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Mindful eating

1 Tapper, K. & Seguias, L. (in press). The effects of mindful eating on food
2 consumption over a half-day period. *Appetite*

3

4

5 **The effects of mindful eating on food consumption over a half-day period.**

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20

Abstract

21

22 This study examined the effects of a key feature of mindful eating (paying
23 attention to the sensory properties of food) on calorie and macronutrient intake
24 over a half-day period. Female participants ($n = 60$) were given a 635 kcal lunch
25 of sandwiches, crisps and grapes. Those allocated to an experimental condition
26 were asked to attend to the sensory properties of the food. After lunch, all
27 participants were given 908 kcal of three energy dense sweet snack foods and
28 asked to taste and rate them on several dimensions. Unknown to participants,
29 the amounts of all foods consumed were recorded. Before they left the
30 laboratory, participants in the experimental group were also asked to continue
31 to pay attention to the sensory properties of their food for the rest of the day. At
32 the end of the day all participants logged onto a website where they completed a
33 suspicion probe and surprise online food recall measure to assess food intake
34 outside the laboratory. Data from participants who guessed their eating was
35 being measured were excluded. There were no differences between the
36 experimental and control groups in terms of calories consumed during the taste
37 test (166 versus 144 kcal respectively; $n = 48$) or across the entire half-day
38 period (1456 versus 1343 kcal respectively; $n = 44$). There were also no
39 differences in total intake of saturated fat, added sugar or fibre. The results fail to
40 support other research that has shown reductions in food intake following
41 mindful eating. This highlights the need to identify underlying mechanisms of
42 action to better understand when this strategy is, and is not, likely to influence
43 diet. Pre-registration: osf.io/f4x2m

44

45 **Keywords:** mindfulness; mindful eating; diet; calories; memory

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48

1. Introduction

49

50 Mindfulness is increasingly being used to aid weight management. However,
51 evidence of its effects is still lacking. For example, Olson and Emery (2015)
52 reviewed 19 mindfulness-based interventions for weight loss and concluded that
53 although 13 of these brought about significant reductions in weight, it was not
54 clear whether these effects were driven by increases in mindfulness.

55

56 A key difficulty in establishing the effects of mindfulness for weight management
57 stems from the fact that interventions typically also involve non-mindfulness
58 components, such as group workshops, information about healthy eating or
59 exercises designed to increase motivation (Tapper, 2017). This is compounded
60 by the fact that it is difficult to convincingly show that levels of mindfulness have
61 increased as a result of the intervention, as self-report measures of mindfulness
62 are prone to bias and there are no alternative, objective measures that can be
63 used (Tapper, 2017; see also Grossman, 2011; Kruger & Dunning, 1999). As such,
64 it can be difficult to establish the extent to which the mindfulness components of
65 an intervention are responsible for any effects.

66

67 An additional challenge is that the concept of mindfulness itself incorporates
68 different elements. Mindfulness can be defined as 'awareness that emerges
69 through paying attention on purpose, in the present moment, and non-
70 judgmentally to the unfolding of experience moment by moment' (Kabat-Zinn,
71 2003). When it comes to eating, this could mean a number of different things,
72 including paying attention to the sensory properties of food as one eats, paying
73 attention to feelings of hunger and satiety, paying attention to internal and
74 external cues that elicit eating or the desire to eat, or taking a non-judgemental
75 attitude to any of these thoughts, feelings or bodily sensations. Each of these
76 strategies could have quite different effects on eating behaviour (Tapper, 2017;
77 Tapper, 2018). Recent research on the concept of mindful eating reinforces the
78 idea that people may be mindful in different ways. For example, the extent to
79 which people report paying attention to the sensory properties of their food is
80 only moderately correlated with the extent to which they report paying attention

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81 to feelings of hunger and satiety (Winkens et al., 2018). This means that the
82 effects of mindfulness-based weight management interventions may be
83 inconsistent, depending on the particular exercises they emphasise and/or the
84 ways in which individuals apply mindfulness to their eating.

85

86 Given the above, there is a need for more experimental work to (a) test the
87 effects of specific, clearly defined mindfulness-based strategies, and (b) employ
88 carefully controlled methods to rule out the influence of other factors unrelated
89 to mindfulness. The present study is one such experiment that examined the
90 effects of paying attention to the sensory properties of food whilst eating.

91

92 Attending to the sensory properties of food whilst eating is an essential feature
93 of mindful eating (Winkens et al., 2018). As well as being described as mindful
94 eating it has also been referred to as 'attentive eating', and 'focussed eating'
95 (Robinson, Kersbergen & Higgs, 2014; Winkens et al., 2018). Of the experimental
96 research published in this area, six assessments have found that this practice
97 significantly reduces subsequent intake of high calorie foods in the laboratory
98 (Arch et al., 2016; Higgs & Donohoe, 2011; Robinson, Kersbergen & Higgs, 2014;
99 Alliot et al., 2018; Seguias & Tapper, 2018; Tapper, Seguias & Pathmanathen,
100 2018), and a seventh assessment has shown a trend in this direction (Cavanagh,
101 Vartanian, Herman & Polivy, 2014). However, four assessments, including two
102 that were pre-registered, have failed to find such effects, leading some
103 researchers to question whether the effects may have been overestimated within
104 the literature (Arch et al., 2016; Whitelock, Higgs, Brunstrom, Halford &
105 Robinson, 2018; Whitelock, Gaglione, Davies-Owen & Robinson, 2019). More
106 recently, a pre-registered 8-week attentive eating intervention (that included
107 mindful eating as one of several intervention components) failed to find any
108 effects on either weight loss or food intake over a 24-hour period (Whitelock,
109 Kersbergen et al., 2019). This raises the possibility that the effects of mindful
110 eating are not sustained over time, do not occur outside the laboratory setting, or
111 are compensated for by increased consumption on other occasions.

112

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113 The aim of the present study was to further explore the effects of paying
114 attention to the sensory properties of food on subsequent consumption. It
115 differed from previous studies by asking participants to eat a whole meal
116 mindfully then examining effects on snack consumption almost immediately
117 after. Previous research in which participants have eaten a whole meal in this
118 way have only examined effects on consumption 2 to 3 hours later (Higgs &
119 Donohoe, 2011; Robinson, Kersbergen & Higgs, 2014; Seguias & Tapper, 2018;
120 Whitelock et al., 2018; Whitelock, Gaglione et al., 2019), though other research
121 employing the consumption of smaller quantities of food has recorded
122 immediate effects on subsequent consumption (Allirot et al., 2018; Arch et al.,
123 2016; Tapper et al., 2018). In this study we aimed to reproduce what might be a
124 more typical type of eating episode for participants, i.e. the opportunity to eat a
125 high calorie food immediately after eating lunch. In light of previous research we
126 predicted that, compared to a control condition, those who ate their lunch
127 mindfully would consume fewer calories of an ad libitum snack presented to
128 them after lunch.

129

130 A second aim of the research was to look at whether any effects extended to
131 participants' eating outside the laboratory. We did this by asking all participants
132 to complete a surprise food recall measure at the end of the day. We expected
133 that, compared to the control condition, those allocated to the mindful eating
134 condition would consume fewer calories over the entire half-day period.

135

136 Additionally, we were interested in whether the mindful eating strategy would
137 impact upon participants' choice of food, as there is some evidence to suggest
138 that mindful eating might encourage participants to make more healthy choices
139 (Allirot et al., 2018; Arch et al., 2016). We achieved this by looking at
140 participants' consumption of saturated fat, added sugar and fibre throughout the
141 half-day period.

142

143 These three aims, together with their associated confirmatory hypotheses, were
144 pre-registered at the Open Science Framework (Tapper & Seguias, 2019).

145

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146 Finally, because this study included both observed (i.e. weighed) and recalled
147 measures of food intake in the laboratory, it allowed us to explore the
148 relationship between these two measures. Some research suggests that the
149 effects of mindful eating on consumption occur because it improves memory for
150 food that has been eaten which is then used to help guide later intake (Higgs &
151 Donohoe, 2011). However, other research has failed to find support for this
152 hypothesis (Robinson, Kersbergen & Higgs, 2014; Seguias & Tapper, 2018).
153 Exploratory analysis conducted in this study examined whether the mindful
154 eating manipulation improved recall of the types and quantities of food eaten.

155

156

157

2. Methods

158

2.1. Participants

159
160 Participants were 60 females with a mean age of 43.61 years ($SD = 14.21$, range =
161 18 to 72). English was a first language for 90% of the participants, mean self-
162 reported body mass index (BMI) was 25.48 ($SD = 5.96$, range = 17.63 to 44.08)
163 and 15% reported dieting to lose weight. Recruitment was conducted in
164 association with the makers of a BBC television programme called 'Trust Me I'm
165 a Doctor'. Advertising for the study stated it was a collaboration between the
166 BBC and the university, investigating the relationship between personality and
167 perception. Adverts were placed on the BBC's social media accounts and emailed
168 to their local contacts. Adverts were also placed around the university buildings
169 and handed as flyers to individuals in the university. Participants received 10
170 pounds sterling for taking part and to cover any travel expenses. To be
171 considered for the study participants needed to be female, living in London, aged
172 18 years or over and fluent in English. (The study was restricted to females to
173 limit the amount of variability in the quantities of food eaten, e.g. see Robinson et
174 al., 2017.) Exclusion criteria were inability to comply with the study
175 requirements, severe food allergies, allergies or restrictions in relation to the
176 foods being used in the study and previous participation in any related study.
177 Ethical approval was provided by the City, University of London Psychology
178 Department Research Ethics Committee. The target sample size was 60 (30 per

179 condition). This was informed by Seguias and Tapper (2018) and assumed a
180 difference in consumption of 70kcal (SD = 90) between the two conditions on ad
181 libitum snack intake in the laboratory. The method and analysis strategy were
182 pre-registered with the Open Science Framework (osf.io/f4x2m).

183

184 **2.2. Study design, randomisation and blinding**

185 The study employed a between groups, double-blind design in which
186 participants were randomised to one of two conditions: provision of standard
187 instructions plus instructions to eat mindfully (experimental condition) or
188 provision of standard instructions (control condition). The first author (KT)
189 generated the randomisation sequence which used a 1:1 allocation ratio and a
190 block size of 2. She then put the appropriate instructions for participants into
191 sequentially numbered opaque sealed envelopes. The second author (LS), who
192 was responsible for participant recruitment and testing, was blind to both the
193 randomisation sequence and participant condition. (In approximately 8
194 instances researcher blinding failed either after lunch was provided or after the
195 snack was provided due to participants leaving instructions out of the envelope.)
196 Blinding of participants was checked at the end of the study using a funnelled
197 suspicion probe (see sections 2.6 and 3).

198

199 **2.3. Experimental manipulation**

200 All participants received a sealed envelope with their lunch, that they were asked
201 to open before eating their lunch. It contained written instructions that told them
202 to eat as much lunch as they liked, informed them that the researcher would
203 return in 10 minutes and asked them to place the instructions back in the
204 envelope once they had finished eating. For those allocated to the experimental
205 condition, these instructions also asked them to pay attention to the sensory
206 properties of the food as they ate and described ways in which they might do
207 this, for example by noticing the colour, smell, taste, texture and sound of the
208 food.

209

210 Before leaving the laboratory, all participants received a second sealed envelope
211 that they were asked to open as soon as they had left. This second envelope

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212 contained details of a username and password and asked them to log into a
213 website half an hour before they went to bed, to answer some additional
214 questions. For those allocated to the experimental condition, these instructions
215 also asked them to continue to pay attention to the sensory properties of their
216 food for the remainder of the day. Again, the instructions described ways in
217 which they might do this. Copies of the instructions can be viewed in the
218 supplementary information.

219

220 **2.4. Lunch and bogus taste test**

221 The lunch provided to participants contained approximately 635 kcal and
222 consisted of one Sainsbury's cheese and tomato sandwich on malted bread (165
223 g; 434 kcal), Walkers ready salted crisps (32.5 g; 171 kcal) and 10 red grapes
224 (approximately 50 g; 30 kcal). These foods were provided to participants on a
225 single plate along with a glass and jug of water. They were left alone for 10
226 minutes to eat lunch. All foods were weighed both before and after consumption
227 to determine the amounts eaten.

228

229 The snack foods were provided after lunch as part of a bogus taste test and
230 consisted of three separate 60 g servings of Sainsbury's milk chocolate digestive
231 biscuits (299 kcal), Cadbury milk chocolate biscuit fingers (310 kcal) and
232 Maryland mini chocolate chip cookies (299 kcal). These foods were broken into
233 smaller pieces to reduce the chances of participants monitoring the amount they
234 were eating. They were served on three individual plates labelled as 'A', 'B' and
235 'C' alongside a sheet of questions asking them to taste and rate each of the foods
236 in terms of sweetness, saltiness and liking. These questions were used to prompt
237 participants to taste the foods but reduce the chances of them guessing that their
238 consumption was being measured, as this knowledge has been shown to suppress
239 intake (Robinson, Kersbergen, Brunstrom & Field, 2014). Participants were also
240 told they could eat as much of the snacks as they liked once they had finished the
241 rating task as any leftovers would be thrown away. They were left alone for 5
242 minutes to complete this task. All foods were weighed both before and after
243 consumption to determine the amounts eaten. The bogus taste test is a widely

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244 employed method of assessing food consumption in the laboratory that has been
245 shown to have good validity and sensitivity (Robinson et al., 2017).

246

247 **2.5. Food recall measure**

248 Self-reported food intake was assessed using a computerised multiple-pass 24-
249 hour recall measure called INTAKE24 (Simpson et al., 2017). The measure first
250 asks users to list all foods and drinks consumed from the time of waking up. It
251 then asks for further details of each item reported (such as type or brand),
252 requests details of serving size and any leftovers, and provides prompts for
253 additional items (such as sugar added to tea) or items that may have been
254 forgotten (e.g. where no drink is reported with lunch). Finally, the user is asked
255 to review all items reported to ensure that the details are correct and nothing
256 has been missed. The INTAKE24 measure has shown good agreement with
257 interviewer-led 24-hour recalls, in terms of both energy and macronutrient
258 intake (Bradley et al., 2016).

259

260 **2.6. Procedure**

261 Participants who contacted the BBC, and met the inclusion criteria, were asked
262 to provide their name and contact details, which were then passed on to the
263 second author (LS) who sent them an information sheet about the study and
264 contacted them the following day to answer any additional questions they had,
265 check exclusion criteria and, where relevant, book an appointment for them to
266 take part. Where participants contacted LS directly, she also assessed inclusion
267 criteria.

268

269 Participants were asked to attend an appointment at the university at either
270 12pm, 12.45pm or 1.30pm and asked not to eat lunch beforehand. Upon arrival,
271 participants were provided with lunch as well as the first sealed envelope. After
272 10 minutes the researcher (LS) returned to the laboratory and cleared away the
273 lunch. The participant was then provided with a questionnaire booklet
274 containing the Reinforcement Sensitivity Theory Personality Questionnaire (Corr
275 & Cooper, 2016) and instructions and materials for sorting coloured tiles into
276 colour categories. These served as both filler tasks and as a way of reducing the

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277 chances that participants would guess the study aims and their group allocation.
278 The researcher left the participant for 10 minutes to complete these tasks before
279 returning to administer the bogus taste test. After the taste test participants
280 were given the second envelope and reminded to open it as soon as they left the
281 laboratory.

282

283 When participants logged on to the website in the evening they completed a
284 funnelled suspicion probe followed by the food recall measure. They were then
285 informed of the real aims of the study and asked to provide or withhold consent
286 for the use of the food intake data collected in the laboratory. After this they
287 were presented with three 9-point rating scales (anchored by 'Not at all' and
288 'Nearly all the time') and rated the extent to which they had paid attention to
289 the sight, smell, taste, texture and sound of the food they had eaten (a) at lunch,
290 (b) during the taste test, and (c) during the rest of the day. They then indicated
291 whether they intended to eat or drink anything else before going to bed, and
292 provided details of their age, first language, weight and height and whether or
293 not they were dieting to lose weight. The researcher called them the next
294 morning at a pre-arranged time to answer any further questions they had.

295

296

297

3. Results

298

3.1. Data screening

300 KT coded the data from the suspicion probe, prior to receiving the data on food
301 consumption, from either the laboratory or food diary measures. According to
302 the suspicion probe data, 11 participants guessed that food consumption was
303 being measured (7 in the experimental group, 4 in the control group) and these
304 participants were excluded from data analysis. One participant could not access
305 the online part of the study so failed to provide consent for the use of the
306 consumption data and was also excluded. An additional four participants either
307 failed to complete the food diary section of the online questionnaire or reported
308 on food consumed on a different day. This left a total of 48 participants for the

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309 assessment of consumption data in the laboratory and 44 for the assessment of
310 intake during the half-day period.

311

312 **3.2. Participant characteristics**

313 As shown in Table 1, participants were well matched across the two conditions
314 in terms of first language and BMI. Participants in the control group were slightly
315 older than those in the experimental group and there were more participants in
316 the control group who reported dieting to lose weight.

317

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

319

Characteristic	Experimental (<i>n</i> = 23)	Control (<i>n</i> = 25)
Age (<i>M, SD</i>)	41.96 (14.63)	48.24 (13.29)
Percentage first language English	91%	92%
Percentage dieting to lose weight	0%	20%
Self reported BMI (<i>M, SD</i>)*	24.85 (6.11)	25.92 (6.65)

320 **n* = 19 and 24 respectively due to missing data.

321

322 **3.3. Manipulation check**

323 Table 2 shows the mean levels of mindful eating reported by participants.

324

325 **Table 2.** Mean (*SD*) ratings by participants of the extent to which they paid
326 attention to the sensory properties of their food at different points in the study.

327

Eating occasion	Experimental (<i>n</i> = 23)	Control (<i>n</i> = 25)
Lunch	8.09 (1.16)	5.48 (2.18)
Taste test	8.00 (1.31)	6.76 (2.09)
Rest of day	6.00 (2.17)	4.76 (2.11)

328 Ratings were made on a scale of 1-9.

329

330 A 2(condition) x 3(eating occasion) mixed ANOVA showed a main effect of
331 condition; those in the experimental group reported significantly more mindful
332 eating than those in the control group, $F(1, 46) = 15.44, p < .001$. There was also
333 a significant interaction between time and condition, $F(1, 46) = 5.82, p = .02$ with

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334 follow-up t-tests showing that the experimental group ate significantly more
335 mindfully during lunch, $t(46) = 5.01, p < .001$, and during the taste test, $t(46) =$
336 $2.44, p = .02$, but not during the rest of the day, $t(46) = 2.00, p = .051$.

337

338 **3.4. Confirmatory analyses: effects on calories consumed during the taste** 339 **test and throughout the half-day period.**

340

341 Calories consumed at lunch and during the taste test were computed using the
342 weight of food consumed by each participant and the caloric information from
343 the food packaging. Calories consumed during the rest of the day were obtained
344 from the INTAKE24 software that automatically calculates calories from the
345 foods and portion sizes reported by participants. These figures are shown in
346 Table 3.

347

348 **Table 3.** Mean (*SD*) calories of food consumed by participants in the
349 experimental and control conditions during lunch, the taste test and throughout
350 the rest of the day.

351

Eating occasion	Experimental	Control
Lunch	434 (110)	436 (130)
Taste test	166 (105)	144 (96)
Rest of day	839 (496)	759 (403)
Total	1456 (560)	1343 (445)

352 $n = 23$ and 25 in the experimental and control groups respectively for lunch and
353 the taste test, 21 and 23 for rest of day and total.

354

355 Two independent t-tests showed that there were no significant differences in
356 consumption during the taste test, $t(46) = 0.76, p = .45$ or throughout the entire
357 half-day period, $t(42) = 0.75, p = .46$.

358

359 **3.5. Confirmatory analyses: effects on macronutrients consumed** 360 **throughout the half-day period.**

361

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362 Grams of saturated fat, added sugar (i.e. non milk extrinsic sugars) and fibre
363 consumed by each participant at lunch and during the taste test were computed
364 for each participant using the weight of food they consumed and the nutritional
365 information from the food packaging. These figures were then added to the
366 figures provided by INTAKE24 in relation to foods consumed after participants
367 had left the laboratory. These totals for the half-day period are shown in Table 4.
368

369 **Table 4.** Mean (*SD*) grams of macronutrients consumed by participants in the
370 experimental and control conditions throughout the half-day period.

371

Macronutrient	Experimental (<i>n</i> = 21)	Control (<i>n</i> = 23)
Saturated fat	26 (12)	23 (9)
Added sugar	42 (32)	39 (31)
Fibre	12 (4)	12 (5)

372

373 A 2-way MANOVA showed no effect of condition on saturated fat, $F(1, 42) = 1.08$,
374 $p = .31$, added sugar, $F(1, 42) = 0.05$, $p = .82$, or fibre, $F(1, 42) = 0.22$, $p = .64$.

375

376 **3.6. Exploratory analyses: relationship between self-reported mindful** 377 **eating and consumption**

378

379 At lunchtime and during the taste test, those who reported paying more
380 attention to the sensory properties of their food as they ate consumed fewer
381 calories, but these correlations were not statistically significant; $r = -.14$, $p = .33$
382 for lunch, $r = -.17$, $p = .24$ for the taste test. There was no association between
383 self-reported mindful eating and amounts consumed outside the laboratory, $r = -$
384 $.04$, $p = .79$.

385

386 **3.7. Exploratory analyses: effect of condition on the relationship between** 387 **observed and recalled consumption in the laboratory**

388

389 A total of 53 participants reported on the lunch they had consumed in the
390 laboratory in the food recall measure. Of these, 27 (51%) failed to include the

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391 biscuits and cookies consumed in the taste test. These participants did not eat
 392 significantly less compared to those who included them in their recall ($M = 123$
 393 kcal, $SD = 85$ compared to $M = 172$ kcal, $SD = 105$ respectively; $t(51) = 1.87$, $p =$
 394 $.067$) and the amounts they consumed were not negligible (range = 30–278 kcal,
 395 $Mdn = 90$ kcal). Failing to recall the biscuits/cookies also did not seem to be
 396 influenced by condition since there was no significant difference in the
 397 proportions omitting them in the two groups (46% in the experimental group,
 398 56% in the control group; $X^2(1) = 0.48$, $p = 0.49$). To examine differences in
 399 memory for amounts of food consumed, calories consumed were calculated for
 400 each of the four foods according to the weighed measure and according to the
 401 portion sizes participants reported in the recall measure. Comparisons of these
 402 measures again showed no evidence that those in the experimental group had a
 403 better memory for the food they had eaten compared to those in the control
 404 group (Table 5).

405

406 **Table 5.** Mean (SD) differences^a in calories consumed according to observed and
 407 recalled measures, and correlations (r_s) between observed and recalled
 408 measures, in the experimental and control groups, for each of the four foods
 409 consumed in the laboratory.

410

Food	Experimental ^b	Control ^c
Sandwich		
Difference	262 (329)	246 (149)
Correlation	-.07	.10
Grapes		
Difference	-3 (16)	-8 (19)
Correlation	.36	.35
Crisps		
Difference	18 (69)	-6 (61)
Correlation	.55	.68
Biscuits/cookies		
Difference	2 (133)	46 (155)
Correlation	.17	.73

411 ^aA positive score indicates that calories were overestimated according to the
 412 recall measure, a negative score that they were underestimated.

413 ^b $n = 27$ for the sandwich, 28 for the grapes and crisps and 15 for the
 414 biscuits/cookies (one participant was excluded from the sandwich data as they
 415 failed to include a portion size estimate).

416 ^c $n = 25$ for the sandwich, grapes and crisps, 11 for the biscuits/cookies.

417

418 **3.8. Sensitivity analysis**

419 When analyses were repeated excluding the five dieters in the control group, the
420 pattern of effects remained unchanged (control group taste test intake: $M = 153$
421 kcal, $SD = 97$; control group rest of day intake: $M = 765$ kcal, $SD = 393$). When
422 analyses were repeated using the entire sample, the results showed that during
423 the rest of day, the experimental group reported eating significantly more
424 mindfully compared to the control group, $t(57) = 3.11$, $p = .003$ (see section 3.3),
425 and that those who reported paying more attention to the sensory properties of
426 their food during the taste test ate significantly fewer calories, $r = -.27$, $p = .04$
427 (see section 3.6). The pattern of effects for all other analyses remained
428 unchanged.

429

430

4. Discussion

431

432 The results showed no effect of mindful eating at lunch on the amount of high
433 calorie snack food consumed immediately after lunch. These findings contrast
434 with other research that has found that mindfully eating lunch reduces snack
435 intake 2-3 hours later (Higgs & Donohoe, 2011; Robinson, Kersbergen & Higgs,
436 2014; Seguias & Tapper, 2018) and that mindfully eating a smaller quantity of
437 food reduces immediate consumption of a second food (Arch et al. 2016; Alliot
438 et al., 2018; Tapper et al., 2018). However, the results are consistent with other
439 research that has failed to find effects (Arch et al., 2016; Whitelock et al., 2018;
440 2019). It is possible that the studies showing significant effects represent false
441 positives, particularly as these studies tend to have smaller sample sizes, which
442 are more likely to lead to false positives. However, it is also possible that the
443 effect only occurs under certain conditions. If so, it would be important to
444 identify underlying mechanisms of action as this would allow for a better
445 understanding of when mindful eating reduces intake and when it does not.

446

447 In line with previous research (Robinson, Kersbergen & Higgs, 2014; Seguias &
448 Tapper, 2018), the current study found no evidence to support the hypothesis
449 that mindful eating influences intake by improving memory for foods eaten. An

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450 alternative explanation for the significant effects reported in the literature is that
451 paying attention to the sensory properties of food increases the cognitive
452 accessibility of goals that are relevant to that food, such as weight loss or healthy
453 eating related goals, which may in turn reduce consumption of high calorie foods
454 or of the total amount of food eaten. Indeed, there is some evidence to show that
455 mindfulness can increase the cognitive accessibility of weight loss related goals
456 (Tapper & Ahmed, 2018). This may explain the absence of effects in the current
457 study; if participants were not motivated to eat more healthily or lose weight,
458 such goals would not have been activated. This interpretation is supported by
459 the fact that only a relatively small proportion of participants (10%) reported
460 dieting to lose weight and these participants all fell into the control group. Future
461 research may benefit from including measures of restrained eating and
462 motivation to eat healthily to explore this suggestion.

463

464 Another possible explanation is that mindful eating reduces intake only where it
465 slows down the rate of eating. A substantial body of research shows that slowed
466 eating and/or increased oral processing is associated with reduced intake
467 (Hollis, 2018; Krop et al., 2018; Robinson, Almiron-Roig et al., 2014; Miquel-
468 Kergoat, Azais-Braesco, Burton-Freeman & Hetherington, 2015). However, rate
469 of eating may be influenced by a wide range of different variables including
470 individual differences, food and meal properties and motivational factors such as
471 hunger and liking for the food (Almiron-Roig et al., 2015; Bobroff & Kissileff,
472 1986; Hill & McCutcheon, 1984; Llewellyn, van Jaarsveld, Boniface, Carnell &
473 Wardle, 2008; Suh & Jung, 2016; Wilkinson et al., 2016; Zhu, Hsu & Hollis, 2013).
474 Thus there may have been floor effects in the rate at which participants ate the
475 snack foods in the current study if they were not hungry (having just eaten
476 lunch) and were taking part in the research in a relatively relaxed fashion. It is
477 possible that certain groups of participants (such as students who complete
478 multiple studies) try to complete the research in a more efficient manner and
479 therefore tend to eat at a faster rate. As such, future research may benefit from
480 either controlling for, or measuring, hunger and speed of eating in order to
481 explore these possibilities.

482

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483 The results of the current study also failed to find any effects of mindful eating on
484 the quantities or types of foods consumed across the half-day period. However,
485 given that those in the experimental group did not report eating significantly
486 more mindfully outside the laboratory compared to those in the control group, it
487 is difficult to draw any firm conclusions from these data. Instead, the research
488 raises the additional question of how best to motivate individuals to apply the
489 mindful eating strategy in their daily lives. It is possible that certain groups of
490 people (such as those trying to lose weight) would be more intrinsically
491 motivated to eat mindfully if they believed it would benefit them. But it is also
492 possible that sustaining motivation for mindful eating would be easier if
493 individuals were only advised to apply it in certain situations, such as when they
494 were hungry or when eating particular foods. Again, identifying underlying
495 mechanisms could help inform such advice.

496

497 The results from the food recall measure also raise the question of whether this
498 type of measure is sensitive enough to detect any changes in diet associated with
499 mindful eating, since such changes are likely to be relatively small. In particular,
500 more than half of participants failed to record the snack they had eaten in the
501 laboratory, even though the energy content of this snack averaged over 100 kcal,
502 representing around 5% of a woman's average energy requirements.

503 Physiological measures, such as changes in weight, may ultimately be a better
504 test of the effect of mindful eating, though this would require sustained
505 application of the strategy by participants over much longer periods of time.

506

507 Another important limitation of the study was the sample size, which was
508 relatively small and showed an imbalance between conditions in terms of both
509 age and whether participants were dieting to lose weight. It was also smaller
510 than the target sample size of 60. Small sample sizes are more likely to result in
511 false positive or false negative results so future research would benefit from
512 recruiting larger numbers of participants.

513

514 Finally, it is important to distinguish between the effects of paying attention to
515 the sensory properties of food and the effects of eating while distracted, for

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516 example whilst watching television. There is some evidence that the latter
517 increases intake, possibly by disrupting memory for food eaten (Higgs, 2015;
518 Oldham, Hardman, Nicoll, Rogers & Brunstrom, 2011) as well as increasing
519 reliance on behaviour that is more automatic in nature (Neal, Wood, Wu &
520 Kurlander, 2011). As such, mindful eating may help reduce consumption where it
521 prompts people to reduce the extent to which they eat whilst engaged in other
522 activities. This is slightly different from the focus of the current study which
523 examined whether actively attending to the sensory properties of food has any
524 benefits. An interesting question for future research may be to look at whether
525 people could be encouraged to pay more attention to the sensory properties of
526 their food even when engaged in other activities, such as working or watching
527 television, and whether this might help reduce the extent to which distraction
528 increases food intake.

529

530

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536

537

Author contributions

538

539 The study was conceived and designed by both authors. LS carried out the data
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542

543

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