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The effect of visualisation and mindfulness-based decentering on chocolate craving

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Abstract

According to the elaborated intrusion (EI) theory of desire, loading visual working memory should help prevent and reduce cravings because cravings occur when intrusive thoughts are elaborated upon in working memory, often as vivid mental images. Mindfulness-based decentering strategies may also help prevent and reduce cravings since they may divert attention away from craving-related thoughts and mental imagery. To compare the effects of visualisation versus decentering on cravings, participants (N = 108) were randomly assigned to one of three conditions: (a) decentering, (b) visualisation, (c) mind-wandering control. Participants in each condition received two audio exercises: (1) a 2-minute exercise, preceding a craving induction but after initial deprivation and cue exposure, (2) a 4-minute exercise, following a craving induction. The audios instructed participants to look at a plate of chocolate that was in front of them whilst either (a) decentering from their thoughts and feelings, (b) engaging in visualisation or (c) letting their mind wander. Participants were asked to rate the strength of their cravings at four time points (Time 1, baseline; Time 2, after the 2-minute audio; Time 3, post-craving induction; Time 4, post-4 minute audio). Frequency of craving-related thoughts was also measured at Time 4. Compared to the control condition, results showed a significant reduction in strength of cravings for the decentering condition after both the 2-minute audio and the 4-minute audio. Decentering was superior to visualisation only after the 2-minute audio. Participants in both the visualisation and decentering conditions also had significantly lower frequencies of craving-related thoughts compared to control participants. The findings support EI theory and suggest that mindfulness-based decentering strategies may be useful for both the prevention and reduction of cravings. Pre-registration: https://osf.io/jv3pq

Keywords: mindfulness; mindful eating; decentering; craving; visualisation; elaborated intrusion theory

1. Introduction

Craving refers to a subjective motivational state that compels a person to consume a particular substance, such as alcohol or drugs, but also food (Baker et al., 1986; May et al., 2015; Shiffman, 2000). Chocolate is thought to be the most widely craved food in the Western world, particularly among women (Erskine & Georgiou, 2013). For most people, occasional food cravings occur without causing any problems (Lafay et al., 2001). However, if cravings become maladaptive, they may lead to disordered eating, including binge eating (Ng & Davis, 2013), low mood and depression (Davis et al., 2011), as well as health problems associated with obesity (von Deneen & Liu, 2011).

The elaborated intrusion theory of desire (EI theory) is a cognitive model that specifies two stages to the development of a craving: intrusion and elaboration (Kavanagh et al., 2005; May et al., 2015). EI theory describes how intrusive thoughts about food occur when a person associates their eating with certain cues. These cues could be internal, such as feeling tired or stressed, or external, such as walking past a bakery on the morning commute or seeing certain foods in the supermarket (Kavanagh et al., 2005; Sun & Kober, 2020; Tapper, 2018). These cues trigger intrusive thoughts about food that may then be elaborated upon in limited capacity working memory systems, most frequently through the sensory modalities of taste, smell and sight (Tiggemann & Kemps, 2005). It is this elaboration that leads to a feeling of craving, which can also interfere with other cognitive tasks (Kavanagh et al., 2005).

Researchers interested in managing food cravings have often targeted the elaboration stage in order to reduce their strength after they have occurred. Effective strategies include those that interrupt elaboration by competing for visuospatial working memory (Kavanagh et al., 2005; May et al., 2010; May et al., 2012), for example, with visual tasks such as Tetris (Skorka-Brown et al., 2014), dynamic visual noise (Kemps et al., 2004), or imagining non-food scenes (e.g., a rainbow; Harvey et al., 2005), and spatiomotor control tasks such as clay modelling (Andrade et al., 2012). Guided imagery, or visualisation, has also been shown to reduce craving intensity for self-reported chocolate cravers (Experiment 2, Schumacher et al., 2017) and a general student population (Hamilton et al., 2013).

Another way in which the elaboration stage has been targeted is through the use of decentering. Decentering is a mindfulness-based strategy where thoughts and feelings are

viewed as transient mental events that are separate from oneself (Bishop et al., 2004; Lebois et al., 2015). Decentering may interrupt craving-related elaboration by diverting attention away from craving-related mental imagery. For example, if imagery relating to the taste of chocolate is followed by an awareness of this imagery as simply 'thoughts', it may in turn be followed by other more general thoughts, such as healthy eating related goals (Tapper & Ahmed, 2018). Several studies have supported the view that decentering can reduce craving strength (Schumacher et al., 2018; Tapper, 2018).

An alternative approach to managing cravings is to target the intrusion stage in order to prevent craving-related intrusive thoughts from being elaborated, in full, or at least with less intensity. According to EI theory, this should weaken craving development. Again, both visualisation and decentering strategies could achieve this by loading visual working memory and/or helping to divert attention elsewhere. Although there is limited research specifically examining the effects of these strategies on the intrusion stage of craving, several studies have found significant effects on cravings and consumption outside the laboratory and it is possible that such effects were in part brought about by weakening craving development (as opposed to reducing craving strength once it had occurred; Jenkins & Tapper, 2014; Schumacher et al., 2018; see also Tapper, 2018).

Few studies have directly compared the effects of visualisation versus decentering. One exception is Schumacher et al. (2017) who, across two studies, looked at the effects of these strategies on craving reduction (i.e., after a craving induction). Study 1 recruited a general sample whilst Study 2 recruited habitual chocolate cravers. Compared to a control condition, they found reductions in craving strength for the decentering group in both studies, but in the visualisation group craving reduction only occurred in the second study. In a subsequent field study (Schumacher et al., 2018) they found that both visualisation and decentering were effective at reducing craving frequency and intensity over a 7-day period.

However, decentering strategies typically also include elements of visualisation. Thus an important limitation of these studies is that it is difficult to rule out the possibility that the effects of decentering occurred simply because of the visualisation element. Tapper and Turner (2018) attempted to address this issue by using visualisation and decentering strategies that were matched for visualisation. Using 4-minute audio exercises, they looked at

the effects of (1) decentering, (2) visualisation, and (3) mind wandering (control) on chocolate cravings following a craving induction. However, there was a reduction in cravings across all conditions with no significant differences between conditions. Nevertheless, exploratory analyses showed that decentering was more effective than visualisation when overall task adherence was high.

The present study aimed to extend this research by looking at the effects of decentering and visualisation on both craving development (i.e., pre-craving induction) as well as craving reduction (i.e. post-craving induction). Specifically, we examined the effects of decentering and visualisation on craving both prior to and following a craving induction, targeting the intrusion and elaboration stages of craving. Additionally, and in contrast to Tapper and Turner (2018), we asked participants to keep their eyes open rather than closed during the decentering and visualisation exercises; we felt this might better reflect the type of strategy that could be more readily employed in daily life, for example in the office, at a party or when passing the supermarket's confectionary aisle.

Thus the first aim of the study was to compare the effects of decentering and visualisation on craving development. In other words, after initial deprivation and cue exposure, but before a more intense craving induction. We predicted a smaller increase in the strength of chocolate cravings for visualisation compared to mind wandering (Hypothesis 1a) and for decentering compared to mind wandering (Hypothesis 1b). Because the decentering and visualisation strategies were matched for visualisation (i.e., the decentering strategy incorporated both visualisation and decentering), we also predicted a smaller increase in strength of cravings for decentering compared to visualisation (Hypothesis 1c).

The second aim was to test the effects of decentering and visualisation on craving reduction. In other words, after participants had undergone a more intense craving induction. We predicted a larger decrease in strength of chocolate cravings for visualisation compared to mind wandering (Hypothesis 2a) and for decentering compared to mind wandering (Hypothesis 2b). Again, because the decentering and visualisation strategies were matched for visualisation, we also predicted a larger decrease in strength of cravings for decentering compared to visualisation (Hypothesis 2c).

The third aim was to test the effects of the two strategies on the frequency of chocolate cravings following the craving induction (i.e., during the craving reduction stage). We predicted a lower frequency of chocolate cravings for visualisation compared to mind wandering (Hypothesis 3a) and for decentering compared to mind wandering (Hypothesis 3b). As before, we also predicted a lower frequency of cravings for decentering compared to visualisation (Hypothesis 3c).

The final aim was to test the moderating effect of self-reported task adherence on the relationship between the conditions and craving strength, after the craving induction (i.e., during the craving reduction stage). We predicted that the effect of condition on craving strength would be greater with higher levels of task adherence. Hypothesis 4a compared visualisation with mind wandering, Hypothesis 4b compared decentering with mind wandering and Hypothesis 4c compared decentering with visualisation. The study hypotheses, method and analysis plan were pre-registered at https://osf.io/jv3pq

2. Methods

2.1. Participants

Participants were 108 females (n = 63) and males (n = 45) with a mean age of 26.7 years (SD = 9.6; range = 18 - 67 years), who responded to adverts seeking 'chocolate lovers' interested in research on managing cravings for sugary foods such as chocolate bars. Participants across three London universities were recruited via posters placed around the university buildings, adverts on university websites and student newsletters, and the social media accounts of the first author. Participants were offered compensation for their time of £5 and/or the chocolate bar selected during the craving induction. Inclusion criteria were aged 18 years or over and consumption of chocolate at least 4 times per month. Exclusion criteria were a current diagnosis of an eating disorder, pregnancy, and medication or health conditions (e.g., allergies, diabetes) that would prevent them from fasting for 2 hours or from eating sugary snacks. The target sample size was 36 participants per condition. This was informed by Tapper and Turner (2018) who used the same scale in relation to chocolate craving. It assumed a mean baseline craving of 16 out of 30 (SD = 7) and was powered to detect a mean difference of 5 in craving level between conditions. Ethical approval was received by City, University of London Psychology Department Research Ethics Committee in March 2019.

185

186 **2.2. Craving induction**

187 Following Kemps and Tiggemann (2007), a combination of deprivation and cue exposure
188 were used to induce chocolate cravings. This occurred in two stages, to induce the occurrence
189 and elaboration of intrusive craving-related thoughts at different levels of intensity. In the
190 first stage (Time 1), a plate of four wrapped chocolate products (Dairy Milk, 45g; Snickers,
191 48g; Bounty, 57g; three Lindor truffles, 40g total) were placed in front of participants, to the
192 left of the computer, with an empty plate placed directly in front of them. These chocolates
193 were visible as soon as the participant entered the room. The second stage (after Time 2) was
194 a more intense craving induction that utilised more sensory modalities; participants were
195 instructed to choose their favourite type of chocolate from the plate, unwrap it, smell it, and
196 place it with its wrapper on the empty plate directly in front of them. They were instructed
197 not to eat the chocolate. If the Lindt chocolate was selected, participants were asked to
198 unwrap all three pieces. Participants were asked to select the name of the chocolate they had
199 chosen and, using a visual analogue scale from 0-100, rate how much they liked it (from 0 =
200 *not at all* to 100 = *very much*) and how much they felt like eating it (from 0 = *no desire or*
201 *urge* to 100 = *extreme desire or urge*).

202

203 **2.3. Experimental manipulation**

204 Participants in all three conditions listened to 2-minute and 4-minute audio recordings with
205 instructions modified from Tapper and Turner (2018). In the visualisation and decentering
206 conditions participants were asked to imagine themselves sitting in a forest by a stream. In
207 the decentering condition they were asked to imagine placing any thoughts or feelings onto a
208 leaf and watch it float down the stream (Hayes, 2005, pp. 76-77 ; Rogers & Hardman, 2015).
209 In the visualisation condition they were simply asked to imagine watching the leaves float by.
210 In the control condition, participants were asked to let their mind wander. The opening and
211 closing instructions were identical across all three conditions (e.g., 'sit back and relax but
212 keep your eyes on the chocolate'; 'you can now look around the room'), and the number and
213 timings of all other audio instructions were matched across the conditions. Participants were
214 asked to keep their eyes open throughout the experimental manipulation. (See Supplementary
215 Files for scripts).

2.4. Measures

2.4.1. Hunger. Participants were asked to 'indicate how hungry you feel right now' using a sliding scale from 0 (*not at all hungry*) to 100 (*extremely hungry*). They were also asked to indicate when they last ate and when they next expected to eat, though in light of Rogers and Hardman (2015) we subsequently excluded these as indices of hunger.

2.4.2. Craving. Strength and frequency of craving-related thoughts were assessed using the intensity sub-scales of the Craving Experience Questionnaire-Strength (CEQ-S; May et al., 2014) and Craving Experience Questionnaire-Frequency (CEQ-F; May et al., 2014). The CEQ-S and CEQ-F both have sub-scales relating to intensity, imagery and intrusiveness. In this study, the intensity sub-scale of the CEQ-S was used to measure current strength of cravings at four intervals. The sub-scale comprises three items scored from 0 (*not at all*) to 10 (*extremely*): 'Right now, how much do you WANT chocolate?'; 'Right now, how much do you NEED chocolate?'; 'Right now, how strong is the urge to have chocolate?'. The intensity sub-scale of the CEQ-F was used once to measure craving frequency and comprises three items also scored from 0 (*not at all*) to 10 (*extremely*): 'During the 4-minute audio recording, how often did you WANT chocolate?'; 'During the 4-minute audio recording, how often did you NEED chocolate?'; 'During the 4-minute audio recording, how often did you have a strong urge for chocolate?'. In a previous study on chocolate cravings (Andrade et al., 2012), the CEQ scales have been shown to have high internal reliability: CEQ-S (α = .93), CEQ-F (α = .97). In the current study, the scales also showed good internal reliability: CEQ-S (α ranged between .83 – .88 across Time 1 to Time 4), CEQ-F (α = .91).

2.4.3. Task adherence. As per Tapper & Turner (2018), participants were asked to report on two measures of task adherence: how well they followed the instructions during the 4-minute audio recording ('overall adherence') and if they were still following the instructions towards the end of the 4-minute audio recording ('end adherence'). Both measures were scored from 0 (*not at all*) to 10 (*all of the time*). Additionally, an open-ended question asked what they were thinking about during the audio recording. The measure of end adherence and the open-ended question were included as exploratory measures.

248

249 **2.5. Procedure**

250 Participants meeting the eligibility criteria were offered a 30-minute appointment at the
251 university and were asked to refrain from eating chocolate products for 24 hours prior to this
252 time. They were also asked to abstain from eating or drinking anything other than water for 2
253 hours prior to the appointment. The experiment was delivered using Qualtrics, an online
254 survey software that collected all measures and randomised participants to one of the three
255 conditions, stratifying by gender (see Figure 1).

256

257 Testing took place in a quiet room. Participants were first asked to report their gender, age
258 and first language, and whether they had eaten any chocolate products in the past 24 hours, or
259 any food or drink other than water in the past 2 hours. If they answered yes to either of these
260 questions, they were asked to specify what they had eaten and when. They then completed
261 measures of hunger and the CEQ-S (Time 1), before being randomised to one of the three
262 conditions (decentering, visualisation or control) and listening to the relevant 2-minute audio.
263 They then completed the CEQ-S for the second time (Time 2), underwent the craving
264 induction, followed by the CEQ-S (Time 3). After this they listened to the 4-minute audio for
265 their allocated condition (decentering, visualisation or control) and completed the CEQ-S for
266 a fourth and final time (Time 4). Finally, participants completed the CEQ-F and task
267 adherence measures as well indicating whether or not they were dieting to lose weight. They
268 also completed exploratory measures of stress and self-esteem that are not discussed in this
269 article.

270

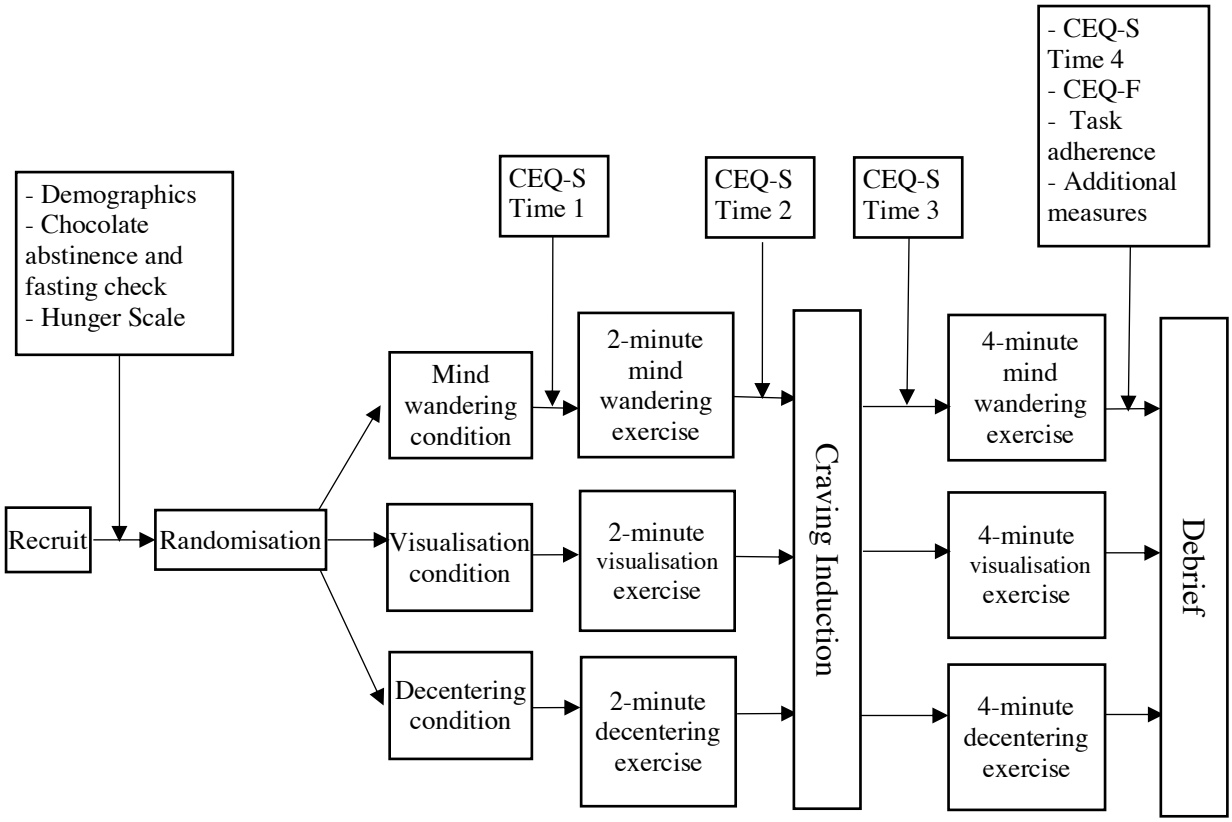

Figure 1. Flow diagram of study procedures. CEQ-S = Craving Experience Questionnaire-Strength. CEQ-F = Craving Experience Questionnaire-Frequency. Additional measures not reported here.

3. Results

3.1. Participant characteristics

As shown in Table 1, more people in the visualisation condition were dieting to lose weight and adhered to the 24-hour chocolate abstinence instructions. This group also had lower baseline levels of craving and hunger but were slightly less likely to have adhered to the 2-hour fasting instructions. Baseline levels of current craving were similar across the three conditions. Gender and age were well-matched across conditions.

Table 1. Characteristics of Study Participants in Each Condition

Characteristic	Decentering (*n* = 36)	Visualisation (*n* = 36)	Control (*n* = 36)
Percentage of females	58%	58%	58%
Age (*M, SD*)	27.8 (11.5)	26.0 (8.5)	26.3 (8.7)
Percentage dieting to lose weight [a]	11%	22%	11%
Percentage adhering to chocolate abstinence instructions	72%	83%	61%
Percentage adhering to fasting instructions	94%	86%	94%
Hunger score (*M, SD*)	58 (23)	52 (25)	60 (26)
Strength of current chocolate cravings (CEQ-S) at baseline (*M, SD*) [b]	15 (7)	13 (6)	15 (8)

Note. CEQ-S = Craving Experience Questionnaire-Strength

[a] Declined to say: Decentering (*n* = 2), Visualisation (*n* = 1), Control (*n* = 1).

[b] CEQ-S scores could range from 0 – 30.

3.2. Effects on strength of cravings

To explore craving development (i.e., after initial deprivation and cue exposure, but before an intense craving induction), a 2 (time) x 3 (condition) mixed ANOVA on strength of cravings at Times 1 and 2 showed no significant main effects of time, $F(1, 105) = 0.03$, $p = .858$, $\eta_p^2 = 0.00$, or condition, $F(2, 105) = 2.55$, $p = .083$, $\eta_p^2 = 0.05$. However, as predicted there was a significant interaction between time and condition, $F(2, 105) = 10.73$, $p < .001$, $\eta_p^2 = 0.17$, (see Figure 2).

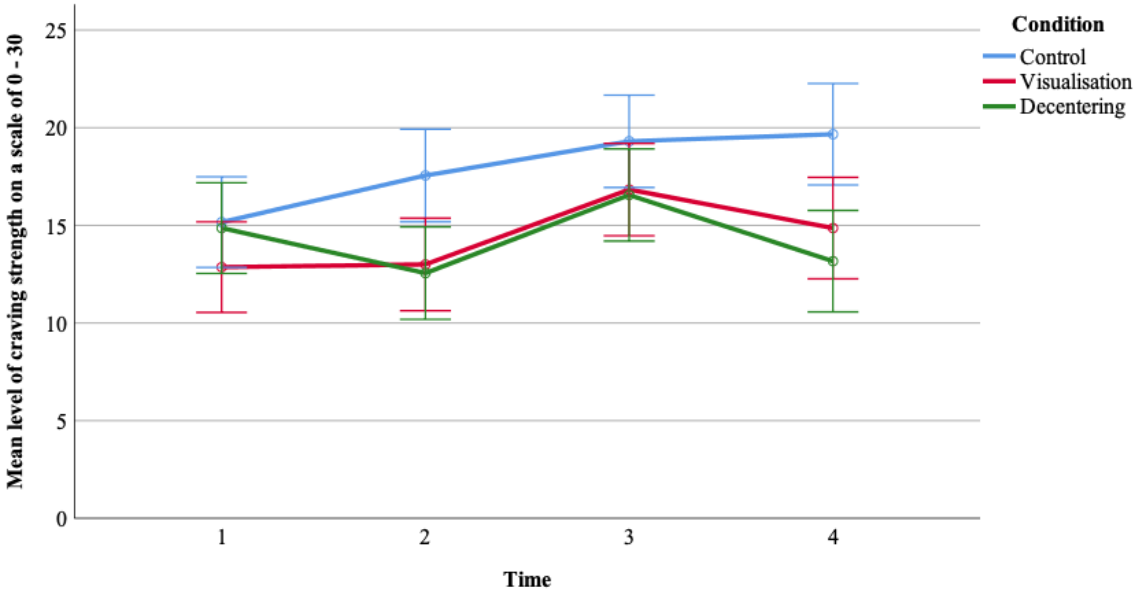

Figure 2. Mean levels of strength of cravings in the three conditions, at four time points. Note. Error bars: 95% Confidence Interval

To explore this interaction, change scores (from Time 1 to Time 2) were computed for each of the three conditions. These were M = -2 (SD = 5) for decentering, M = 0 (SD = 5) for visualisation and M = 2 (SD = 3) for control. As predicted, follow-up t-tests showed significant differences between the decentering and control conditions, $t(52.17) = 5.02$, $p < .001$, $d = 0.97$, between the visualisation and control conditions, $t(52.69) = 2.44$, $p = .018$, $d = 0.49$, and between the decentering and visualisation conditions $t(70) = 2.10$, $p = .040$, $d = 0.40$.

To explore craving reduction (i.e., after the more intense craving induction), a 2 (time) x 3 (condition) mixed ANOVA on strength of cravings at Times 3 and 4 showed a significant main effects of time, $F(1, 105) = 13.12$, $p < .001$, $\eta_p^2 = 0.11$, and condition, $F(2, 105) = 4.21$, $p = .017$, $\eta_p^2 = 0.07$. As predicted, there was also a significant interaction between time and condition, $F(2, 105) = 5.64$, $p = .005$, $\eta_p^2 = 0.10$. Again, change scores (between Times 3 and 4) were computed for each condition to explore this interaction: decentering, M = -3 (SD = 5); visualisation, M = -2 (SD = 5); control, M = 0 (SD = 4). As predicted, follow-up t-tests revealed significant differences between the decentering and control conditions ($t(65.38) = 3.63$, $p = .001$, $d = 0.66$) and between the visualisation and control conditions ($t(70) = 2.10$, p

= .039, d = 0.44). Contrary to predictions, there was no significant difference between the decentering and visualisation conditions ($t(70) = 1.15$, $p = .253$, $d = 0.20$).

3.3. Effects on frequency of cravings

Mean frequency of cravings (Time 4) was 12 (*SD* = 8) in the decentering condition, 13 (*SD* = 8) in the visualisation condition and 18 (*SD* = 9) in the control condition. A one-way between-groups ANOVA found a significant effect of condition, $F(2, 105) = 4.70$, $p = .011$, $\eta_p^2 = 0.08$. Follow-up *t*-tests showed that, as predicted, craving frequency was lower in the decentering and visualisation conditions compared to the control condition; $t(70) = 2.87$, $p = .005$, $d = 0.70$ and $t(70) = 2.32$, $p = .023$, $d = 0.59$ respectively. However, contrary to predictions, there was no significant difference between the visualisation and decentering conditions; $t(70) = 0.55$, $p = .586$, $d = 0.13$.

3.4. Moderating effects of task adherence

Mean overall task adherence (Time 4) was 7 (*SD* = 2) in the decentering group, 7 (*SD* = 2) in the visualisation group, and 9 (*SD* = 1) in the control group. A one-way ANOVA showed these were significantly different; $F(2,105) = 18.97$, $p < .001$, $\eta_p^2 = 0.27$.

Two hierarchical regression models were used to estimate the moderating effect of overall task adherence on the effect of condition on change in strength of cravings between Time 3 and Time 4. Overall task adherence was entered at Step 1, condition at Step 2, and the interaction term at Step 3. The dependent variable was change in craving score between Time 3 and Time 4. In the first model the experimental conditions (decentering/visualisation) were compared with the control condition (experimental = 1, control = 0) whilst in the second model the decentering condition was compared with the visualisation condition (decentering = 1, visualisation = 0). Contrary to predictions, neither model showed an interaction between condition and overall task adherence (first model: $b = -0.44$, $SE\ B = 0.74$, $\beta = -0.31$, $p = .555$; second model: $b = 0.52$, $SE\ B = 0.74$, $\beta = 0.36$, $p = .480$).

Exploratory analysis also examined end adherence scores (decentering: $M = 7$, $SD = 2$; visualisation: $M = 7$, $SD = 2$; control, $M = 9$, $SD = 1$). When end adherence scores were used in the models described above, these showed a significant interaction when the experimental

conditions were contrasted with the control condition (b = -1.27, $SE\ B$ = 0.63, β = -0.93, p = .045), but not when the decentering condition was contrasted with the visualisation condition (b = 0.98, $SE\ B$ = 0.54, β = -0.68, p = .076). Simple slopes analysis on centred variables showed that when end adherence was low (1 *SD* below the mean), there was no effect of experimental versus control condition on change in craving (b = -0.02, 95% CI [-4.31, 4.26]; t = -0.01, p = .991). However, at mean levels of end adherence, and when end adherence was high (1 *SD* above the mean), there were greater reductions in craving in the experimental conditions compared to the control condition (b = -2.74, 95% CI [-5.22, -0.25]; t = -2.18, p = .031 and b = -5.45, 95% CI [-8.02, -2.89]; t = -4.21, p < .001 respectively). The Johnson-Neyman method indicated that the transition point occurred when end adherence was -0.14 *SD*s below the mean, with all scores above this showing a significant effect of condition on craving change.

4. Discussion

The results showed that both decentering and visualisation reduced craving strength and frequency following a craving induction. These findings are in line with a number of previous studies (Hamilton et al., 2013; Schumacher et al., 2017; Tapper, 2018). They are also consistent with EI theory that predicts that these strategies will interfere with the process of elaboration which underpins cravings (Kavanagh et al., 2005; May et al., 2015). The results of the present study also extend previous research by showing that both decentering and visualisation were able to weaken the development of cravings. This may be because the strategies prevented intrusive thoughts from being elaborated upon, either partially or in full. Ultimately, targeting cravings at this earlier stage in their development may be a more effective strategy for two reasons. First, it may prevent the development of very strong cravings and so may reduce the likelihood of cravings leading to consumption. And second, it may be easier for a person to choose to engage in decentering or visualisation at this point; according to EI theory, craving-related imagery is initially pleasurable, thus once a person reaches the elaboration stage they may be less inclined to engage in decentering or visualisation. This interpretation is consistent with the fact that our results also showed that decentering and visualisation were not effective at reducing cravings when participants reported low adherence to these strategies. Future research would benefit from comparing levels of strategy adherence during craving development versus craving reduction.

An important strength of the current study is that, like Tapper and Turner (2018), visualisation was matched across the visualisation and decentering conditions. Since decentering strategies tend to include elements of visualisation, this matching allows more confidence that any extra advantage gained by the decentering strategy was due to the decentering elements, rather than just additional visualisation. The results showed that the decentering strategy was indeed more effective than visualisation when used to weaken craving development (i.e., following cue exposure but prior to a craving induction). We speculate that this may be because decentering increases the accessibility of other thoughts and goals that are important to the individual, some of which may be incompatible with satisfying the craving (Tapper & Ahmed, 2018). This in turn may help motivate the individual to continue with the strategy and keep their attention diverted away from craving-related imagery. However, other interpretations are possible, in particular, the grounded cognition theory of desire states that decentering works by reducing the subjective realism of intrusive craving-related thoughts and mental imagery (Papies et al., 2011). Further research would be needed to distinguish between these two accounts.

However, in contrast to the above findings, and to Schumacher et al. (2017), there was no evidence to indicate that decentering was superior to visualisation at reducing craving following an intense craving induction that utilised multiple sensory modalities. Further research using Bayesian analysis could help confirm the absence or presence of a difference in efficacy between the two strategies at this point in the craving process.

An additional strength of our study was that we asked participants to keep their eyes open whilst engaging in the two strategies. This is in contrast to Tapper and Turner (2018) where participants were asked to close their eyes and where equivalent levels of craving reduction were seen across all three conditions (i.e., in a mind wandering control condition as well as in the decentering and visualisation conditions). Whilst many previous studies do not indicate whether participants were directed to keep their eyes open or closed, it is possible that strategy effects only emerge when participants' eyes are open and when the food item is maintained within their field of vision, making intrusive thoughts more likely. Where a participant closes their eyes or diverts their gaze away from the food it may become easier for those in the control condition to employ their own effective strategies. For example, in

Tapper and Turner, participants in the control group reported thinking about things such as course assignments or their plans for the rest of the day; thoughts that were likely sufficiently engaging to prevent craving-related elaboration. From an applied perspective, a strategy that allows one to keep one's eyes open is also likely to be easier to implement in everyday life.

Nevertheless, the study had a number of limitations that are important to highlight. First, although craving levels at Time 1 were well matched between the control and decentering groups, they were numerically lower in the visualisation group. At Times 3 and 4, the effects of the strategies on craving reduction are also more difficult to interpret since participants had already employed their assigned strategy during the development stage and levels of craving were higher among control group participants compared to those in the experimental groups. To address this issue, future research would benefit from assessing effects on craving development and craving reduction on separate occasions.

Second, the study did not include any follow-up measures of craving. For example, Schumacher et al. (2017), measured craving at three time points, with the final measurement taking place 10 minutes after the experimental manipulation. This type of follow-up measure would help explore the extent to which reductions in craving can be maintained over time and would help rule out any rebound effects. This may be particularly important given that levels of craving appeared to rise more steeply during the craving induction phase (between Times 2 and 3) among those in the decentering and visualisation conditions.

Third, we did not include a measure of consumption so cannot be sure of the extent to which differences in cravings would translate into differences in consumption. Other research has shown that reductions in cravings do not always lead to reductions in consumption (Schumacher et al., 2017). Additional research is needed to explore this further as well as examine the effects of these strategies on craving and consumption outside the laboratory; research by Schumacher et al. (2018) indicates that decentering and visualisation strategies similar to those used in the present study can reduce both levels of craving and consumption outside the laboratory.

Finally, in contrast to many previous studies on food cravings, we included males in our sample as well as females. Although females reportedly experience stronger food cravings

than males (Hormes et al., 2014), craving management may be just as important for men who are attempting to lose weight or quit other substances such as cigarettes. It is therefore important that the study of craving amongst males is not neglected. Although our study was not powered to examine sex differences in the efficacy of these strategies for craving management, this could be usefully explored in future research.

In summary, the results of this study add to a growing body of literature that suggests that decentering strategies may be helpful for managing cravings as well as achieving healthy eating and weight loss goals (Caselli & Spada, 2016; Jenkins & Tapper, 2014; Lacaille et al., 2014; Papies & Barsalou, 2015; Tapper, 2017, 2018; Tapper & Ahmed, 2018). Given the simplicity of the decentering strategy used in the current study, it would also be relatively easy to incorporate it into existing weight management and healthy eating interventions.

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Author contributions

EW contributed to study design, collected the data, took the lead on data analysis and wrote the first draft of the manuscript. KT took the lead on study design, contributed to data analysis and wrote sections of the paper. All authors contributed to data interpretation and to the final version of the manuscript.

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Conflict of interest

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