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The effect of a mindfulness-based decentering strategy on chocolate craving

Katy Tapper
Abigail Turner

City, University of London

Department of Psychology
School of Social Sciences
Whiskin Street
London
EC1R 0JD
UK
Katy.tapper.1@city.ac.uk

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Abstract

According to the elaborated-intrusion theory of desire, strategies that load visual working memory will reduce cravings. According to the grounded cognition theory of desire, cravings will be reduced with mindfulness-based decentering strategies that encourage individuals to see their thoughts as thoughts. However, decentering strategies also tend to load visual working memory making it difficult to test the latter prediction. This study addressed this issue by matching visualization across decentering and guided imagery tasks. Male and female participants (n=101) underwent a chocolate craving induction before listening to a 4-minute audio recording that guided them to (a) decenter from their thoughts and feelings, (b) engage in visualization, or (c) let their mind wander. Participants reported on chocolate craving before and after the craving induction and following the 4-minute recording. They also provided retrospective reports of craving during the recording, reported on the extent to which they had adhered to the audio instructions and briefly indicated what they had been thinking about during the recording. Results showed a significant reduction in cravings to baseline following the recording across all three conditions (p<.001), but no significant differences between conditions or in the retrospective reports of craving. There was some evidence to suggest that participants in the mind wandering condition had been thinking about alternate goals, which may have inhibited thoughts about chocolate and been just as effective at reducing craving as the imagery and decentering strategies. Exploratory analyses showed a trend toward decentering being more effective than imagery where participants reported higher task adherence throughout the 4 minutes (p=.067). This raises the possibility that decentering effects may be improved with better strategy adherence, which might be achieved through practice or increased motivation.

Keywords: mindfulness; decentering; craving; food; visual imagery; goals

Introduction

A craving is an intense, conscious desire, typically to consume a specific food or drug (Drummond, 2001; May, Kavanagh & Andrade, 2015; Pelchat, 2002; Tiffany & Wray, 2012). Although some authors have questioned the extent to which drug craving is causally linked to drug use (Wray, Gass & Tiffany, 2013), food cravings have been shown to predict eating, weight gain and weight loss success (Boswell & Kober, 2016; Dalton et al., 2017). For this reason, researchers have looked at ways to reduce food cravings, on the assumption that this will help people manage their eating behaviours (e.g. Hsu et al., 2014).

One of the most effective strategies for reducing food cravings seems to be tasks that load visual working memory, such as guided imagery (Hamilton, Fawson, May, Andrade & Kavanagh, 2013; Kemps & Tiggemann, 2007), clay modelling (Andrade, Pears, May & Kavanagh, 2012), dynamic visual noise (Kemps & Tiggemann, 2013; Kemps, Tiggemann & Christianson, 2008) or playing games that require visuospatial skills (Skorka-Brown, Andrade & May, 2014). Such findings are consistent with the elaborated intrusion theory of desire (Kavanagh, Andrade & May, 2005; May, Andrade, Kavanagh & Hetherington, 2012; May et al., 2015). This theory states that craving occurs when intrusive thoughts about a desired object are elaborated on. In other words, the individual uses working memory to actively construct vivid sensory images about the desired object and its acquisition. Because these images tend to be visual in nature, and because working memory has limited capacity, any task that also requires visual working memory will prevent this elaborative process, and in doing so will also prevent or interrupt the craving episode.

A number of laboratory studies have demonstrated such an effect. For example, Skorka-Brown et al. (2014) found that playing 3 minutes of a visuospatial computer game reduced both craving intensity after the 3-minute period and craving frequency during the 3-minute period (compared to waiting for the computer game to load). Similarly, Andrade et al. (2012) found that compared to 10 minutes of counting or 10 minutes of 'letting your mind wander', 10 minutes of clay modelling reduced craving intensity immediately following the 10-minute period and craving frequency during the 10-minute period.

Likewise, Hamilton et al. (2013) found that compared to 10 minutes of mind wandering, 10 minutes of guided imagery prevented a rise in craving during this time. (Strength of craving following the 10 minutes was lower in the guided imagery group compared to the mind wandering group but the difference failed to reach statistical significance.) (See also Kemps & Tiggemann, 2007 and Kemps et al., 2008.)

Similar effects have been recorded outside the laboratory. For example, Knäuper, Pillay, Lacaille, McCollam and Kelso (2011) compared a visual imagery strategy (imagining engaging in a favourite non-food related activity) with other non-visual imagery strategies (such as reciting the alphabet backwards or repeating an implementation intention). They allocated participants to four conditions and asked them to engage in one of these strategies every time they experienced a food craving over a 4-day period. Compared to a baseline phase, the visual imagery strategy significantly reduced the intensity of cravings over the 4 days but no such effects were found for the other strategies. (See also Kemps & Tiggemann, 2013 and Skorka-Brown, Andrade, Whalley & May, 2015.)

Another strategy that has been used to target cravings is decentering (Tapper, 2018). Decentering is a mindfulness-based strategy in which the individual is encouraged to see their thoughts and feelings as transient events that are separate to oneself and not necessarily a true reflection of reality (Bishop et al., 2004; Shapiro et al., 2006; Tapper, 2017). This may be achieved in several different ways. For example, individuals may be asked to engage in an exercise that encourages them to visualise their thoughts and feelings as separate entities (e.g. Jenkins & Tapper, 2014), or they may simply be asked to view their thoughts as passing mental events that arise and dissipate (e.g. Papies, Pronk, Keesman & Barsalou, 2015). According to the grounded cognition theory of desire (Papies, Best, Gelibter & Barsalou, 2017), when individuals encounter objects in their environment, they draw on previous experiences to simulate interacting with these objects, which in turn activate similar areas of the brain to real interactions and elicit associated physiological responses that increase craving. According to this theory, viewing thoughts as transient mental events will reduce their believability and the extent to which they elicit feelings of desire.

There is some evidence to suggest that decentering may help reduce craving (Tapper, 2018). For example, Papies et al. (2015) asked individuals to view a series of pictures (including some of high calorie foods) and to observe their reactions to these as passing mental events. Compared to participants who had been asked to view the pictures in a relaxed manner, they subsequently reported lower food cravings ($p = .058$). More recently, Schumacher, Kemps and Tiggemann (2017) compared the effects of decentering, guided imagery and mind wandering on cravings for chocolate. They found no effect of guided imagery and mind wandering but a significant reduction in craving among those who had engaged in decentering. However, in a second study they found significant reductions in cravings in both the decentering and guided imagery conditions but not in the mind wandering condition.

An important limitation of these studies is that visual imagery was not matched across conditions. As such, it is unclear whether any reductions in craving that occurred in the decentering conditions arose as a direct result of decentering or simply because the decentering strategy loaded visual working memory. For example, being asked to 'view your responses as passing mental events' (Papies et al., 2015) may prompt a person to engage in visualisation. The present study was designed to address this limitation by matching elements of visualisation across a decentering strategy and a guided imagery strategy. The effects of these on craving were compared with a control group that was not provided with a specific strategy but was instead asked to simply let their mind wander. Since both the decentering and guided imagery strategies involve visual imagery, consistent with the elaborated intrusion theory of desire we would expect them both to be more effective at reducing craving compared to the control group. Additionally, consistent with the grounded cognition theory of desire, we would expect the decentering strategy to be more effective than the guided imagery strategy. We examined effects on craving for chocolate as chocolate is a food that has been shown to elicit strong cravings (Rozin, Levine & Stoess, 1991).

Methods

Participants

Participants were 101 females (n = 72) and males (n = 29) with a mean age of 25.38 years (SD = 10.16) who responded to adverts asking for 'chocolate lovers' to take part in a study on chocolate cravings. The adverts were placed around university buildings and on an online platform affiliated with the university. Participants received course credits or 4 pounds sterling upon study completion, as well as the chocolate bar used in the craving induction procedure (see below). Inclusion criteria were consumption of chocolate or chocolate related products at least three times a week, aged 18 years or over and not pregnant. Exclusion criteria were suffering from a medical condition that influences appetite, taking medication that influences appetite or having an existing or previous diagnosis of anorexia, binge eating disorder or any other eating disorder. Ethical approval was provided by the City, University of London Psychology Department Research Ethics Committee. The target sample size was 33 per condition, based on Schumacher et al. (2017); due to scheduling of participants by several researchers an additional two participants were recruited.

Craving induction

Four wrapped chocolate bars (Dairy Milk, 36g; KitKat Chunky, 40g; Mars, 39g; Twix, 40g) placed on a tray and covered with a tea towel were set on a table with a computer to the left of the keyboard, prior to the participant entering the laboratory. An empty paper plate was placed to the right of the keyboard. During the craving induction, text on the computer screen instructed participants to uncover the tray and choose their favourite chocolate bar from the selection. They were asked to unwrap it and place it on the plate in front of them but not to eat it. They were told that they would be able to eat it at the end of the study. They were then asked to indicate which chocolate bar they had selected, and, using a sliding scale from 0-100, rate how much they liked the chocolate bar they had chosen (anchored by 'Not at all' and 'Very much') and how much they felt like eating the chocolate bar they had chosen (anchored by 'No desire or urge' and 'Extreme desire or urge').

Experimental manipulation

Participants in all three conditions listened to an audio recording lasting 4 minutes and 10 seconds. The audio contained a series of instructions interspersed with periods of silence. The opening instructions and the final instructions were identical across all three conditions; these prompted individuals to close their eyes and relax at the start of the exercise and to open their eyes at the end of the exercise. The number of instructions, and the points at which they occurred, were matched across the decentering and imagery conditions. The audio in the decentering condition was based on a mindfulness exercise in which individuals are asked to imagine themselves sitting by a stream, watching leaves fall into the stream and float away. They are then asked to notice each thought or feeling that arises and to imagine placing this on a leaf and watching it float away (Hayes & Smith, 2005). The audio in the imagery condition asked individuals to imagine themselves by a stream, watching leaves fall into the stream and float away. The wording was matched, as far as possible, with the decentering exercise, but did not ask participants to notice their thoughts or feelings or to place these on the leaves. In the control condition there was just one other instruction in addition to the opening and closing instructions. This occurred after 1 minute and 5 seconds and asked participants to allow their mind to wander and to think about whatever they felt like thinking about. Copies of the scripts are available on request from the first author.

Measures

Hunger. This was assessed using the Grand (1968) Hunger Scale. Participants were asked to indicate, on a sliding scale from 0 to 100, how hungry they were at the moment (anchored by 'Not at all hungry' and 'Extremely hungry') and how much of their favourite food they would be able to eat at the moment (anchored by 'None at all' and 'As much as I could get'). They were also asked to indicate approximately how many minutes it was since they last ate something and how many minutes it was likely to be until they next ate something. A total score was computed by standardising the four subscales, adding together the standardised scores for the two ratings and time since last ate, and subtracting the standardised score for time till next eat.

Craving. Two measures of craving were taken, current craving intensity and craving frequency during the audio. Current craving intensity was assessed using the intensity subscale of the Craving Experience Questionnaire-Strength (May et al., 2014). This comprised three items rated from 0 to 10: 'Right now, how much do you WANT chocolate?', 'Right now, how much do you NEED chocolate?' (both anchored by 'Not at all' and 'Extremely'), 'Right now, how strong is the urge to have chocolate?' (anchored by 'Extremely weak' and 'Extremely'). Craving frequency during the audio was assessed using the intensity subscale of the Craving Experience Questionnaire-Frequency (May et al., 2014). This consisted of three items asking 'During the 4 minute audio recording, how often did you…' followed by either '…WANT chocolate?', '…NEED chocolate?' or '…have a strong urge for chocolate?' All items were rated on a scale from 0 to 10, anchored by 'Not at all' and 'Constantly'. Scores for both current craving and craving during the audio were computed by taking the mean of the corresponding items.

Task adherence. Two measures of task adherence were taken. Participants were asked to indicate, on a scale from 0 to 10, how well they thought they followed the instructions during the audio recording (anchored by 'I didn't follow them at all', I followed them some of the time' and 'I followed them all of the time'). They were also asked to indicate, on a scale from 0 to 10 the extent to which they were still following the instructions toward the end of the 4-minute audio recording (anchored by 'I wasn't following the instructions at all' and 'I was still following the instructions'). An additional open-ended question asked them to briefly describe what they were thinking about during the audio recording.

Procedure

Upon contacting the researcher about the study, participants were asked to confirm, via email, that they met the inclusion criteria. They were also asked to abstain from chocolate and chocolate-related products for at least 24 hours prior to their appointment and to abstain from all food and drink, other than water, for 2 hours prior to their appointment. At their appointment participants first reported their gender, age and first language before indicating whether they had

eaten chocolate or a chocolate related product less or more than 24 hours ago and whether they had eaten or drunk anything other than water less or more than 2 hours ago. Where participants indicated that they had not followed the abstinence and fasting instructions, they were asked to provide more details about what they had eaten/drunk and when. They then completed the hunger scale, reported on current craving, underwent the craving induction and reported on current craving a second time. After this they were asked to re-cover all the chocolate bars and were randomised to listen to one of the three audio recordings. They then reported on current craving for a third time, reported on craving frequency during the audio, completed measures of task adherence and indicated whether or not they were dieting to lose weight. Online survey software delivered all measures and instructions and randomised participants to groups. The researcher remained in the room for the duration of the study.

Results

Participant characteristics

As shown in Table 1, there were slightly more females in the mindfulness and imagery conditions compared to the control condition but more people reporting dieting to lose weight in the control condition compared to the mindfulness and imagery conditions. (In terms of change in current craving from time 2 to time 3, there were no significant differences between males and females, $t(99) = 0.65$, $p = .52$, $M = 1.64$, $SD = 1.77$ and $M = 1.34$, $SD = 2.18$ respectively or between dieters and non-dieters, $t(90) = 0.10$, $p = .92$. $M = 1.42$, $SD = 1.39$, $M = 1.48$, $SD = 2.21$ respectively.) More people in the control condition also adhered to the chocolate abstinence instructions. Nevertheless, levels of hunger and current craving at the start of the study were very similar across the three conditions.

Table 1. Characteristics of study participants as a function of condition

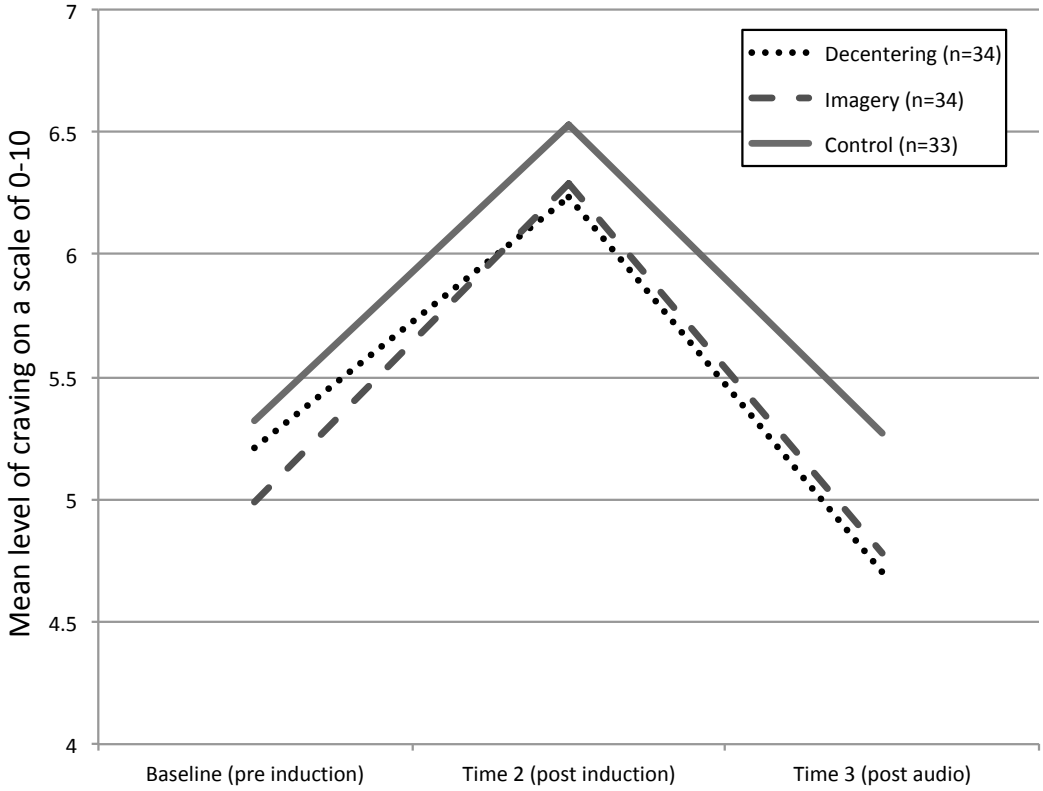
Characteristic	Decentering (*n* = 34)	Imagery (*n* = 34)	Control (*n* = 33)
Percentage of females	79%	71%	64%
Age (*M, SD*)	26.59 (12.06)	24.38 (9.68)	25.15 (8.43)
Percentage first language English	82%	91%	85%
Percentage dieting to lose weight*	9%	9%	18%
Percentage adhering to chocolate abstinence instructions	68%	79%	88%
Percentage adhering to fasting instructions	91%	88%	91%
Hunger score (*M, SD*)	7.26 (2.71)	7.22 (2.42)	7.89 (2.83)
Baseline current craving (*M, SD*)	5.21 (2.44)	4.99 (1.88)	5.32 (2.32)

*Number who declined to say: mindfulness = 6, visualisation = 0, control = 3.

Effects on craving

A 2 (time) x 3 (condition) mixed ANOVA on current craving at baseline and at time 2 (i.e. after the craving induction) showed a main effect of time, $F(1,98) = 124.94$, $p < .001$, partial $\eta^2 = 0.56$, but no effect of condition, $F(2,98) = 0.15$, $p = .86$, partial $\eta^2 = 0.00$ and no interaction between time and condition, $F(2,98) = 0.63$, $p = .53$, partial $\eta^2 = 0.01$. Thus, as shown in Figure 1, the craving induction was successful at increasing craving across all three conditions, from an overall mean of 5.17 ($SD = 2.21$) at baseline to 6.34 ($SD = 2.24$) at time 2.

Figure 1. Mean levels of current craving in the three conditions at the three time points.



A 2 (time) x 3 (condition) mixed ANOVA was also used to examine the effect of the experimental manipulations on current craving, i.e. at time 2 and time 3. This showed a main effect of time, $F(1,98) = 47.26$, $p < .001$, partial $\eta^2 = 0.33$, but no main effect of condition, $F(2,98) = 0.46$, $p = .63$, partial $\eta^2 = 0.01$ and no interaction between time and condition, $F(2,98) = 0.18$, $p = .83$, partial $\eta^2 = 0.00$. As shown in Figure 1, there was a reduction in craving following the 4-minute audio in all three conditions, from 6.22 (*SD* = 2.45) to 4.70 (*SD* = 2.37) in the decentering condition, from 6.29 (*SD* = 1.77) to 4.78 (*SD* = 1.94) in the imagery condition and from 6.53 (*SD* = 2.50) to 5.27 (*SD* = 2.33) in the control condition.

Mean craving frequency during the audio was 3.74 (*SD* = 2.90, *Mdn* = 3.5) in the decentering condition, 2.96 (*SD* = 2.22, *Mdn* = 3.0) in the imagery condition and 3.94 (*SD* = 2.39, *Mdn* = 4.0) in the control condition. Because these data showed a positive skew that was not corrected through square root transformations, a Kruskal-Wallis test was used to look for group differences.

This showed no significant difference between the three groups, $H(2) = 2.83$, $p = .24$.

Exploratory analyses: effects of task adherence, hunger and baseline craving on strategy efficacy

A series of exploratory analyses were conducted in order to look at additional factors (task adherence, hunger, baseline craving) that might influence the extent to which visualisation and decentering reduce cravings. Since both the decentering and imagery strategies involved visualisation, they were combined and contrasted with the control condition. In order to compare any additional effects of decentering over and above visualisation, the decentering strategy was contrasted with the imagery strategy.

Task adherence. Additional analyses were conducted to examine differences in task adherence across the three conditions and to explore whether task adherence moderated the effects of the strategies on craving reduction. Two one-way ANOVAs showed no significant group differences between task adherence during the 4-minute period ($F(2,98) = 2.31$, $p = .10$, partial $\eta^2 = 0.05$; decentering: $M = 6.29$, $SD = 2.11$; imagery: $M = 6.65$, $SD = 2.07$; control: $M = 7.42$, $SD = 2.40$) or toward the end of the 4-minute period ($F(2,98) = 0.31$, $p = .73$, partial $\eta^2 = 0.01$; decentering: $M = 6.03$, $SD = 2.44$; imagery: $M = 6.47$, $SD = 2.64$; control: $M = 6.48$, $SD = 2.98$). Hierarchical regression analyses were used to look for moderation effects of task adherence on the effect of condition on craving reduction. Change in craving from time 2 (i.e. post craving induction) to time 3 (i.e. post audio) was used as the dependent variable in these regression models, the measure of adherence (either overall adherence or end adherence) was entered at step 1, condition at step 2 and the interaction term between condition and adherence at step 3. Results showed that both overall adherence and end adherence significantly predicted craving reduction, with higher levels of adherence associated with greater reductions in craving ($\beta = .25$, $p = .013$, $R^2 = .06$ and $\beta = .40$, $p < .001$, $R^2 = .16$ for overall and end adherence respectively). When experimental condition (decentering/imagery, coded as 1) was contrasted with control condition (coded as 0) there was no significant interaction between condition and adherence at step 3 for either overall adherence ($\beta = .26$, $p = .42$,

ΔR^2 = .01) or end adherence (β = .22, p = .39, ΔR^2 = .01). When decentering (coded as 1) was contrasted with imagery (coded as 0) there was a trend towards an interaction between condition and adherence at step 3 for overall adherence (β = .72, p = .067, ΔR^2 = .05). There was no significant interaction for end adherence (β = .39, p = .19, ΔR^2 = .02). Simple slopes analysis on centred variables was used to explore the trend toward the interaction for overall adherence. This showed that when overall adherence was low (1 *SD* below the mean) craving reduction was (non-significantly) greater in the imagery group (b = -0.66, t = -1.68, p = .27) but when overall adherence was high (1 *SD* above the mean) craving reduction was (non-significantly) greater in the decentering group (b = 0.92, t = -1.54, p = .13). No statistical significance transition points were identified using the Johnson-Neyman method.

Hunger. Exploratory analyses were also conducted to look at whether hunger moderated the effects of condition on craving reduction. This was examined in a similar way to moderation by task adherence; craving reduction was the dependent variable in two separate regression models with hunger entered as a predictor at step 1, condition at step 2 (either experimental versus control or decentering versus imagery, each coded as 1 and 0 respectively) and the interaction between condition and hunger at step 3. Hunger significantly predicted craving reduction, with higher levels of hunger being associated with greater reductions in craving (β = .24, p = .016, R^2 = .06). When the experimental conditions were contrasted with the control condition there was no interaction between hunger and condition at step 3 (β = -.21, p = .50, ΔR^2 = .00). This was also the case when the decentering condition was contrasted with the imagery condition (β = .35, p = .39, ΔR^2 = .01)

Baseline craving. Finally, exploratory analyses were used to examine moderation by baseline levels of craving. A similar approach was taken to the previous exploratory analyses; two separate regression models contrasted the experimental conditions (coded as 1) with the control condition (coded as 0) and the decentering condition (coded as 1) with the imagery condition (coded as 0). The dependent variable was reduction in craving from time 2 to time 3, baseline craving was entered at step 1, condition at step 2 and the interaction between baseline craving and condition at step 3. Results showed that baseline craving

significantly predicted craving reduction with higher levels of baseline craving being associated with greater reductions in craving (β = .34, p < .001, R^2 = .12). There was also a significant interaction between condition and baseline craving when the experimental conditions were contrasted with the control condition (β = -.68, p = .011, ΔR^2 = .06). Simple slopes analysis on centred variables showed then when baseline craving was low (1 *SD* below the mean) craving reduction was significantly greater in the experimental condition (b = 1.41, t = 2.45, p = .02) but when baseline craving was high (1 *SD* above the mean) there was no significant difference between the experimental and control conditions (b = -0.66, t = -1.19, p = .24). However, Johnson-Neyman Regions of Significance showed that craving reduction was significantly higher in the control condition compared to the experimental conditions for the 1.98% of the sample who reported the highest levels of baseline craving. Craving reduction was significantly higher in the experimental conditions for the 32.67% of the sample who reported the lowest levels of baseline craving. When decentering was contrasted with imagery there was no significant interaction (β = .16, p = .67, ΔR^2 = .00).

Discussion

The results showed that compared to a mind wandering control task, neither guided imagery nor decentering significantly reduced cravings for chocolate, either during or after the task. There was also no difference in the effect of decentering versus guided imagery. These findings fail to support our hypothesis, based on the elaborated intrusion theory of desire (Kavanagh et al., 2005; May et al., 2012; May et al., 2015) that the guided imagery strategy would be more effective at reducing cravings compared to mind wandering. They are at odds with Hamilton et al. (2013) who found that compared to 10 minutes of mind wandering, 10 minutes of guided imagery prevented a rise in food cravings. However, they are partly consistent with Schumacher et al. (2017) who found no differences between guided imagery and mind wandering in one study, but in a second study found significant reductions in chocolate craving following guided imagery but not mind wandering.

The results also fail to support our hypothesis, based on the grounded cognition theory of desire (Papies et al. 2017), that decentering would be more effective at reducing craving compared to guided imagery. Decentering has not previously been directly contrasted with guided imagery, though in keeping with the current findings Schumacher et al. (2017) found similar reductions in chocolate cravings following both guided imagery and decentering. Nevertheless, in contrast to the current findings, in a second study Schumacher et al. found significant reductions in chocolate craving following decentering but not guided imagery.

One possible explanation for the lack of difference between the experimental and control conditions is that those in the latter were engaging in mental processes that were also effective at reducing cravings. This explanation is supported by the fact that all three conditions showed significant reductions in craving following the 4-minute audio (in contrast to Hamilton et al., 2013, where craving showed a significant increase during mind wandering). This interpretation is also supported by participants' responses when asked to indicate what they had been thinking about during the audio recording; many in the control condition referred to goals or plans such as assignments they had to complete, what they were going to do later that day, or plans for the weekend. Such thoughts may have involved visual working memory, which may in turn have prevented or interrupted the elaboration of any chocolate related thoughts. Where participants were thinking about goals that were important to them, these may also have helped inhibit hedonic goals relating to chocolate consumption (Shah, Friedman & Kruglanski, 2002), potentially suppressing intrusive thoughts about chocolate, or the extent to which such thoughts were elaborated. It is important to note that although 12% of the sample reported dieting to lose weight (a total of 6 participants in the control group), there was no evidence to suggest that the other 88% of participants were motivated to limit their consumption of chocolate or their cravings. Paradoxically, had weight loss or healthy eating been an important goal for participants, this may have inhibited thoughts about other goals (Shah et al., 2002, see also Green & Rogers, 1998), making intrusive thoughts about chocolate more likely, as well as the elaboration of these thoughts. Indeed, Schumacher et al. (2017) found beneficial

effects of guided imagery relative to mind wandering only among participants who wanted to reduce their intake of chocolate. Thus, future research may benefit from examining whether motivation moderates decline in cravings over time in a mind wandering condition. Alternatively, studies could restrict recruitment to participants who are motivated to reduce their cravings. Research examining the effect of thinking about alternative goals on craving would also be informative.

Another related possibility is that participants were motivated to reduce cravings and purposely engaged in their own strategies that were more effective than the guided imagery and decentering strategies. Arguably, thinking about an alternate, important goal will engage working memory more effectively than either the guided imagery or decentering strategies. This interpretation is consistent with the fact that the control condition was more effective at reducing cravings where baseline levels of craving were higher (i.e. when participants may have been more motivated to reduce them). Such an interpretation has applied implications; one would not want to encourage individuals to replace existing, effective craving reduction strategies with alternative strategies that are less effective. Recruiting participants who report that they struggle to control cravings may be useful to ensure the applied utility of the research. Alternatively, one could examine the extent to which this moderates effects.

Another factor that may have limited the effects of both the guided imagery and decentering strategies is the extent to which participants adhered to the tasks. Both audio recordings contained pauses in between instructions. This was necessary in the decentering audio to allow participants time to observe their own thoughts and feelings and decentre from these. The guided imagery audio contained pauses to ensure that it was, as far as possible, matched with the decentering audio. However, this would have meant that the guided imagery likely required more attention regulation on the part of participants than a recording that contained no pauses. In other words, there would have been more opportunity in this recording for participants' minds to wander (as per the mind wandering strategy). Indeed, in the open ended responses two participants in the imagery condition mentioned having difficulty concentrating

and whilst some participants reported thinking about leaves floating on a stream, others reported thinking about chocolate.

This issue of attention regulation also applies to the decentering task. Indeed, it is possible that some participants may have simply given up on the task if they found it too hard. For decentering it is more difficult to evaluate adherence using the open-ended responses; whilst some clearly indicated that participants followed the instructions, other responses were ambiguous. The quantitative ratings relating to task adherence showed no significant differences between the three conditions, but the means were lower in the decentering condition and it is possible that participants lacked insight into the extent to which they had accurately followed the decentering instructions. The fact that there was a trend toward the decentering strategy being more effective at reducing craving compared to the imagery strategy where task adherence was high suggests it would be worth trying to address such issues in future research. For example, it may be helpful to recruit a sample that is more motivated to follow the audio instructions. A period of practice may also help improve task adherence.

Additionally, we may have failed to find any effects of the decentering and imagery strategies because the cravings that were elicited were relatively transient. The reported strength of cravings following the craving induction were comparable to those found in other studies (e.g. Schumacher et al., 2017), but it is possible they dissipated more quickly once the chocolate was out of view resulting in floor effects across the three conditions. As such it would be informative to repeat the study but with participants who are likely to experience more sustained cravings (for example heavy smokers or those who report struggling with cravings). Relatedly, it would be informative to compare the extent to which the decentering and imagery strategies could help prevent the development of craving during cue exposure (as opposed to reducing craving following a craving induction). Arguably, depending on the nature of the cue exposure task, it may be easier to simultaneously engage in decentering than visual imagery.

In conclusion, the research failed to show any benefits of guided imagery and decentering for craving reduction compared to mind wandering; it is

possible that for this sample participants' own strategies for reducing craving were just as effective as the guided imagery and decentering strategies. However, it is also possible that effects did not emerge because participant adherence to the decentering and imagery strategies was not sufficiently high or because the cravings that were elicited were too short-lived. Future research may benefit from recruiting participants who are motivated to reduce cravings but report struggling to do so. It may also be helpful to provide an opportunity for participants to practice the decentering strategy and to examine its effect on craving development during cue exposure.

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Conflict of interest

Conflicts of interest: none

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