What works better?

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What works better? Food cue exposure aiming at the habituation of eating desires or food cue exposure aiming at the violation of overeating expectancies?

Ghislaine Schyns*, Karolien van den Akker, Anne Roefs, Rianne Hilberath, Anita Jansen

Department of Clinical Psychological Science, Faculty of Psychology and Neuroscience, Maastricht University, PO Box 616, 6200 MD Maastricht, The Netherlands

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ABSTRACT

Objective: This study tested the role of habituation of eating desires and violation of overeating expectancies during food cue exposure in obese women.

Method: 52 obese females were randomised into a two-session exposure condition aimed at habituation, a two-session exposure condition aimed at expectancy violation, or a no-treatment control condition. Eating in the absence of hunger of foods included during cue exposure (i.e., exposed foods) and foods not included during cue exposure (i.e., non-exposed foods), and duration of exposure were measured.

Results: Both cue exposure conditions ate significantly less of the exposed foods compared to the control condition, though there were no differences between both types of exposure. No differences were found between conditions regarding the eating of non-exposed foods. In addition, the duration of exposure was not different between both cue exposure conditions.

Conclusions: While food cue exposure in obese women led to less eating of exposed foods, focusing on either habituation of eating desires or expectancy violation did not matter. It is discussed why exposure works.

1. Introduction

Worldwide, the obesity prevalence has reached dramatic proportions, and the necessity for effective interventions is high (Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016). The fact that weight loss interventions that aim at a negative energy balance, by reducing energy intake and increasing energy expenditure, have disappointing effects on successful weight loss fuels the search for effective interventions (e.g., Curioni & Lourenco, 2005; Franz et al., 2007). A major cause for weight gain is the eating for hedonic purposes instead of physiological needs, also referred to as eating in the absence of hunger (EAH; Kral et al., 2013; Lowe & Butryn, 2007). EAH can be promoted by several factors, including exposure to food-related cues; these cues can initiate preparatory processes for food intake, including psychological (e.g., eating desires) and physiological responses (e.g., salivary production; Jansen, 1998). Indeed, this so-called cue reactivity has shown to be higher in overweight versus normal weight individuals (Ferriday & Brunstrom, 2011), significantly correlated to food intake in overweight individuals (Jansen et al., 2003), prospectively related to weight gain (Boswell & Kober, 2016), and significantly reduced in successful dieters (who were previously obese) versus unsuccessful dieters

(Jansen, Stegerman, Roefs, Nederkoorn, & Havermans, 2010). Hence, it might be important to tackle cue reactivity in interventions in order to achieve successful weight loss.

Cue reactivity might (at least partly) be learned through classical conditioning (Jansen, 1998; Jansen, Schyns, Bongers, & van den Akker, 2016): when specific cues, such as the smell or sight of food, become associated with food intake (unconditioned stimulus; US) through repeated pairings, these become predictors, or conditioned stimuli (CS), of food intake and capable of initiating cue reactivity (conditioned response; CR). Several human laboratory studies found evidence that associations between food intake (US) and initially neutral stimuli (CS) are easily learned, and that – as a result of this learning process – CSs easily acquire the ability to elicit conditioned eating desires (e.g., Bongers, van den Akker, Havermans, & Jansen, 2015; van den Akker, Jansen, Frentz, & Havermans, 2013). Because many eating desires are so easily acquired through classical conditioning, extinction of such associations might be the appropriate way to decrease the learned cue reactivity. Exactly this is the aim of food cue exposure: to expose participants to CSs, such as the smell and sight of food, while food intake (US) is prevented. Doing this repeatedly enables the development of a new association: the CS does not lead to the US (Bouton & King, 1983;

* Corresponding author.

E-mail address: ghislaine.schyns@maastrichtuniversity.nl (G. Schyns).

Bouton, 1993; Jansen, 1998). Exposure therapy is theorized to be most effective when inhibitory learning is maximal; the new CS-noUS association should become stronger than the old CS-US association (Craske et al., 2008). Pilot studies have shown that food cue exposure successfully reduces food cravings and binge eating in bulimia nervosa patients (Jansen, Broekmate, & Heymans, 1992; Jansen, Van den Hout, De Loof, Zandbergen, & Griez, 1989; Martinez-mallen et al., 2007; Toro et al., 2003; see also; Jansen et al., 2016). Further, studies in overweight adult samples have shown that cue exposure is effective in preventing weight regain after successful weight loss (Mount, Neziroglu, & Taylor, 1990), as well as in diminishing EAH of foods that were specifically included in therapy (i.e., exposed foods; Schyns, Roefs, Mulken, & Jansen, 2016).

Although food cue exposure indeed seems beneficial for overeating (Schyns et al., 2016), there is little research available on its working mechanism: why is it effective? According to the influential Emotional processing Theory, habituation of fear during exposure therapy provides important information as input for changing the pathological fear structure (i.e., emotional processing). Habituation therefore serves as an index of emotional processing during exposure therapy, and should predict treatment outcome (Foa & Kozak, 1986; Foa & McNally, 1996). However, Craske et al. (2008) argue that the degree of habituation during exposure therapy is not consistently related to better treatment outcome. This seems to be true for food cue exposure as well; habituation of cue reactivity was not related to better outcomes (Schyns, Roefs, Smulders, & Jansen, 2018; Schyns et al., 2016). These findings might have important clinical implications: therapists should no longer focus on diminishing eating desires during exposure sessions. However, this automatically leads to the question what the alternative focus of cue exposure sessions *should* be.

Craske, Treanor, Conway, Zbozinek, and Vervliet (2014) argue that one should focus on the explicit violation of CS-US expectancies during exposure (Craske et al., 2014). Instead of waiting until fear declines during exposure, therapists should carefully introduce CSs (e.g., high heart-rate) that maximize the mismatch between the expectancy of the US to take place (e.g., heart attack) and the actual outcome (e.g., the absence of the heart attack; noUS), thereby strengthening the CS-noUS association. Using this method, exposure sessions can be stopped when the feared outcome is no longer expected, which might take less time than waiting until fear levels habituate. Exposure sessions for panic disorder with agoraphobia focusing on expectancy violation have shown to result in better treatment outcome compared to exposure sessions focusing on habituation (Salkovskis, Hackmann, Wells, Gelder, & Clark, 2006), and continuing exposure therapy until the expectancy of the feared outcome was 5% or less was superior to exposure therapy that ended at higher expectancies (Deacon et al., 2013). Expectancy violation during exposure seems well-translatable to food cue exposure, as expectancies of overeating and loss of control can be violated (Jansen et al., 2016; van den Akker, Schyns, & Jansen, 2016). Indeed, lower expectancies after food cue exposure have found to be related to less EAH of exposed foods (Schyns et al., 2016).

The aim of the present study is to investigate whether focusing food cue exposure on violation of expectancies is more effective to reduce kcal intake of exposed and non-exposed foods than focusing on habituation of eating desires. Two exposure conditions are compared: one exposure condition focuses two sessions on the habituation of eating desires (Exposure focused on Habituation; ExpHAB), and the other exposure condition focuses two sessions on the violation of overeating expectancies (Exposure focused on Expectancy Violation; ExpEV). Participants are randomly assigned to either the ExpHAB condition, the ExpEV condition, or a no-treatment control condition. It is hypothesized that 1) the ExpEV condition eats less of exposed and non-exposed foods than the ExpHAB condition, while kcal intake in the control condition will be lower compared to both the ExpEV and ExpHAB conditions, and that 2) shorter exposure times are needed for the violation of expectancies (ExpEV) than for the habituation of eating desires (ExpHAB).

2. Methods

2.1. Participants

Female obese participants (BMI > 30) who were motivated to lose weight, aged 18–65 years, were recruited through advertisements. The exclusion criteria were: suffering from self-reported smelling problems (indication of anosmia), pregnancy, currently receiving psychotherapeutic or psychopharmacological treatment, and bariatric surgery (pre and post-operative). Participants were randomly assigned to the ExpHAB condition ($n = 17$), the ExpEV condition ($n = 18$), or the control condition ($n = 17$). No participants dropped out during the study. The study was approved by the Ethical Committee of the Faculty of Psychology and Neuroscience of Maastricht University.

2.2. Procedure

Two exposure sessions were planned on two separate days within one workweek. Prior to session one, the participant was instructed to buy four highly palatable snack foods that were perceived as the 'favourite foods' and difficult to refrain from. The participant was instructed to bring three normal-sized packages of each food item to the first session. To standardize hunger, the participant was also instructed to consume a small meal 2 h prior to each appointment.

A summary of the timing of the main study assessments and design is displayed in Fig. 1. After arrival in the laboratory on day 1, the participant immediately handed in the food items and gave informed consent, followed by rating baseline hunger and desire to eat. In order to induce a state of absence of hunger during food cue exposure, the participant received a prepacked cup of yoghurt and muesli in a flavour of choice (neutral, honey, strawberry, peach, berries; ~170 g, ~233 kcal). If a participant was lactose-intolerant, she received two muesli bars in a flavour of choice (neutral, cranberry, hazelnut, golden syrup; 2 bars: ~54 g, ~231 kcal). The participant was instructed to finish the entire cup or both bars, and to fill out a questionnaire about its taste and quality, followed by 15 min of satiation time. After these 15 min, the participant again rated hunger, as well as tailored food-specific overeating expectancies and the palatability of the food items. Then, the intervention started at this point: both exposure conditions (ExpEV and ExpHAB) received food cue exposure for at least 10 and maximally 40 min, dependent on whether the target of the specific intervention (habituation or expectancy violation) was reached (see 2.3). On the second day, the participant started with the measurement of baseline hunger and eating desire, followed by the muesli snack and 15 min of satiation. After 15 min, hunger was rated and the second food cue exposure session took place. After the exposure in session two, the participant received another muesli snack to ensure that the participant remained in the absence of hunger during test (though the participant was allowed to not finish the second muesli snack if it was too much), once more followed by 15 min of satiation time and ratings of hunger and eating desires. The participant then rated the food-specific overeating expectancies, followed by the bogus taste test. Thereafter, the abstinence check of food items was completed and the participant's weight and height was measured.

Participants in the control condition followed the only the second part of the program on day two, in which each participant received a muesli snack (including satiation time and hunger rating) and completed food-specific overeating expectancies, current desire to eat, the bogus taste test, abstinence and palatability check, and the measurement of weight and height. Participants in the exposure condition were instructed on the first day that they were not allowed to eat the four food items until the appointment on day 2 was completed; participants in the control condition received this instruction one to five days before the first appointment. Participants received € 50,- for participation and a refund for the purchased foods. To keep recruitment advertisements similar for all conditions (i.e., receiving a training), the control

Fig. 1. Overview of main study measurements during days 1 and 2 including exposure sessions 1 and 2 (S1 and S2), separately for the control condition and both exposure conditions (ExpEV and ExpHAB). The symbol $\downarrow$ reflects measurements as displayed in the upper text, while the symbol $\uparrow$ reflects the muesli snack which was always followed by 15 min of satiation time in order to induce a state of absence of hunger.

condition received two sessions of food cue exposure after all measurements were finished (without data-collection during the exposure).

2.3. Exposure intervention

The participant was exposed to large portions of two of four favourite foods, which were put in bowls which were continuously available right in front of the participant on a tray. Foods were randomly allocated as exposed or non-exposed foods. The participant was instructed to smell, touch, lick the foods, and to take a tiny bite. Both exposure conditions received the same rationale prior to the exposure exercises, which was largely descriptive in nature, followed by a condition-specific verbal script during exposure, see Table 1. Eating desires and overeating expectancies were measured at condition-specific time-points and the length of the exposure session was determined by the 50% reduction target (see 2.4.1 and 2.4.2). At the end of each session, the participant was instructed to throw away all food in a garbage bin.

2.3.1. Exposure aimed at habituation (ExpHAB)

The therapist followed the verbal script as displayed in Table 1. The questions in the script were asked every 5 min to the participant, between the eating desires measurements. Eating desires were measured before the start of the exposure, when food was already visible, and every 5 min during exposure. In addition, general overeating expectancies were measured at the start, at the peak of eating desires, and at the end of the session. Exposure sessions in this condition were terminated when eating desires were reduced by 50% relative to the peak desire, or when 40 min of exposure were reached.

2.3.2. Exposure aimed at expectancy violation (ExpEV)

The therapist followed the verbal script in Table 1. The questions in the script were asked every 5 min to the participant, between the general overeating expectancy measurements. General overeating expectancies were measured before the start of the exposure, when food was visible, and every 5 min during exposure. In addition, eating desires were measured at the start, at the peak of overeating expectancies,

Table 1
Verbal script during exposure for the exposure habituation (ExpHAB) and exposure expectancy violation (ExpEV) conditions.

Rationale^a We are going to do exposure exercises; this means that we will investigate what happens when we see, touch, lick and taste this food, but <i>wait</i> to actually eat the food. Eating desires can become high during these exercises; we are going to examine how this works for you, and how this develops over time. For this investigation, I will occasionally ask you to fill in a short questionnaire.	
ExpHAB^b 1. Smell the entire bowl and take one piece of food in hands to smell > How does the smell affect your eating desires? > How does holding the food in your hand affect your eating desires? 2. Lick the food > How does licking the food in your hand affect your eating desires? 3. Take a tiny bite > How does tasting the food affect your eating desires? > How does chewing the food affect your eating desires? General: > At what level are your eating desires right now? > Seeing the food right now, how does this affect your eating desires?	ExpEV^b 1. Smell the entire bowl and take one piece of food in hands to smell > How does the smell affect you, how hard is it to not eat the food? > How does holding the food in your hand affect you, how hard is it to not eat the food? 2. Do you think that licking the food will make it harder to refrain from eating the food/will cause you to lose control? Let's test it out. > What happened? Why did you not lose control? > Do you find it hard not to eat the food after licking the food? 3. Do you think taking a tiny bite will make it harder to refrain from eating the food/will cause you to lose control? Let's test it out. > What happened? Why did you not lose control? > It is hard to stop eating after this bite? > It is hard to stop eating after chewing the food? > How it is possible that you are able to stop eating? General: > Seeing the food right now, how hard is it to not eat the food? > Why are you not losing control? End of exposure: > What did you learn from these exercises?

^a Both conditions received the same rationale.

^b The questions in the scripts for each condition were asked every 5 min during cue exposure.

and at the end of the session. Exposure sessions in this condition were terminated when overeating expectancies were reduced by 50% relative to the peak expectancies, or when 40 min of exposure were reached.

2.4. Assessment

2.4.1. Habituation of eating desires

Desire to eat was measured on a visual analogue scale (VAS; 'How strongly do you desire palatable food right now?'), ranging from 0 (no desire at all) to 100 (very strong desire).

2.4.2. Expectancy violation

Two *general* overeating expectancy items were rated during the exposure sessions using 100 mm VAS ('How strongly do you believe in the following thought right now?'), ranging from 0 (not at all) to 100 (very strongly): 'If palatable food is in front of me, then I cannot refrain from eating it' and 'If I eat a small amount of palatable food, then I cannot stop eating'. The average score of both items was used. Further, both expectancy items were adapted to each of four (exposed and non-exposed) food items: 'If [food item] is in front of me, then I cannot refrain from eating it' and 'If I eat a small amount of [food item], then I cannot stop eating', resulting in eight tailored *food-specific* overeating expectancy items. Overeating expectancy scores were calculated for exposed and non-exposed foods.

2.4.3. Duration of exposure

Each exposure session stopped when habituation or expectancy violation had occurred ($\geq 50\%$ reduction of desires vs. expectancies). The number of exposure minutes was recorded for each session.

2.4.4. EAH

The EAH paradigm was adapted from Birch and Fisher (2000). To induce a state of satiation, the participant received a muesli yoghurt or muesli bars (see 2.2). 15 min after eating the muesli snack, current hunger was measured on a VAS ('How hungry are you right now?'), ranging from 0 (not hungry at all) to 100 (very hungry). Then, a 10-min bogus taste test started during which the participant was told that this test was to assess taste perception of the four different foods that were individually selected by the participant. The participant was instructed to rate the taste of each of the food items (using a questionnaire) while being allowed to eat as much as she wanted from the generous portions of each food item. After the taste test, foods were removed. Each food item was weighed before and after the test, and the number of consumed kcal was calculated and averaged for the exposed vs. the non-exposed foods.

2.4.5. BMI

Height and weight of the participant was measured to calculate BMI (kg/m^2).

2.4.6. Palatability check

To control for the palatability of the four food items used in the study, palatability was measured using a VAS: 'How tasty is [food item] for you?', ranging from 0 (not tasty at all) to 100 (very tasty). Palatability ratings were calculated for exposed and non-exposed foods.

2.4.7. Abstinence check

The participant rated the number of eating occasions on which they consumed the four food items that were used in the study, since receiving the instruction of not consuming these items (i.e., on the first appointment in the ExpHAB and ExpEV condition, or before the first appointment in the control condition), from 0 (not at all) to 6 (six times or more). In addition, the number of days between the instruction and the taste test were recorded.

2.5. Statistical analyses

For comparisons between the three conditions (ExpHAB, ExpEV, control) on BMI, age, hunger, number of days of abstinence, post-intervention eating desires and overeating expectancies, and kcal eaten of the exposed and non-exposed foods, one-way ANOVA's were conducted. Analyses on the comparison of both exposure conditions (ExpHAB and ExpEV) included independent samples t-tests and mixed model ANOVAs for within-subjects variables. In addition, paired-samples t-tests were used to examine the reduction of eating desires (i.e., habituation) and overeating expectancies (i.e., expectancy violation) during cue exposure within the conditions, and to compare hunger levels during exposure and the taste test. Mixed model ANOVA was also used to check the palatability of exposed *versus* non-exposed foods between the conditions. Finally, Pearson correlations were used to examine the association between the reduction of eating desires and general overeating expectancies during cue exposure. The data were normally distributed and no covariates were included in any of the analyses. Since separate overeating expectancies and consumed kcal for exposed and non-exposed foods could not be calculated for the control condition, two (identical) average scores of all food items were used in this condition.

3. Results

3.1. Participants

The participants' mean BMI was not significantly different between the ExpHAB condition ($M = 34.68$, $SD = 3.46$), the ExpEV condition ($M = 34.95$, $SD = 2.79$), and the control condition ($M = 36.14$, $SD = 4.41$), $F(2,51) = 0.79$, $p = .460$, $\eta_p^2 = 0.03$. This also held for age, with a mean age of 42.06 years ($SD = 8.99$) in the ExpHAB condition, 46.67 years ($SD = 6.05$) in the ExpEV condition, and 45.94 years ($SD = 8.58$) in the control condition, $F(2, 51) = 1.68$, $p = .197$, $\eta_p^2 = 0.06$.

3.2. Manipulation checks

3.2.1. Experimental manipulation of eating desires and expectancy violation during food cue exposure

Average baseline, peak and end-level eating desires and overeating expectancies are shown in Fig. 2. Neither baseline eating desires nor baseline overeating expectancies were significantly different between conditions on either exposure session (p 's > 0.531). In the ExpHAB condition, participants experienced a significant reduction from peak to end-level eating desires during the cue exposure sessions, indicating that habituation indeed took place in this condition, $t(16) = 5.60$, $p < .001$, $d = 1.40$. In the ExpEV condition, participants experienced a significant reduction from peak to end-level general overeating expectancies during the cue exposure sessions, indicating that expectancies were indeed violated in this condition, $t(17) = 6.82$, $p < .001$, $d = 1.65$.

3.2.2. Abstinence check

The number of days of during which participants were instructed to remain abstinent of the four food items before the taste test was not significantly different between conditions (ExpHAB: $M = 1.76$, $SD = 0.97$; ExpEV: $M = 2.22$, $SD = 0.94$; Control: $M = 2.12$, $SD = 1.17$), $F(2,49) = 0.94$, $p = .398$, $\eta_p^2 = 0.04$. Consumption of the four selected food items, against the instruction, was reported by seven participants (ExpEV: $n = 1$; ExpHAB: $n = 2$; Control: $n = 4$) who reported one or two eating occasions. Excluding these participants did not significantly change the main analyses below (hypotheses 1 and 2), and the participants were therefore not excluded.

Fig. 2. Average eating desires (top) and overeating expectancies (bottom) during the sessions and pre- and post-intervention, separated by condition (ExpEV: Exposure Expectancy Violation; ExpHAB: Exposure Habituation; Control). Error bars represent standard errors of means.

3.2.3. Palatability check

Average palatability ratings of the exposed foods (ExpHAB: $M = 86.44$, $SD = 17.50$; ExpEV: $M = 84.64$, $SD = 11.42$; Control: $M = 86.72$, $SD = 11.90$) and non-exposed foods (ExpHAB: $M = 85.43$, $SD = 12.15$; ExpEV: $M = 86.42$, $SD = 13.43$; Control: $M = 86.72$, $SD = 11.90$) were equally high and similar in all conditions, as reflected by the absence of a significant main effects of condition, $F(2,49) = 0.05$, $p = .954$, $\eta_p^2 < 0.01$, food item (exposed versus non-exposed), $F(1,49) = 0.02$, $p = .884$, $\eta_p^2 < 0.01$, and an absent condition*food item interaction effect, $F(2,49) = 0.22$, $p = .803$, $\eta_p^2 < 0.01$.

3.2.4. Hunger ratings

Baseline hunger ratings were not significantly different (p 's > 0.531) between both exposure conditions on either session (session 1: $M = 30.09$, $SD = 27.33$; session 2: $M = 34.71$, $SD = 26.63$). Although average hunger ratings before starting both exposure sessions were low ($M = 19.23$, $SD = 17.83$), indicating absence of hunger, hunger levels before starting the taste test were significantly lower ($M = 13.54$,

$SD = 17.04$), $t(34) = 2.54$, $p = .016$, $d = 0.43$. When comparing hunger before the taste test in all three conditions, a significant difference was found (ExpHAB: $M = 15.29$, $SD = 14.36$; ExpEV: $M = 11.89$, $SD = 19.50$; Control: $M = 29.00$, $SD = 25.22$), $F(2,49) = 3.48$, $p = .039$, $\eta_p^2 = 0.12$. Post-hoc tests reveal that hunger was significantly higher in the control condition than the ExpEV condition ($p = .016$), and marginally higher in the control condition than the ExpHAB condition ($p = .053$), while differences were not significantly different between both exposure conditions ($p = .620$). Including hunger as a covariate was however not a significant contributor for any of the outcome measures, nor was the interaction between condition and hunger significant for any of the outcome measures. Hunger was therefore not included in the analyses below.

3.3. Reduction of eating desires and overeating expectancies

The average percentage reduction in eating desires over two sessions in the ExpHAB condition was -39.57 percent ($SD = 29.93$), while a similar percentage reduction of eating desires was also found in

the ExpEV condition ($M = -37.35$, $SD = 29.53$), $t(33) = 0.22$, $p = .827$, $d = 0.08$. The average percentage reduction was lower than 50% due to a considerable number of participants who did not reach the end-of-session target within 40 min, see 3.5. The average percentage reduction in general overeating expectancies over two sessions in the ExpEV condition was -61.96 ($SD = 31.63$), and significantly stronger than in the ExpHAB condition ($M = -35.40$, $SD = 29.27$), $t(33) = 2.57$, $p = .015$, $d = 0.87$. However, the percentage reduction of eating desires strongly correlated with the percentage reduction of general overeating expectancies, $r(35) = 0.61$, $p < .001$. Clearly, the reduction of eating desires during exposure sessions coincides with the violation of expectancies.

In addition to the general overeating expectancies measured during the exposure sessions, food-specific expectancies were also assessed at pre and post-measurement. The average reduction of food-specific overeating expectancies from pre to post-measurement did not differ significantly between the ExpEV and ExpHAB conditions, $F(1,33) = 0.12$, $p = .731$, $\eta_p^2 < 0.01$. From pre to post-intervention, the average reduction of expectancies was stronger for the exposed foods compared to the non-exposed foods, $F(1,33) = 8.66$, $p = .006$, $\eta_p^2 = 0.21$. The condition*food item interaction was however not significant, $F(1,33) = 0.09$, $p = .766$, $\eta_p^2 < 0.01$, indicating that both exposure conditions had similar overeating expectancy reductions for exposed and non-exposed foods. When comparing absolute post-intervention overeating expectancies between all conditions (including the control condition), differences were significant for exposed foods, $F(2,49) = 36.19$, $p < .001$, $\eta_p^2 = 0.60$, with post-hoc tests indicating significantly higher expectancies in the control condition vs. both exposure conditions (p 's < 0.001), while no differences between both exposure conditions emerged ($p = .916$). The same finding held for the expectancies of non-exposed foods: the three conditions differed significantly, $F(2,49) = 25.89$, $p < .001$, $\eta_p^2 = 0.51$. Expectancies were significantly higher in the control condition vs. both exposure conditions (p 's < 0.001), while no differences between both exposure conditions were found ($p = .985$). Absolute eating desires at post-intervention were not significantly different between all three conditions, $F(2,49) = 1.44$, $p = .247$, $\eta_p^2 = 0.06$.

3.4. Hypothesis 1) the ExpEV condition eats less of exposed and non-exposed foods than the ExpHAB condition, while kcal intake in the control condition will be lower compared to both ExpEV and ExpHAB

3.4.1. EAH: kcal intake of exposed foods

As can be seen in Fig. 3, kcal intake of the exposed foods was significantly different between conditions, $F(2, 51) = 5.24$, $p = .009$, $\eta_p^2 = 0.18$. Post-hoc tests reveal that the ExpEV condition consumed significantly fewer kcal than the control condition ($p = .005$), as did the ExpHAB condition compared to the control condition ($p = .011$). However, the kcal consumption was not significantly different between both exposure conditions (ExpEV vs. ExpHAB; $p = .781$).

Fig. 3. Kcal intake of exposed and non-exposed food items, separated by condition (ExpEV: Exposure Expectancy Violation; ExpHAB: Exposure Habituation; Control). Error bars represent standard error of means.

3.4.2. EAH: kcal intake of non-exposed foods

Also shown in Fig. 3, kcal intake of the non-exposed foods was not significantly different between conditions, $F(2,51) = 0.04$, $p = .965$, $\eta_p^2 < 0.01$.

3.5. Hypothesis 2) shorter exposure times are needed for the violation of expectancies (ExpEV) than for the habituation of eating desires (ExpHAB)

17 of 35 (49%; ExpHAB 53%; ExpEV 44%) of participants receiving cue exposure did not reach the end-of-session target in session one within 40 min, and used the entire 40 min of exposure. In session two, 10 of 35 (29%; ExpHAB 41%; ExpEV 17%) participants did not reach the end-of-session target within 40 min. The number of minutes of exposure was larger in session one (ExpHAB: $M = 30.00$, $SD = 12.25$; ExpEV: $M = 28.06$, $SD = 12.26$) than in session two (ExpHAB: $M = 25.88$, $SD = 13.72$; ExpEV: $M = 19.17$, $SD = 11.54$), but similar for both exposure conditions, as reflected by a main effect of session, $F(1,33) = 12.08$, $p = .001$, $\eta_p^2 = 0.27$, and no main effect of condition, $F(1,33) = 1.32$, $p = .259$, $\eta_p^2 = 0.05$, or a session*condition interaction, $F(1,33) = 1.63$, $p = .211$, $\eta_p^2 = 0.05$.

4. Discussion

The aim of the present study was to investigate whether aiming food cue exposure at expectancy violation is more effective than aiming sessions at habituation of eating desires. It was found that both exposure aimed at habituation of eating desires (ExpHAB) and exposure aimed at expectancy violation (ExpEV) led to less intake of exposed foods compared to intake in the control condition. However, the hypothesized difference between the ExpEV and ExpHAB condition was not found. Both exposure conditions, whether habituation of eating desires or violation of expectancies was aimed at, had a decreased intake of exposed foods compared to a non-exposure control condition. No significant differences were found between the conditions on the intake of non-exposed foods, indicating that exposure did not lead to generalisation of the exposure effect (in neither exposure condition). In addition, the duration of exposure was not different between the ExpEV and ExpHAB conditions.

The finding that the intake of exposed foods was significantly less for the exposure conditions compared to a no-treatment control condition, with a large effect size, whereas no generalisation to non-exposed foods was found, replicated findings of previous studies with active control conditions (Schyns et al., 2016, 2018). These findings confirm that cue exposure therapy is indeed effective to reduce the overeating of the specific snack foods the person was exposed to, though the effect does not generalize to other favourite snack foods.

Considering the working mechanism of food cue exposure, habituation occurred in both conditions. Thus, without focusing attention on eating desires in the ExpEV condition, desires reduced in this 'cognitive' condition as well. So focusing on the violation overeating expectancies while being exposed to one's favourite foods, will also lead to a decrease of eating desires. The other way around, it was demonstrated that expectancies were significantly stronger violated in the condition that explicitly challenged the expectancies during exposure compared to the pure habituation condition, while the change of expectancies from pre-to post-exposure was as strong in both conditions. So it might be concluded that even though more inhibitory learning occurs during exposure sessions when explicitly targeting eating expectancies, the reduction of overeating expectancies after finishing exposure sessions is as strong as compared to exposure sessions aiming at habituation. Clearly, confirmed by the high correlations between reduction of eating desires and overeating expectancies during cue exposure, these mechanisms cannot be disentangled: habituation of desires violates expectancies and violated expectancies decrease eating desires.

Altogether, these results demonstrate that food cue exposure is a successful intervention to reduce the intake of favourite foods. This

study contributes that the focus of cue exposure sessions might not matter; whether the exposure is directed at habituation or expectancy violation, both are successful in decreasing desires, expectancies and food intake. Our findings contrast the recommendations made by Craske et al. (2014), who propose that exposure sessions aimed at violation of expectancies yield better treatment outcomes than exposure sessions aimed at habituation. However, the current findings do fit with an exposure study in spider phobics in which exposure explicitly aimed at the challenging of dysfunctional cognitions led to similar treatment effects and cognitive alterations compared to an exposure condition that was purely behavioral (Raes, Koster, Loey, & De Raedt, 2011).

It should be noted that the present study was underpowered to detect subtle differences between both exposure conditions, and interpretations of the study effects should therefore be done with caution. Replication of the study effects is necessary. In addition, while the first author was the only therapist performing the cue exposure sessions in both conditions and strictly followed the protocol and verbal script as displayed in Table 1, integrity ratings were not included in the present study. Further, a considerable number of participants did not reach the end-of-session target during the exposure sessions within 40 min, which might explain why no duration differences could be detected (hypothesis 2). It is possible that extending the maximum exposure time, allowing for stronger reduction of eating desires and overeating expectancies, would have led to different results. Finally, considering the specificity of cue exposure effects to exposed foods, it should be noted that the food-specific overeating expectancy measurement might be more valid than the general overeating expectancy measurement as assessed during cue exposure. Therefore, it might be valuable to consider measuring food-specific overeating expectancies (only), but also food-specific eating desires, for future research.

To conclude, while two sessions of food cue exposure in obese women led to less intake of exposed foods, specifically aiming exposure at violation of expectancies did not lead to less intake than aiming exposure at habituation of eating desires. The strong positive correlation between the reduction of eating desires and the reduction of overeating expectancies during sessions shows that overeating expectancy reduction and desire reduction go hand in hand. Although it remains important to pinpoint the working mechanism of cue exposure interventions, the current data do have an optimistic message for clinical practice: doing cue exposure, regardless of its 'special' focus, is effective to decrease food desires, overeating expectancies, and food intake.

Conflicts of interest

The authors declare no conflict of interest.

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