

Chocolate craving

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

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24

**Abstract**

25

26 According to the elaborated-intrusion theory of desire, strategies that load visual  
27 working memory will reduce cravings. According to the grounded cognition  
28 theory of desire, cravings will be reduced with mindfulness-based decentering  
29 strategies that encourage individuals to see their thoughts as thoughts. However,  
30 decentering strategies also tend to load visual working memory making it  
31 difficult to test the latter prediction. This study addressed this issue by matching  
32 visualization across decentering and guided imagery tasks. Male and female  
33 participants (n=101) underwent a chocolate craving induction before listening to  
34 a 4-minute audio recording that guided them to (a) decenter from their thoughts  
35 and feelings, (b) engage in visualization, or (c) let their mind wander.

36 Participants reported on chocolate craving before and after the craving induction  
37 and following the 4-minute recording. They also provided retrospective reports  
38 of craving during the recording, reported on the extent to which they had  
39 adhered to the audio instructions and briefly indicated what they had been  
40 thinking about during the recording. Results showed a significant reduction in  
41 cravings to baseline following the recording across all three conditions ( $p<.001$ ),  
42 but no significant differences between conditions or in the retrospective reports  
43 of craving. There was some evidence to suggest that participants in the mind  
44 wandering condition had been thinking about alternate goals, which may have  
45 inhibited thoughts about chocolate and been just as effective at reducing craving  
46 as the imagery and decentering strategies. Exploratory analyses showed a trend  
47 toward decentering being more effective than imagery where participants  
48 reported higher task adherence throughout the 4 minutes ( $p=.067$ ). This raises  
49 the possibility that decentering effects may be improved with better strategy  
50 adherence, which might be achieved through practice or increased motivation.

51

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

53

## Introduction

54

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

63 One of the most effective strategies for reducing food cravings seems to  
64 be tasks that load visual working memory, such as guided imagery (Hamilton,  
65 Fawson, May, Andrade & Kavanagh, 2013; Kemps & Tiggemann, 2007), clay  
66 modelling (Andrade, Pears, May & Kavanagh, 2012), dynamic visual noise  
67 (Kemps & Tiggemann, 2013; Kemps, Tiggemann & Christianson, 2008) or playing  
68 games that require visuospatial skills (Skorka-Brown, Andrade & May, 2014).  
69 Such findings are consistent with the elaborated intrusion theory of desire  
70 (Kavanagh, Andrade & May, 2005; May, Andrade, Kavanagh & Hetherington,  
71 2012; May et al., 2015). This theory states that craving occurs when intrusive  
72 thoughts about a desired object are elaborated on. In other words, the individual  
73 uses working memory to actively construct vivid sensory images about the  
74 desired object and its acquisition. Because these images tend to be visual in  
75 nature, and because working memory has limited capacity, any task that also  
76 requires visual working memory will prevent this elaborative process, and in  
77 doing so will also prevent or interrupt the craving episode.

78 A number of laboratory studies have demonstrated such an effect. For  
79 example, Skorka-Brown et al. (2014) found that playing 3 minutes of a  
80 visuospatial computer game reduced both craving intensity after the 3-minute  
81 period and craving frequency during the 3-minute period (compared to waiting  
82 for the computer game to load). Similarly, Andrade et al. (2012) found that  
83 compared to 10 minutes of counting or 10 minutes of 'letting your mind wander',  
84 10 minutes of clay modelling reduced craving intensity immediately following  
85 the 10-minute period and craving frequency during the 10-minute period.

## Chocolate craving

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

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

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

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

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

149

150

## Methods

151

152 **Participants**

153 Participants were 101 females (n = 72) and males (n = 29) with a mean age of  
154 25.38 years (SD = 10.16) who responded to adverts asking for 'chocolate lovers'  
155 to take part in a study on chocolate cravings. The adverts were placed around  
156 university buildings and on an online platform affiliated with the university.  
157 Participants received course credits or 4 pounds sterling upon study completion,  
158 as well as the chocolate bar used in the craving induction procedure (see below).  
159 Inclusion criteria were consumption of chocolate or chocolate related products  
160 at least three times a week, aged 18 years or over and not pregnant. Exclusion  
161 criteria were suffering from a medical condition that influences appetite, taking  
162 medication that influences appetite or having an existing or previous diagnosis of  
163 anorexia, binge eating disorder or any other eating disorder. Ethical approval  
164 was provided by the City, University of London Psychology Department Research  
165 Ethics Committee. The target sample size was 33 per condition, based on  
166 Schumacher et al. (2017); due to scheduling of participants by several  
167 researchers an additional two participants were recruited.

168  
169 **Craving induction**

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

183  
184 **Experimental manipulation**

## Chocolate craving

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

205

### 206 **Measures**

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

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

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

242

### 243 **Procedure**

244 Upon contacting the researcher about the study, participants were asked to  
245 confirm, via email, that they met the inclusion criteria. They were also asked to  
246 abstain from chocolate and chocolate-related products for at least 24 hours prior  
247 to their appointment and to abstain from all food and drink, other than water, for  
248 2 hours prior to their appointment. At their appointment participants first  
249 reported their gender, age and first language before indicating whether they had

## Chocolate craving

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

263

264

## Results

265

### 266 Participant characteristics

267 As shown in Table 1, there were slightly more females in the mindfulness and  
268 imagery conditions compared to the control condition but more people reporting  
269 dieting to lose weight in the control condition compared to the mindfulness and  
270 imagery conditions. (In terms of change in current craving from time 2 to time 3,  
271 there were no significant differences between males and females,  $t(99) = 0.65$ ,  $p$   
272  $= .52$ ,  $M = 1.64$ ,  $SD = 1.77$  and  $M = 1.34$ ,  $SD = 2.18$  respectively or between dieters  
273 and non-dieters,  $t(90) = 0.10$ ,  $p = .92$ .  $M = 1.42$ ,  $SD = 1.39$ ,  $M = 1.48$ ,  $SD = 2.21$   
274 respectively.) More people in the control condition also adhered to the chocolate  
275 abstinence instructions. Nevertheless, levels of hunger and current craving at the  
276 start of the study were very similar across the three conditions.

277

278

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

| Characteristic   | Decentering<br>( <i>n</i> = 34) | Imagery<br>( <i>n</i> = 34) | Control<br>( <i>n</i> = 33) |
|--|---------------------------------|-----------------------------|-----------------------------|
| Percentage of females                                    | 79%                             | 71%                         | 64%                         |
| Age ( <i>M, SD</i> )                                     | 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 ( <i>M, SD</i> )                            | 7.26 (2.71)                     | 7.22 (2.42)                 | 7.89 (2.83)                 |
| Baseline current craving ( <i>M, SD</i> )                | 5.21 (2.44)                     | 4.99 (1.88)                 | 5.32 (2.32)                 |

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

281

### 282 **Effects on craving**

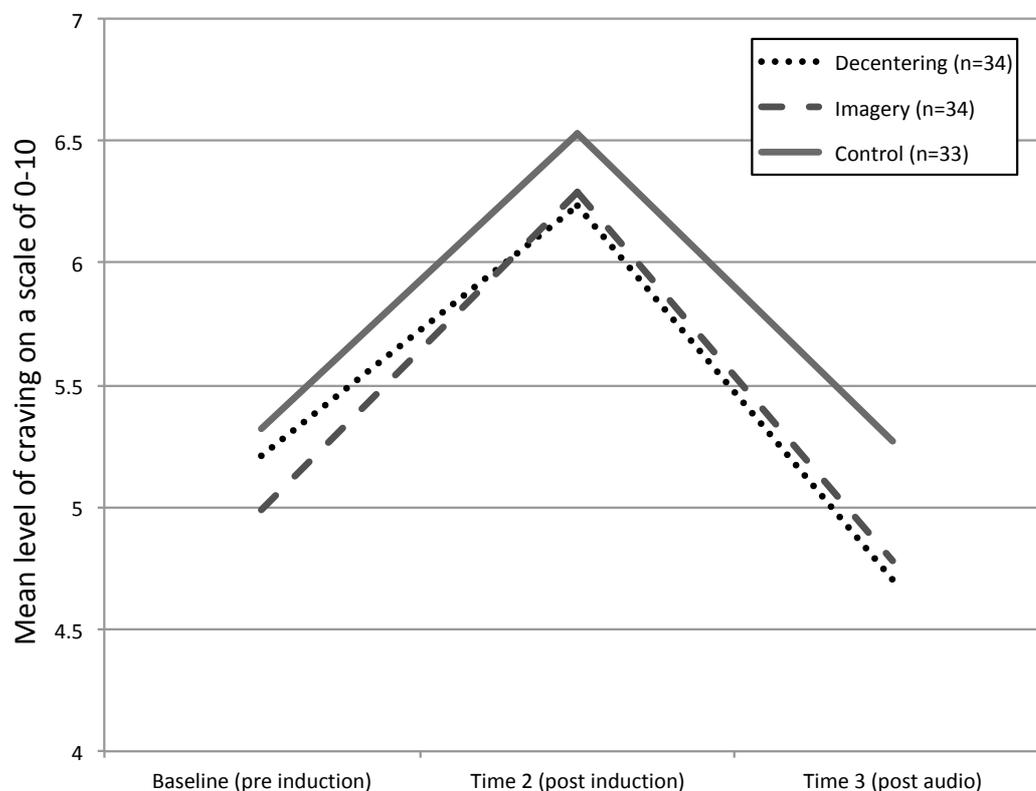
283 A 2 (time) x 3 (condition) mixed ANOVA on current craving at baseline and at  
 284 time 2 (i.e. after the craving induction) showed a main effect of time,  $F(1,98) =$   
 285  $124.94, p < .001$ , partial  $\eta^2 = 0.56$ , but no effect of condition,  $F(2,98) = 0.15, p =$   
 286  $.86$ , partial  $\eta^2 = 0.00$  and no interaction between time and condition,  $F(2,98) =$   
 287  $0.63, p = .53$ , partial  $\eta^2 = 0.01$ . Thus, as shown in Figure 1, the craving induction  
 288 was successful at increasing craving across all three conditions, from an overall  
 289 mean of 5.17 ( $SD = 2.21$ ) at baseline to 6.34 ( $SD = 2.24$ ) at time 2.

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## Chocolate craving

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



294

295

296 A 2 (time) x 3 (condition) mixed ANOVA was also used to examine the effect of  
297 the experimental manipulations on current craving, i.e. at time 2 and time 3. This  
298 showed a main effect of time,  $F(1,98) = 47.26, p < .001$ , partial  $\eta^2 = 0.33$ , but no  
299 main effect of condition,  $F(2,98) = 0.46, p = .63$ , partial  $\eta^2 = 0.01$  and no  
300 interaction between time and condition,  $F(2,98) = 0.18, p = .83$ , partial  $\eta^2 = 0.00$ .

301 As shown in Figure 1, there was a reduction in craving following the 4-minute  
302 audio in all three conditions, from 6.22 ( $SD = 2.45$ ) to 4.70 ( $SD = 2.37$ ) in the  
303 decentering condition, from 6.29 ( $SD = 1.77$ ) to 4.78 ( $SD = 1.94$ ) in the imagery  
304 condition and from 6.53 ( $SD = 2.50$ ) to 5.27 ( $SD = 2.33$ ) in the control condition.

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

## Chocolate craving

310 This showed no significant difference between the three groups,  $H(2) = 2.83, p =$   
311 .24.

312

### 313 **Exploratory analyses: effects of task adherence, hunger and baseline** 314 **craving on strategy efficacy**

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

322 **Task adherence.** Additional analyses were conducted to examine  
323 differences in task adherence across the three conditions and to explore whether  
324 task adherence moderated the effects of the strategies on craving reduction. Two  
325 one-way ANOVAs showed no significant group differences between task  
326 adherence during the 4-minute period ( $F(2,98) = 2.31, p = .10, \text{partial } \eta^2 = 0.05$ ;  
327 decentering:  $M = 6.29, SD = 2.11$ ; imagery:  $M = 6.65, SD = 2.07$ ; control:  $M = 7.42,$   
328  $SD = 2.40$ ) or toward the end of the 4-minute period ( $F(2,98) = 0.31, p = .73,$   
329  $\text{partial } \eta^2 = 0.01$ ; decentering:  $M = 6.03, SD = 2.44$ ; imagery:  $M = 6.47, SD = 2.64$ ;  
330 control:  $M = 6.48, SD = 2.98$ ). Hierarchical regression analyses were used to look  
331 for moderation effects of task adherence on the effect of condition on craving  
332 reduction. Change in craving from time 2 (i.e. post craving induction) to time 3  
333 (i.e. post audio) was used as the dependent variable in these regression models,  
334 the measure of adherence (either overall adherence or end adherence) was  
335 entered at step 1, condition at step 2 and the interaction term between condition  
336 and adherence at step 3. Results showed that both overall adherence and end  
337 adherence significantly predicted craving reduction, with higher levels of  
338 adherence associated with greater reductions in craving ( $\beta = .25, p = .013, R^2 =$   
339  $.06$  and  $\beta = .40, p < .001, R^2 = .16$  for overall and end adherence respectively).

340 When experimental condition (decentering/imagery, coded as 1) was contrasted  
341 with control condition (coded as 0) there was no significant interaction between  
342 condition and adherence at step 3 for either overall adherence ( $\beta = .26, p = .42,$

## Chocolate craving

343  $\Delta R^2 = .01$ ) or end adherence ( $\beta = .22, p = .39, \Delta R^2 = .01$ ). When decentering  
344 (coded as 1) was contrasted with imagery (coded as 0) there was a trend  
345 towards an interaction between condition and adherence at step 3 for overall  
346 adherence ( $\beta = .72, p = .067, \Delta R^2 = .05$ ). There was no significant interaction for  
347 end adherence ( $\beta = .39, p = .19, \Delta R^2 = .02$ ). Simple slopes analysis on centred  
348 variables was used to explore the trend toward the interaction for overall  
349 adherence. This showed that when overall adherence was low (1 *SD* below the  
350 mean) craving reduction was (non-significantly) greater in the imagery group ( $b$   
351  $= -0.66, t = -1.68, p = .27$ ) but when overall adherence was high (1 *SD* above the  
352 mean) craving reduction was (non-significantly) greater in the decentering  
353 group ( $b = 0.92, t = -1.54, p = .13$ ). No statistical significance transition points  
354 were identified using the Johnson-Neyman method.

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

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

## Chocolate craving

376 significantly predicted craving reduction with higher levels of baseline craving  
377 being associated with greater reductions in craving ( $\beta = .34, p < .001, R^2 = .12$ ).  
378 There was also a significant interaction between condition and baseline craving  
379 when the experimental conditions were contrasted with the control condition ( $\beta$   
380  $= -.68, p = .011, \Delta R^2 = .06$ ). Simple slopes analysis on centred variables showed  
381 then when baseline craving was low (1 *SD* below the mean) craving reduction  
382 was significantly greater in the experimental condition ( $b = 1.41, t = 2.45, p = .02$ )  
383 but when baseline craving was high (1 *SD* above the mean) there was no  
384 significant difference between the experimental and control conditions ( $b = -$   
385  $0.66, t = -1.19, p = .24$ ). However, Johnson-Neyman Regions of Significance  
386 showed that craving reduction was significantly higher in the control condition  
387 compared to the experimental conditions for the 1.98% of the sample who  
388 reported the highest levels of baseline craving. Craving reduction was  
389 significantly higher in the experimental conditions for the 32.67% of the sample  
390 who reported the lowest levels of baseline craving. When decentering was  
391 contrasted with imagery there was no significant interaction ( $\beta = .16, p = .67, \Delta R^2$   
392  $= .00$ ).

393

394

## Discussion

395

396 The results showed that compared to a mind wandering control task, neither  
397 guided imagery nor decentering significantly reduced cravings for chocolate,  
398 either during or after the task. There was also no difference in the effect of  
399 decentering versus guided imagery. These findings fail to support our  
400 hypothesis, based on the elaborated intrusion theory of desire (Kavanagh et al.,  
401 2005; May et al., 2012; May et al., 2015) that the guided imagery strategy would  
402 be more effective at reducing cravings compared to mind wandering. They are at  
403 odds with Hamilton et al. (2013) who found that compared to 10 minutes of  
404 mind wandering, 10 minutes of guided imagery prevented a rise in food cravings.  
405 However, they are partly consistent with Schumacher et al. (2017) who found no  
406 differences between guided imagery and mind wandering in one study, but in a  
407 second study found significant reductions in chocolate craving following guided  
408 imagery but not mind wandering.

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

418           One possible explanation for the lack of difference between the  
419 experimental and control conditions is that those in the latter were engaging in  
420 mental processes that were also effective at reducing cravings. This explanation  
421 is supported by the fact that all three conditions showed significant reductions in  
422 craving following the 4-minute audio (in contrast to Hamilton et al., 2013, where  
423 craving showed a significant increase during mind wandering). This  
424 interpretation is also supported by participants' responses when asked to  
425 indicate what they had been thinking about during the audio recording; many in  
426 the control condition referred to goals or plans such as assignments they had to  
427 complete, what they were going to do later that day, or plans for the weekend.  
428 Such thoughts may have involved visual working memory, which may in turn  
429 have prevented or interrupted the elaboration of any chocolate related thoughts.  
430 Where participants were thinking about goals that were important to them,  
431 these may also have helped inhibit hedonic goals relating to chocolate  
432 consumption (Shah, Friedman & Kruglanski, 2002), potentially suppressing  
433 intrusive thoughts about chocolate, or the extent to which such thoughts were  
434 elaborated. It is important to note that although 12% of the sample reported  
435 dieting to lose weight (a total of 6 participants in the control group), there was  
436 no evidence to suggest that the other 88% of participants were motivated to  
437 limit their consumption of chocolate or their cravings. Paradoxically, had weight  
438 loss or healthy eating been an important goal for participants, this may have  
439 inhibited thoughts about other goals (Shah et al., 2002, see also Green & Rogers,  
440 1998), making intrusive thoughts about chocolate more likely, as well as the  
441 elaboration of these thoughts. Indeed, Schumacher et al. (2017) found beneficial

## Chocolate craving

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

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

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

## Chocolate craving

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

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

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

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

## Chocolate craving

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

516

517

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### **Conflict of interest**

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