

Acute versus repeated chocolate exposure

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Acute versus repeated chocolate exposure: Effects on intake and cravings in restrained and unrestrained eaters

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Jennifer S Coelho, Chantal Nederkoorn
and Anita Jansen

Abstract

The cue-reactivity model, which is based on conditioning processes, posits that repeated food exposure (in the absence of consumption) should decrease cue reactivity. To examine whether repeated chocolate exposure attenuates cravings and intake, relative to those exposed to an acute cue, a 2 (repeated vs acute cue) \times 2 (restrained vs unrestrained eaters) design was employed. Fifty female participants were recruited. Repeated exposure reduced cravings in unrestrained eaters (relative to acute exposure), but increased cravings in restrained eaters. An interaction between restraint and exposure emerged on intake, such that restrained eaters ate less after acute exposure than did unrestrained eaters.

Keywords

cue exposure, cue reactivity, dietary restraint, food intake, food cravings

Food cues are appetitive—even after eating to satiation, exposure to palatable foods increases cravings and can restimulate intake (Cornell et al., 1989). Jansen (1998) put forth a model to account for the effects of food-related cues on craving and intake. This cue-reactivity model posits that food-related cues act as conditioned stimuli, which in turn trigger conditioned responses, such as craving, salivation, and insulin secretion. The psychological mechanism active in cue reactivity is therefore a learning mechanism. Unreinforced conditioned stimuli (e.g. food-related cues presented in the absence of the unconditioned stimulus—that is, intake) will eventually lead to an extinction of the conditioned response. Although the underlying mechanism involved in cue reactivity is

expected to be the same across individuals, it is arguable that certain individuals (e.g. those with bulimia nervosa or those who are restrained eaters (R)) exhibit stronger conditioned responses because they had a more robust learning history in which exposure to high-calorie food cues (conditioned stimuli) was more reliably paired with intake (unconditioned stimulus). A stronger learning history is consistent with stronger

Department of Clinical Psychological Science, Maastricht University, The Netherlands

Corresponding author:

Jennifer S Coelho, Eating Disorders Program,
Douglas Mental Health University Institute,
6875 LaSalle Blvd., Verdun, QC, Canada H4H 1R3.
Email: jennifer.coelho@douglas.mcgill.ca

conditioned responses. According to Jansen, conditioning is stronger in individuals who binge (e.g. individuals with bulimia nervosa), as they typically undergo prolonged food restriction followed by a period of bingeing. Restrained eaters may also experience stronger conditioning—although they are unlikely to have objective binges, their cycle of dieting and overeating serves as an analog to bulimia nervosa (e.g. Nederkoorn et al., 2004).

Research supports the predictions of the cue-reactivity model that individuals with bulimia have particularly strong cue reactivity. Individuals with bulimia report increased urges to binge after food-cue exposure (Jansen et al., 1992; Staiger et al., 2000) and exhibit increased salivation relative to participants without an eating disorder (Legenbauer et al., 2004). Similarly, restrained eaters report more cravings and eat more after direct food-cue exposure than do unrestrained eaters (UR) (e.g. Coelho et al., 2009; Fedoroff et al., 1997; Jansen and Van den Hout, 1991) and also exhibit increased salivation (Klajner et al., 1981). Following the logic of the cue-reactivity model, in which conditioning processes are occurring with food-cue exposure, it should be possible to extinguish cue reactivity through cue exposure and response prevention (CERP), as the conditioned cue (sight/smell of food) will no longer predict intake (Jansen, 1998). In accordance with this logic, a pilot study demonstrated that CERP led to abstinence in binge eating for six patients with bulimia (Jansen et al., 1992). It is conceivable that CERP could also reduce cravings and intake in restrained eaters. Research on exposure to food-related cues in restrained eaters has typically employed short one-session paradigms (e.g. Fedoroff et al., 1997; Jansen and Van den Hout, 1991). Extended exposure to chocolate over one session decreased salivation, but not craving (Lappalainen et al., 1994), suggesting that CERP repeated over several sessions may be necessary to effect changes in various conditioned responses. Furthermore, Lappalainen and colleagues did not differentiate between restrained and unrestrained eaters; given the hypothesized

differences in conditioning processes, some of the effects may have been suppressed by not studying the interaction between dieting and food-cue exposure.

The current study was conducted to examine the effects of repeated exposure to food-related cues in restrained eaters and unrestrained eaters. CERP paradigms used in bulimia nervosa employ many sessions of CERP, ranging from 9 sessions of 45 minutes (Kennedy et al., 1995), 10 sessions of 1 hour (Jansen et al., 1992), 12 sessions of up to 90 minutes (Martinez-Mallén et al., 2007), to 12–36 sessions of 1 hour (Toro et al., 2003). Preliminary support for the potential utility of repeated exposure in individuals without eating disorders has recently emerged in individuals identified as chocolate cravers (Van Gucht et al., 2008). The procedure employed by Van Gucht and colleagues involved exposing participants to either a control or a chocolate cue (in which participants were exposed to 10 trials of smelling/looking at/holding chocolate across two sessions). There was a significant decrease in chocolate craving in the chocolate-exposed participants both between sessions, as well as from the beginning to the end of the experiment, whereas craving increased for control participants. However, the between-session decrease in salivation response for chocolate-exposed participants reached only marginal levels of statistical significance. This marginally significant response, in addition to the more extensive exposure and response prevention (ERP) sessions within the clinical literature, suggests that increased exposure (i.e. duration and/or frequency) could be beneficial in the application of CERP to restrained eaters. Stronger conditioned responses (which appear to exist in restrained eaters) will require more or longer extinction sessions than weaker conditioned responses, as participants have to learn a new association (i.e. that the conditioned stimulus does not predict intake).

Although clinical studies have typically used around 10 sessions of CERP, it was anticipated that CERP could be effective with fewer sessions in nonclinical participants. It was thus

decided that three repeated exposure sessions (either of a chocolate cue or a control, nonfood-related cue) would be conducted, with inclusion of a fourth exposure in which all participants would be exposed to a chocolate cue, with their craving and intake assessed. It was expected that CERP would result in lower cravings and intake relative to acute exposure. However, given that restrained eaters (but not unrestrained eaters) typically have higher cravings and eat more after acute exposure (Fedoroff et al., 1997; Jansen and Van den Hout, 1991), it was expected that an interaction between time and restraint status would emerge. However, given the limited research in the area, the precise direction of the predicted interaction was unclear. On one hand, it is possible that restrained eaters would exhibit larger decreases in intake and craving response over the course of the repeated exposures than would unrestrained eaters (as there is less room for movement in the responses of unrestrained eaters, with their dampened reactivity to food cues relative to restrained eaters). In other words, a floor effect might emerge in unrestrained eaters. Alternatively, because restrained eaters typically have higher cue reactivity after direct food-cue exposure than do unrestrained eaters, it may take longer to extinguish their craving and intake relative to unrestrained eaters.

Methods

Participants

A total of 50 female undergraduate students completed this study. All participants were run individually between 11 a.m. and 6 p.m. and received a choice of either partial course credit or a voucher for €25 as compensation for their participation.

Materials

The chocolates used during both the repeated exposure and the taste test were Côte d'Or dark chocolate (Kraft Foods; 505 kcal/100 g), Côte d'Or milk chocolate (Kraft Foods; 530 kcal/100 g),

and Milka milk chocolate with mousse filling (Kraft Foods; 560 kcal/100 g). The control stimuli included rose-scented bath salts, dried chamomile flowers, and wood chips.

Measures

Restraint Scale (Polivy et al., 1988). This scale assesses weight fluctuations and concern with dieting. Participants were provided with a Dutch translation of this measure (Jansen et al., 1988). Dietary restraint was treated dichotomously based on a median split. The obtained median was 13 in the current sample, with participants classified as restrained eaters if they scored 13 or above on the scale ($n = 25$, $M = 16.7$, standard deviation (SD) = 3.6) and as unrestrained eaters if they scored less than 13 ($n = 25$, $M = 7.7$, SD = 2.5). This cutoff is consistent with other recent research using European samples (e.g. Meule et al., 2011).

Procedure

Participants were told that the purpose of the study was to investigate changes in sensory perception over time and were invited to participate in four sessions during a 1-week period. Their pre-experiment liking of chocolate was assessed on a 10-point scale, to ensure that all participants had some degree of liking for chocolate (i.e. a minimum rating of 5 was necessary for inclusion). Upon arrival at the laboratory for the first session, participants provided their informed consent and proceeded to complete baseline ratings of general food cravings, using a 140-mm Visual Analog Scale (VAS) (0 = not at all and 140 = completely). After obtaining baseline measures, participants were exposed to either the control cue (acute exposure condition) or the repeated chocolate cue (depending on the condition to which they had been randomly assigned).

Acute chocolate cue (control). Three bowls of nonfood-related items (bath salts, wood chips, and dried flowers) were placed on the table in front of the participant over the first three

exposure sessions. Participants were asked to look at and smell the contents of each of the bowls over a 15-minute exposure period and were asked to rate different qualities of the items during exposure (e.g. the scent and color of the products, and the effects of the products on mood). Participants also completed ratings of food cravings at 1, 5, 10, and 15 minutes after the start of the exposure (using the same measure that was completed at baseline).

Repeated chocolate cue. Three bowls of chocolates were placed on the table in front of the participant. The chocolates were broken up into small pieces (approximately 4 g each). The instructions and procedure were identical to the control condition. Participants were instructed not to taste any of the products, and the weight of the bowls was measured to verify compliance.

Upon completion of the first session, all participants (regardless of the condition to which they had been assigned) were asked to refrain from eating chocolate (e.g. chocolate bars, hot chocolate, and chocolate spreads) until after their fourth appointment at the end of the week. This request was made to ensure that the “response prevention” component was maintained (i.e. to prevent participants in the chocolate exposure condition from consuming chocolate immediately after the session) and to ensure that all participants were equally chocolate-restricted at the taste test. Participants were aware that they would be doing a taste test in their fourth session. Participants attended three exposure sessions that were all identical (i.e. exposure to either the control or the chocolate cue, with baseline measurements of craving, as well as ratings throughout the 15-minute exposure period). During the fourth and final sessions, all participants were exposed to the chocolate cue for 15 minutes, with measurements of craving taken at 0, 1, 5, 10, and 15 minutes (as in previous sessions). After the exposure, all participants took part in a taste test, in which they were invited to taste the chocolates and complete perceptual ratings of each of the three chocolates (e.g. smell, taste, and saltiness).

Participants had 10 minutes to complete the ratings and were invited to taste as much chocolate as they wished during this time. The chocolates were weighed surreptitiously to measure total intake. Participants were then asked to record what they thought was the purpose of the study, to ensure that they had believed the cover story. Finally, participants completed the Restraint Scale (Polivy et al., 1988). Participants’ height and weight were measured at the end of the final session, and their compliance with the instructions to restrict chocolate over the course of the week was assessed. The time elapsed since their last intake prior to the taste test was also assessed. Participants were debriefed upon termination of the study. All procedures were approved by the departmental ethics committee at the university where this research was conducted.

Data analyses

A total of 50 participants completed this study; however, data were dropped from participants who indicated that they had not been compliant with the instructions to restrict chocolate over the course of the testing week (UR: $n = 2$; R: $n = 6$). One additional participant (UR) was excluded from analyses on intake as she did not follow the instructions to eat at least one piece of each of the three chocolates. Partial eta-squared (η^2) was used to estimate effect sizes.

Results

Characteristics of participants

An analysis of variance (ANOVA) on body mass index (BMI) was conducted, with group (UR vs R) entered as the independent variable, which demonstrated a main effect of restraint on BMI ($F_{1,40} = 7.1, p \leq .02, \eta^2 = 0.15$). Restrained eaters had a higher BMI ($M = 23.3, SD = 2.7$) than did unrestrained eaters ($M = 21.0, SD = 2.7$).¹ An additional ANOVA on the time elapsed since the last intake prior to the taste test was conducted, with both group and condition entered as independent variables.

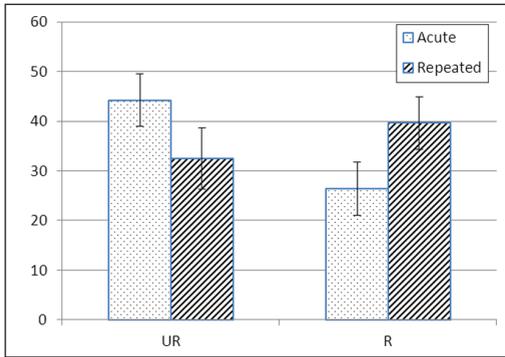


Figure 1. Total chocolate intake (g) with standard error for restrained and unrestrained eaters in the acute exposure condition (UR: $n = 12$; R: $n = 8$) and the repeated chocolate exposure condition (UR: $n = 11$; R: $n = 11$).

UR: unrestrained eaters; R: restrained eaters.

This analysis demonstrated that there were neither main effects nor an interaction (all $ps > .3$). The average time elapsed since participants' last intake was 175.4 minutes (SD = 196.1). ANOVA also demonstrated that there were no significant group differences in liking of chocolate (neither main effects nor an interaction, all $ps > .3$). The mean rating of chocolate-liking was 8.3 (SD = 1.1; range = 6–10).

Food intake

An ANOVA was performed to assess total caloric intake, with restraint status and cue condition entered as independent variables. There were no main effects of the cue condition ($F_{1,37} = 0.02, p > .05, \eta^2 = 0.001$) or restraint status ($F_{1,37} = 0.93, p > .05, \eta^2 = 0.025$); however, a significant interaction emerged ($F_{1,37} = 5.07, p \leq .03, \eta^2 = 0.121$; see Figure 1). Fisher's least significant difference (LSD) post hoc tests indicated that the restrained eaters in the acute exposure condition ate significantly less than did the unrestrained eaters in the acute exposure condition ($p < .05$). Restrained eaters demonstrated a tendency to eat more in the repeated exposure condition than in the acute exposure condition, whereas unrestrained eaters demonstrated the

opposite tendency; however, these comparisons did not reach statistical significance ($p \leq .13$). Similarly, the difference between restrained eaters and unrestrained eaters in the repeated exposure condition was not significant ($p = .35$).

Craving

Participants' craving scores across the four sessions are depicted in Figure 2. Given that the fourth session was the critical session, during which all participants were exposed to the same cue, craving scores during this session were entered as a dependent variable in a repeated-measures ANOVA, with group and condition entered as independent variables. Due to violations of sphericity, Greenhouse–Geisser tests were used. There was an effect of time on cravings ($F_{2,0,78,1} = 29.2, p \leq .001, \eta^2 = .435$), with a significant increase in craving over the exposure period from baseline to 15 minutes ($p < .001$). This analysis also demonstrated that the increase in craving over the exposure period peaked at 5 minutes, with significant increases from baseline to 1 minute, and another increase between 1 and 5 minutes ($ps < .001$), but no further significant increases in craving at 10 or 15 minutes ($ps > .05$). There were no interactions between time and condition, nor time and group, nor did the three-way interaction reach significance (all $ps > .35$).

Given that the increases in craving peaked for all participants after 5 minutes of exposure in the final session, a between-subjects ANOVA was conducted on craving scores at this time point to assess for interaction effects. There were no main effects of condition ($F_{1,38} = 0.08, p = ns, \eta^2 = 0.002$) nor restraint status ($F_{1,38} = 0.85, p > .05, \eta^2 = 0.02$); however, a significant interaction emerged ($F_{1,38} = 9.65, p \leq .005, \eta^2 = 0.203$; see data points 4–3 in Figure 2 for means). Fisher's LSD post hoc tests indicated that the unrestrained eaters in the acute exposure condition reported more cravings than did both unrestrained eaters in the repeated chocolate exposure condition and restrained eaters in the

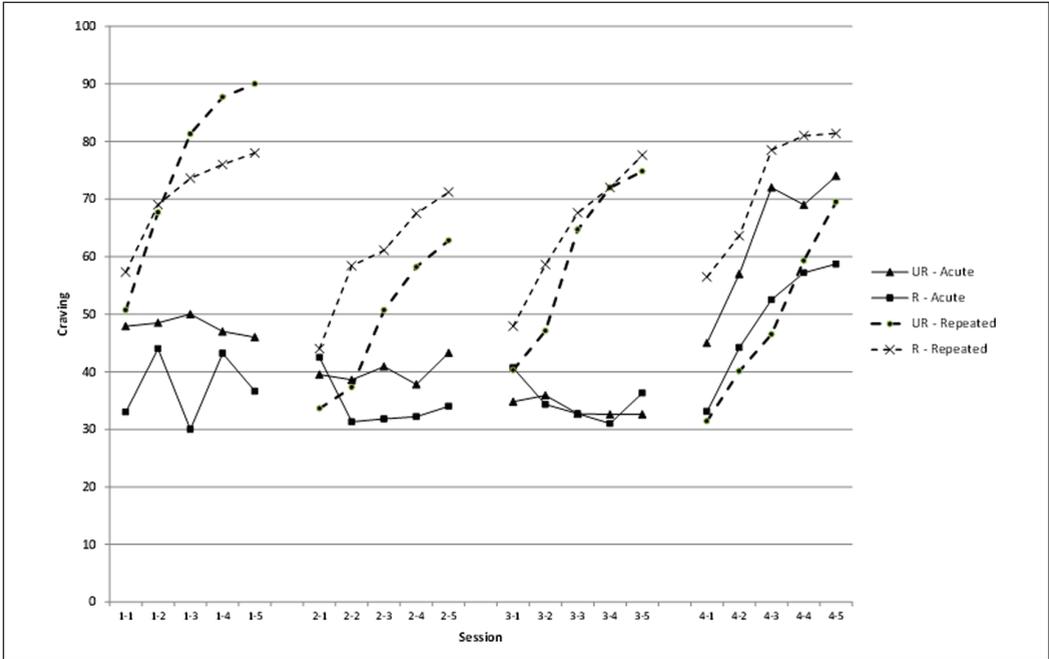


Figure 2. Self-reported cravings across groups over the four sessions. The following notation system is used: baseline craving = 1, craving after 1 minute of exposure = 2, craving after 5 minutes of exposure = 3, craving after 10 minutes of exposure = 4, and craving after 15 minutes of exposure = 5. UR: unrestrained eaters; R: restrained eaters.

acute exposure condition ($p < .05$). Furthermore, restrained eaters in the repeated chocolate exposure condition reported more cravings than did those in the acute exposure condition ($p < .05$).

To test the hypothesis regarding the presence of an interaction between condition and restraint status on craving after repeated exposure, craving at the end of each of the three repeated exposure sessions (i.e. craving at the fifth measurement at the end of the session) was entered in a repeated-measures ANOVA for those in the repeated chocolate exposure condition (with restraint status entered as a between-subjects factor). Only the first three exposures were entered, given that participants knew that they would taste the chocolate in the fourth session (and their craving may have differed as a result of this anticipation). The fifth measurement of craving (at 15 minutes) was chosen, given that this was the maximum mean craving for all groups. There were no significant effects of

time on craving ($F_{2,40} = 2.27, p > .05, \eta^2 = 0.10$) nor was there a significant interaction between time and restraint status, $F_{2,40} = 2.19, p > .05, \eta^2 = 0.099$.

Discussion

The results presented a pattern of findings that partly diverged from the original expectations. The cravings of unrestrained eaters followed the predicted pattern, in which repeated exposure led to lower craving in the final session in unrestrained eaters relative to those unrestrained eaters who received acute exposure to chocolate. However, the intake and cravings of restrained eaters did not demonstrate similar decreases; in fact, restrained eaters exposed repeatedly to chocolate cues reported significantly more cravings than did those exposed to an acute cue. Similarly, there were no differential craving responses over time in restrained eaters and

unrestrained eaters who were exposed to the repeated cue. A lack of extinction of conditioned responses was therefore evident in restrained eaters. Given that restrained eaters typically show stronger cravings and higher intake than unrestrained eaters after food-cue exposure (e.g. Fedoroff et al., 1997; Jansen and Van den Hout, 1991), it may be that more exposure is needed to extinguish their cravings. It was initially expected that the extension of the exposure paradigm to three repeated exposures of 15 minutes would be sufficient to decrease cravings in restrained eaters, given that previous research has demonstrated significant reductions in some indices of cue reactivity after one session of extended exposure (Lappalainen et al., 1994) and two sessions of brief, repeated exposures (Van Gucht et al., 2008). However, it appears that this extension was not sufficient for restrained eaters, as no trend toward extinction was observed in any of the sessions. The duration of exposure to conditioned stimuli appears to be a critical component in the process of extinction. Both human and animal research indicate that extinction is more effective when presentations of the conditioned stimuli are longer, with blocks of longer exposure spaced apart (Cain et al., 2003; Craske and Mystkowski, 2006). Thus, it may be important to extend the duration of exposure to food-related cues to decrease cue reactivity in restrained eaters. Examination of craving response during CERP in clinical participants demonstrates that it took up to 50–60 minutes for craving to reduce by half (Jansen et al., 1992). We cannot, therefore, rule out the possibility that an extension of the duration of the cue exposure would be more effective in reducing craving and intake in restrained eaters.

An unexpected finding that emerged was the decreased intake in restrained eaters exposed to the acute chocolate cue (relative to unrestrained eaters exposed to the acute cue). Typically, restrained eaters exposed to a food-related cue in a one-session exposure eat more than do unrestrained eaters (e.g. Jansen and Van den Hout, 1991). The decreased intake suggests that

perhaps restrained eaters were successful in inhibiting their intake under the conditions of the current study. Although restrained eaters are typically disinhibited by food-cue exposure, they can successfully inhibit their intake after food-cue exposure under certain conditions, such as with incidental food-cue exposure (e.g. Coelho et al., 2009). One mechanism that can explain a lack of disinhibited eating after food-cue exposure is the counteractive-control model (Trope and Fishbach, 2000). According to this model, food cues may remind weight-concerned individuals of their dieting-related goals and lead to healthier food choices (Fishbach et al., 2003). However, strong temptations may ultimately lead to inhibition of dieting goals and increased intake (Fishbach et al.). The repeated exposure condition therefore likely represents a strong temptation, as it led to increased cravings, and a (nonsignificant) increase in intake in restrained eaters (relative to acute exposure).

The current study raises methodological considerations associated with CERP and points to the need for further research to tease apart the length and/or frequency of exposure sessions associated with decreases in craving across groups. Within the current study, visual examination of the graph depicting craving response across sessions demonstrated that there were no within-session decreases in chocolate craving for those in the repeated exposure condition. Traditional views on extinction argue that short-exposure sessions might produce sensitization, and it is argued that CERP will be most effective when responses extinguish during the exposure (Bradley and Moorey, 1988). The fact that the current paradigm appeared to stop exposure sessions at the peak of the craving may have dampened habituation (and perhaps even led to sensitization in the restrained eaters). The optimal exposure treatment for anxiety disorders suggest that stopping at the peak of one's anxiety does not lead to less successful exposures (Arch and Craske, 2011; Craske et al., 2008). Craske and colleagues stress that the

strength of inhibitory learning during exposure depends on the way the exposure is done. A most effective exposure—that is, an exposure that leads to strong inhibitory learning—increases the variability of individual cues and contexts that are related to intake. Craske and colleagues argue that treatment results are not influenced by the level of anxiety at the end of treatment. By extension, therefore, it may not be necessary that food cravings extinguish during exposure for successful applications of CERP. The exposure aims to reduce the expectations associated with the cue (e.g. the expectation of intake upon seeing a food-related cue).

The need for more extensive research into the parameters necessary for successful CERP is not limited to research on food cravings and intake, but has also been recommended in the literature on addictions (e.g. Conklin and Tiffany, 2002). The current study is limited by small sample sizes in each group, which may have obscured possible effects as a result of inadequate power. However, the fact that significant interactions emerged for the main dependent variables, despite the small samples, suggests that the effects observed in the current research can be relatively potent. The results indicate that short CERP can reduce cravings in unrestrained eaters, but not in restrained eaters.

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Note

1. The increased body mass index (BMI) of restrained eaters relative to unrestrained eaters is consistent with the previous research (e.g. Trottier et al., 2005). Following the approach taken by Kroese et al. (2009), BMI was initially entered as a covariate in analyses on food intake and craving during the final session; however, this factor did not emerge as a significant covariate in either analysis ($p = .77$ and $.11$, respectively) nor did it change the pattern of significant results and was therefore not kept in the analysis.

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