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Chocolate craving

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4

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

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21 Shortened title: Chocolate craving

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23

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.

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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**

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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

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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 (<i>n</i> = 34)	Imagery (<i>n</i> = 34)	Control (<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**

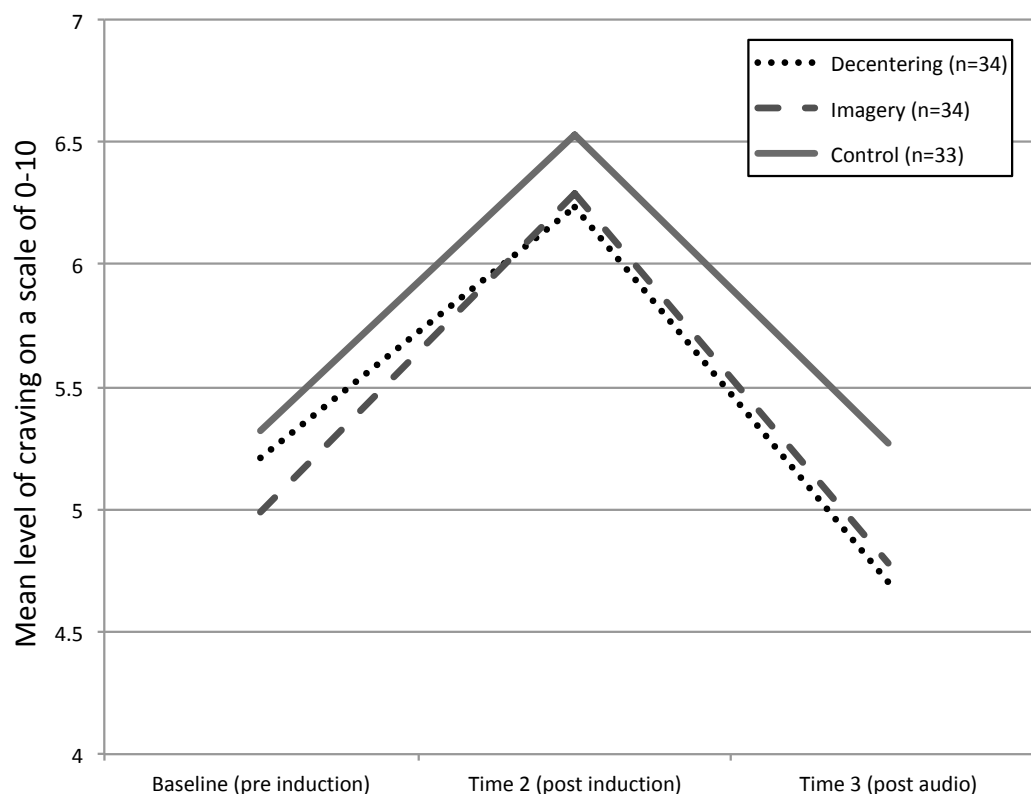
283 A 2 (time) x 3 (condition) mixed ANOVA on current craving at baseline and at
 284 time 2 (i.e. after the craving induction) showed a main effect of time, $F(1,98) =$
 285 $124.94, p < .001$, partial $\eta^2 = 0.56$, but no effect of condition, $F(2,98) = 0.15, p =$
 286 $.86$, partial $\eta^2 = 0.00$ 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.

290

291

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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

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

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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 ($\beta = .26, p = .42,$

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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

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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 (β
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

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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

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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

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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

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Conflict of interest

527

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