, the present study demonstrated significant associations in the magnitude of cravings induced by smoking cues and chocolate cues under controlled laboratory conditions, as well as in daily life. These findings contribute to a growing appreciation that a common phenotype of increased cue-reactivity, which may reflect underlying genetic variability in brain responses to incentive stimuli, could contribute to increased risk of multiple negative health outcomes in the context of addictive behaviors.

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Highlights

- Self-reported cravings for chocolate increase following exposure to chocolate cues; self-reported cravings for cigarettes increase following exposure to smoking cues.
- Higher levels of smoking cue-induced cigarette cravings are associated with heightened chocolate cue-induced chocolate cravings, supporting the possibility of a “cue-reactive” phenotype.
- Substantial deprivation periods are not necessary to see significant correlations between these two responses to appetitive cues.

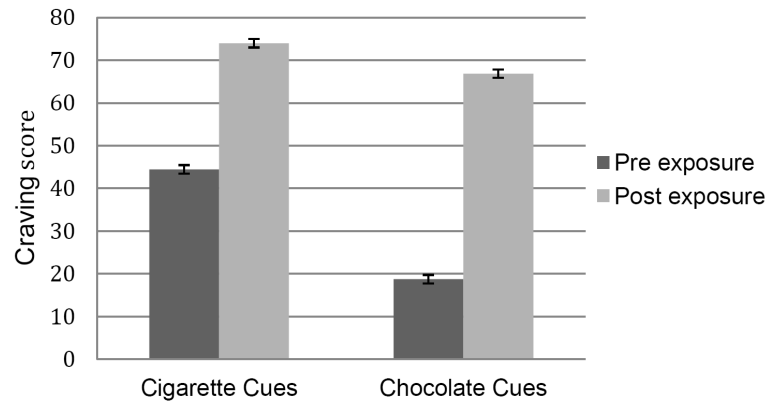


Figure 1. Cigarette Cue-Induced Cigarette Cravings and Chocolate Cue-Induced Chocolate Cravings

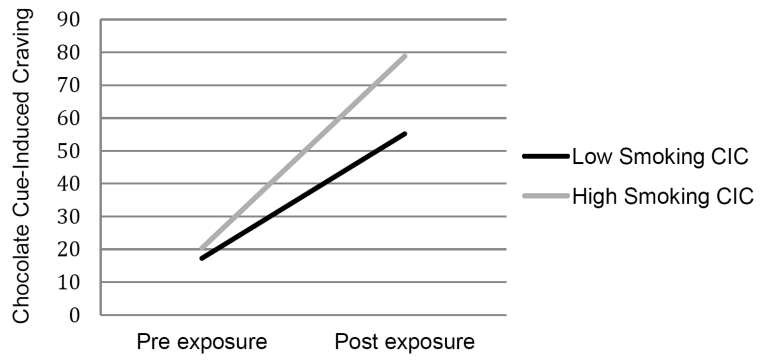


Figure 2.
Relationship Between Smoking Cue-Induced Craving and Chocolate Cue-Induced Craving

Table 1

Mean craving scores measured pre and post cue exposure and measured with the Situational Appetite Measures instruments.

| Variable | Mean | SD |
|--------------------|------|------|
| Cigarette Craving | | |
| Pre Neutral Cue | 41.5 | 35.8 |
| Post Neutral Cue | 28.5 | 35.5 |
| Pre Smoking Cue | 44.4 | 36.2 |
| Post Smoking Cue | 74.0 | 32.8 |
| Chocolate Craving | | |
| Pre Neutral Cue | 22.0 | 30.1 |
| Post Neutral Cue | 14.3 | 25.3 |
| Pre Chocolate Cue | 18.7 | 29.6 |
| Post Chocolate Cue | 66.9 | 35.8 |
| SAM - E | 79.4 | 21.6 |
| SAM - U | 77.7 | 17.6 |