Repeated cue exposure effects on subjective and physiological indices of chocolate craving

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Abstract

The aim of this study is to investigate the effects of repeated unreinforced exposure to chocolate cues in persons reporting chocolate craving. Participants in the experimental group (n = 40) received 10 consecutive brief exposures to chocolate cues in each of two sessions, separated by 1–3 days. Control participants (n = 18) received two exposures at the start and end of each session. Chocolate craving was measured (alternately) through subjective report and the amount of saliva secretion to chocolate cues. Results showed a between-sessions decrease in both craving measures in the experimental group, whereas no differences in craving between sessions were observed in the control group. These results provide evidence for the effects of cue exposure treatment in chocolate craving.

Keywords: Chocolate craving; Cue exposure; Salivation

Introduction

Food craving, which is defined as an intense desire or longing (Kozlowski & Wilkinson, 1987; Weingarten & Elston, 1990) to eat a particular food (Marlatt, 1987; Rozin, 1976), is a common phenomenon in the general population (Weingarten & Elston, 1991). In Western cultures, the food most frequently craved is chocolate, especially among women (Pelchat, 1997; Rogers & Smit, 2000; Rozin, Levine, & Stoess, 1991). Although for the majority of people chocolate craving is not harmful (Lafay et al., 2001), it may be subjectively experienced as unwanted, being an element of an unhealthy life style and possibly contributing to weight problems. In some cases, it may become a real problem when it rises to the level of binge eating (Kales, 1990). Therefore, it is important to gain insight into the craving process and to develop ways that can help to reduce chocolate craving (Kemps, Tiggemann, & Hart, 2005). Moreover, given that chocolate craving is highly prevalent and, unlike for example alcohol dependency and binge eating (Jansen, 1998), much less confounded by psychiatric co-morbidity, it allows craving and craving reduction techniques to be investigated in a relatively pure manner in easily accessible populations (Weingarten & Elston, 1991).

Only a few studies have hitherto been devoted to the reduction of chocolate craving, none of which has yielded clear results. One study looked at suppression of craving-related thoughts, but this did not seem to have a substantial effect (Johnston, Bulik, & Anstiss, 1999). Kemps et al. (2005) recently found that visuo-spatial working memory-based techniques reduced imagery vividness and self-reported chocolate craving in both female chocolate cravers and non-cravers. However, contrary to what was predicted, irrelevant speech also reduced both vividness and craving, be it to a lesser extent.

For any attempt to reduce chocolate craving, it is relevant to understand the critical cues and processes underlying the craving response to chocolate. Several accounts have been proposed (e.g., Rozin et al., 1991), which we will briefly discuss.

Chocolate is known for its “melt in the mouth” sensation that is attributed to one of its main fat
ingredients, cocoa butter. Chocolate is also high in sugar. The combination of sugar and fat has a particular appeal (Drewnowski & Greenwood, 1983). Chocolate also has a uniquely attractive aroma. As a result, the taste and flavor of chocolate have a high incentive value (Rozin et al., 1991). Comparing the role of sensory and pharmacological properties of chocolate revealed that the former but not the latter satisfied the craving response (Michener & Rozin, 1994). In line with this, chocolate cravers reported that non-chocolate substitutes were inadequate to abate their craving (Polivy, Coleman, & Herman, 2005; Weingarten & Elston, 1991). In sum, results suggest that pharmacological factors play little—if any—role in the satisfaction of craving (Rogers & Smit, 2000).

Despite findings that depressed mood may increase chocolate craving (Willner et al., 1998) and that people report to self-medicate with chocolate (Schuman, Gitlin, & Fairbanks, 1987), a recent review revealed that the mood-enhancing effect of chocolate consumption is short-lived and that chocolate prolongs a dysphoric mood when consumed for comforting (Parker, Parker, & Brotchie, 2006).

Women often report a stronger craving for chocolate in their perimenstruum (e.g., Hill & Heaton-Brown, 1994), suggesting a role for sex hormones (Bruinsma & Taren, 1999). However, Spanish women reported much less premenstrual chocolate craving than American women, suggesting a cultural origin (Osman & Sobal, 2006; Zellner, Garriga-Trillo, Centeno, & Wadsworth, 2004). One way to frame this is by assuming that chocolate craving is triggered by classically conditioned food cues. Zellner and Edwards (2001) state that conditioning is strongly involved in the production of food cravings; neutral stimuli or cues that have been associated with food intake can, over time, elicit reactivity that can be experienced as craving for the food. So, with repeated consumption of chocolate during the perimenstruum, moods and typical feelings during this period may become conditioned cues for the high incentive value of the sensory properties of chocolate. Chocolate craving is then seen as a mediator of cue-induced eating.

Craving or urge to use a given drug is considered an important source of maintenance and relapse in addiction literature (Drummond, Tiffany, Glautier, & Remington, 1995; Jansen, 1998). Exposure-based therapies, inspired by Pavlovian conditioning models of addiction, aim to extinguish this craving. These therapies consist of repeated exposures to drug cues while preventing drug use (response prevention) and have proven successful to extinguish craving. Given its success in the domain of alcohol abuse (Drummond et al., 1995), bulimia nervosa (Carter, McIntosh, Joyce, Frampton, & Bulik, 2006) and binge eating (Jansen, 1998; Jansen, Broekmate, & Heymans, 1992), the conditioning model of food craving (Jansen, 1998; Zellner & Edwards, 2001) seems to provide the best heuristic tool when trying to devise techniques to reduce chocolate craving. Specifically, Jansen et al. (1992) have demonstrated cue exposure to be efficacious in binge eaters, reducing the binge frequency. Nevertheless, techniques for chocolate craving reduction based on the conditioning model have not been put to empirical test yet.

In the present study, we repeatedly presented chocolate cues to chocolate cravers in a clinical analogue study in two consecutive sessions. Chocolate craving was measured in two ways and this alternately: By subjective report and by the amount of saliva secretion to chocolate cues, using the cotton roll method. This method appears to yield a sensitive, valid and reliable index of craving (Nederkoorn, de Wit, Smulders, & Jansen, 2001; Tuomisto et al., 1999; White, 1977).

Research on addiction has shown that effects of exposure are often limited to the context in which exposure is conducted (e.g. Thewissen, Snijders, Havermans, van den Hout, & Jansen, 2006). Therefore, the experiment also contained a mood induction manipulation aimed at exploring to what extent reduction of craving would generalize to different mood contexts. However, our mood manipulation failed to induce the intended mood changes (see infra); therefore, the contextual control of chocolate craving could not be addressed.

Method

Participants

Participants (n = 58) were recruited on the basis of a questionnaire, administered to 335 students, that labeled them as chocolate cravers. They met the criterion for chocolate craver when they reported to (a) be “very bad”/“bad”/“rather bad” at postponing a chocolate craving, (b) “rather like”/“very much like” to gain more control over their chocolate craving and (c) find it “neutral”/“rather difficult”/“very difficult” to gain more control over their chocolate craving. All were female psychology students at the University of Leuven, aged between 20 and 24 years (M = 20.71, SD = 0.80). All participated on a voluntary basis.

Measures

Chocolate craving was measured, alternately, through subjective report and the amount of saliva secretion to chocolate cues.

Subjective report

Self-reported craving was measured using an online scale. The scale, presented on a computer screen in front of the participant, ran from bottom to top and ranged from 0 (no craving for chocolate at all) to 100 (extreme craving for chocolate). It was divided in 10 boxes representing 10 units each. Above the scale the question “How strong is your craving for chocolate at this moment?” appeared.

During the time of an exposure trial (2 min), participants were instructed to rate their craving at any time, but at
least every time they heard a tone (every 30 s; at 0.5’, 1’, 1.5’ and 2’ into the trial). They were told that their craving could either change or not and that it was important to re-evaluate their craving at every specific moment. Since participants hardly ever reported their craving in absence of the tones, only the four scores reported at the times of the tones were taken into account for the analyses. Per trial a craving score was calculated by taking the mean of those four scores.

**Saliva secretion**

The amount of salivation was measured by weighing the amount of saliva absorbed by rolls of cotton before and after application to the mouth. This amount can be interpreted as an indicator of craving (Nederkoorn et al., 2001).

Participants were shown where and how to place the cotton rolls at fixed locations in the mouth, consistently in the same order (left, right, middle), and how to take them out. It was emphasized that swallowing needed to be restricted as much as possible. After each cotton roll measurement participants were instructed to take a little sip of water.

**Procedure**

The experiment consisted of two 1-h sessions with 1–3 days between sessions. Participants were instructed not to eat nor drink coffee 3 h prior to the sessions and to abstain from chocolate and other candies 24 h prior to the sessions.

Each participant was asked beforehand what kind and brand of chocolate she preferred; this was then used for cue exposure.

The experiment also implied mood induction manipulations in order to explore to what extent reduction of craving would generalize to different mood contexts. In the first session half of the participants were shown a film fragment (4 min, 40 s) from Dead poets society (Witt, Thomas, & Weir, 1989) intended to induce a negative mood. The other half watched two film fragments: one (3 min, 26 s) from There’s something about Mary (Farrelly & Farrelly, 1998) intended to induce a positive mood (clips were selected on the basis of film excerpts used in previous research by Schaefer, Nils, Sanchez, & Philippot, 2007). In the second session participants were instructed to look at both the negative movie clip and the two positive fragments, to see whether reduced craving would generalize to the same and a different mood context. The valence of the mood induction (first session) and the order (positive or negative mood induction; second session) were counterbalanced across participants. To measure emotional changes the Positive and Negative Affect Schedule (PANAS) Scales (Watson, Clark, & Tellegen, 1988) were used (Dutch validated version: Engelen, De Peuter, Victor, Van Diest, & Van den Bergh, 2006). The mood manipulations did not yield the intended effects1 and mood-related aspects will not be discussed further.

First the two sessions for the experimental group (n = 40) will be described. Then the procedural differences for the control group (n = 18) will be mentioned.

**Session 1**

Participants were first asked to fill out an informed consent form, a biographical questionnaire and the PANAS Scales. An exercise trial with the cotton rolls followed, which served as a baseline measurement of saliva secretion (BS = baseline salivation). Following BS measurement, participants were exposed to chocolate for the first time. The chocolate (an unwrapped bar) was presented on a plate, which was placed behind the monitor, out of sight of the participant. When an exposure trial started, the experimenter placed the plate in front of the participant. At the end of each trial, the plate was again placed behind the monitor. All cue exposure trials lasted 27 min, during which time participants either had to report their craving online or salivation was measured. Participants were instructed to first look at the chocolate for 30 s, and to then hold the chocolate for another 30 s, followed by 1 min of constantly smelling the chocolate. At the end of the first trial only, participants were allowed—after smelling the chocolate—to taste a very small piece.

Craving during the first exposure trial was measured by means of an online scale (C1 = first online craving). A second exposure trial followed (S0 = salivation measure) after approximately 1 min. After this trial, film fragments were shown, followed by four cue exposure trials. Craving was measured alternately by means of the cotton rolls and the online scale (S1, C2, S2, C3). Next, the same film fragments were presented and followed by another four cue exposure trials (S3, C4, S4, C5). The last trial (C5) lasted for 10 min (9 min of constant smelling, with a tone probing for online craving every 30 s) or until a participant rated her craving to be lower than 10 on the online scale.

In sum, the first session consisted of 10 cue exposure trials with five salivation measurements and five online craving measurements, in the following order: (BS), C1, S0, (film), S1, C2, S2, C3, (film), S3, C4, S4, C5. At the end of the session participants were again asked to fill out the PANAS Scales.

**Session 2**

This session was similar to the first session, with the following exceptions. Participants were now presented with both the negative and the positive mood movie clips. The first clip was presented between S0 and S1, the second between C3 and S3. An additional set of PANAS Scales

1 Apart from a significant induction effect in the NA-scores for session 1, F(1, 56) = 4.93, p < .05; our mood manipulations failed to result in reliable mood change effects. Consequently, mood induction was not included as a factor in statistical analyses.
was administered right before the second clip. The last exposure trial (C5) lasted 2 min.

**Control group**

Participants in the control group were treated in the same way as participants in the experimental group, except that they only received exposure to chocolate at the beginning of each session and at the end. More precisely, they were only exposed to chocolate at C1, S0, S4 and C5. Their craving was measured in the same way as for participants in the experimental group at the other trials (S1, C2, S2, C3, S3 and C4) but without chocolate exposure.

**Data analysis**

A 2 × 2 × 3 (group × session × trial) ANOVA was performed on the amount of saliva secreted. The three trials that were included were (1) the BS, (2) the mean of S1, S2 and S3 since these were the three trials where the experimental group was exposed to chocolate whereas the control group was not \[M(S1,S2,S3)], (3) and the last exposure trial S4.2

Similarly, a 2 × 2 × 3 (group × session × trial) ANOVA was run on the online craving scores, with the following three trials: (1) C1, (2) the mean of C2, C3 and C4 since these were the three trials where the experimental group was exposed to chocolate whereas the control group was not \[M(C2,C3,C4)]. (3) and the last exposure trial C5. We followed these ANOVAs up with planned comparisons to check for effects of exposure within and between sessions in both groups.

**Results**

**Online craving scores**

As can be seen in Fig. 1, there was a significant decrease from session 1 to session 2 for the experimental group, \(F(1, 56) = 35.14, p < .001\), whereas there was no difference between sessions for the control group, \(F < 1\). The group × session interaction was significant, \(F(1, 56) = 11.91, p < .01\), but the group × session × trial interaction was not, \(F(2, 112) = 1.54, n.s.\)

In the experimental group, we observed no decrease in craving from start to end (C1–C5) in session 1, \(F < 1\), and even an increase in session 2, \(F(1, 56) = 7.59, p < .01\). From the beginning of the experiment (C1 in session 1) to the end (C5 in session 2), a significant decrease in reported craving was observed, \(F(1, 56) = 6.08, p < .05\).

In the control group, we saw an increase in reported craving from C1 to C5 both in session 1, \(F(1, 56) = 6.42, p < .05\), and in session 2, \(F(1, 56) = 9.67, p < .05\). From the beginning of the experiment (C1 in session 1) to the end (C5 in session 2), a significant increase in reported craving was observed, \(F(1, 56) = 4.18, p < .07\) [interaction between groups: \(F(1, 56) = 9.43, p < .01\)]. The mean reported craving at C2, C3 and C4 (when participants were not exposed) was significantly lower than at C1 and C5 (when exposure did take place) in both sessions, \(F(1, 56) = 78.72, p < .001\). Note that subjective craving at C1 did not differ between groups in session 1, \(F(1, 56) = 2.35, p > .05\).

**Amount of salivation**

As can be seen in Fig. 2, there was a marginally significant decrease from session 1 to session 2 for the experimental group, \(F(1, 56) = 3.52, p = .07\), whereas there was no difference between sessions at all for the control group.

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2Right before the S0 measure, participants were instructed to taste a small piece of chocolate. Due to the chocolate tasting right before, the S0 trial can be seen as a maximal amount of saliva secreted and is therefore not included in the analysis.
group, $F<1$. Similar to the online craving data, the mean amount of saliva secreted in session 2 was lower than in session 1 in the experimental group but not in the control group. However, neither the three-way interaction, nor the group by session interaction turned out significant, $F<1$. Note that BS did not differ between groups in session 1, $F<1$.

**Discussion**

In this clinical analogue study, chocolate cravers were repeatedly exposed to their favorite chocolate in two consecutive sessions in order to extinguish their cue-induced craving. Both subjective craving and the amount of saliva secretion were measured. In the experimental group, reported craving for chocolate was not reduced within a single session of repeated exposure to the cues, but did diminish between sessions and from the beginning of the experiment to the end. In contrast, in the control group, no differences between sessions were found and reported craving increased within both sessions and from the beginning to the end of the experiment. These results show that a cue-exposure manipulation was effective in reducing subjective craving in the experimental group and not in the control group. The data pattern that emerges for salivation was in line with these findings, rendering it unlikely that the subjective craving results would be due to mere demand.

In general, our data are in accordance with a conditioning model in showing that exposure is effective to reduce chocolate craving. This mirrors the positive effects of exposure-based therapies for bulimia nervosa, alcoholism and phobias (e.g. Carter et al., 2006; Drummond et al., 1995; Öst, 1997). However, also differences emerged. For example, a typical within-session pattern during exposure to fear cues in anxiety disorders implies an initial increase in fear reactions followed by a continuous decrease until the end of the exposure session, while fear is reduced across trials (Foa & Kozak, 1986). The present results are in line with the between-session, but not with the within-session part. Possibly, different expectations may play a role here: Exposure to fear cues is typically framed in a fear reduction context, whereas in the present study no clear information was given as to the course of the sessions. It is likely that at the end of a session participants were still expecting to receive chocolate, possibly leading to a within-session increase of craving. Another possible explanation is the short duration of our experiment (28 min in session 1; 20 min in session 2); Jansen et al. (1992) found that craving in binge eaters only extinguished after half an hour of cue exposure.

Although cue exposure has been proven efficient for the treatment of alcoholism (Drummond et al., 1995), a review by Conklin and Tiffany (2002) concluded that no consistent evidence was available for the efficacy of cue exposure for the treatment of other addictions and that there is a need for "cue-reactivity work investigating the value of different response measures (e.g. self-report, physiological, behavioral) for tracking extinction learning" (p. 165). Their plea is consistent with Bouton’s (2000) and Huvermans and Jansen’s argument (2003) that learning theory can provide a strong model to conceptualize problems of maintenance and change of health-related behavior. The current experiment constitutes one of the first steps in this direction.

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