



University of
Salford
MANCHESTER

Larger portions make me eat more : awareness of the external factors that influence food intake

Keenan, GS, Sheen, F, Haynes, A and Hardman, C

10.31234/osf.io/8befm

Title	Larger portions make me eat more : awareness of the external factors that influence food intake
Authors	Keenan, GS, Sheen, F, Haynes, A and Hardman, C
Type	Article
URL	This version is available at: http://usir.salford.ac.uk/id/eprint/58229/
Published Date	2020

USIR is a digital collection of the research output of the University of Salford. Where copyright permits, full text material held in the repository is made freely available online and can be read, downloaded and copied for non-commercial private study or research purposes. Please check the manuscript for any further copyright restrictions.

For more information, including our policy and submission procedure, please contact the Repository Team at: usir@salford.ac.uk.

1 Larger portions make me eat more: Awareness of the external factors
2 that influence food intake

3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Gregory S. Keenan^{1,2}, Florence Sheen², Ashleigh Haynes^{2,3}, & Charlotte A, Hardman²

¹ School of Psychology, School of Health & Society, University of Salford, UK

² Department of Psychology, University of Liverpool, Liverpool, UK

³ Centre for Behavioural Research in Cancer, Cancer Council Victoria, Melbourne, Australia

Corresponding Author:

Gregory Keenan, School of Psychology, School of Health & Society, University of Salford,
UK,
g.s.keenan@salford.ac.uk

21 **Running head:** Awareness of external factors that influence food intake

22

23

ABSTRACT

24 There is consistent evidence that the amount of food people consume can be influenced by
25 external factors, such as food portion size or the amount of food others are eating. However
26 research studies to date have suggested that people are generally unaware of the influence
27 that these external factors have on food intake. In the present research we directly tested
28 whether consumers are aware of how external factors can affect their food intake. In Study 1
29 we re-analysed data from a study in which an effect of portion size on food intake was
30 observed and post-consumption, participants were asked whether they believed portion size
31 had influenced their food intake. In Study 2 participants were asked to indicate whether
32 several different external factors known to increase food intake would be likely to increase,
33 decrease or have no effect on how much they would eat in hypothetical scenarios. In Study 1,
34 a large proportion of participants (56%) believed that their food intake was influenced by
35 portion size. In Study 2, a large proportion of participants accurately identified that external
36 factors known to affect eating behaviour would be likely to increase their food intake:
37 portion size (73%), social influence (40%), food variety (75%), and distraction (59%).
38 Together these results suggest that consumers show awareness of the influence that external
39 factors have on their food intake.

40

41

42

43

44

45

INTRODUCTION

46

47 The amount eaten during a meal is influenced by several factors. For example, pre-meal
48 hunger predicts ad-libitum meal intake (Bellisle, Lucas, Amrani, & Lemagnen, 1984; Sadoul,
49 Schuring, Mela, & Peters, 2014). Factors in the ‘external’ environment can also influence
50 eating behaviour. There is consistent evidence that consumers eat more when meals contain
51 a variety of different flavours (Raynor & Epstein, 2001; Remick, Polivy, & Pliner, 2009),
52 when they are distracted during eating (Bellisle, Dalix, & Slama, 2004; Temple, Giacomelli,
53 Kent, Roemmich, & Epstein, 2007), if they eat in the presence of someone who eats a large
54 amount of food (Vartanian, Spanos, Herman, & Polivy, 2015) and when served larger portion
55 sizes (French et al., 2014; Hollands et al., 2015; Zlatevska, Dubelaar, & Holden, 2014).

56 There is some evidence to suggest that people may be largely unaware of the
57 influence that external factors have on their food intake (Spanos, Vartanian, Herman, &
58 Polivy, 2014; Vartanian, Herman, & Wansink, 2008; Vartanian, Sokol, Herman, & Polivy,
59 2013). First, participants in laboratory studies appear relatively insensitive to the effects of
60 eating different sized portions (e.g., Levitsky & Youn, 2004; Rolls et al., 2002) and may
61 therefore not identify that they have over or undereaten due to external factors. In addition,
62 when asked why they have eaten the amount of food consumed, participants in these
63 laboratory studies often cite internal cues as the drivers for their food intake (e.g. hunger,
64 satiety, taste) rather than external factors, such as the portion size (Cavanagh, Vartanian,
65 Herman, & Polivy, 2014; Vartanian, Herman, & Wansink, 2008; Vartanian, Sokol, Herman,
66 & Polivy, 2013; Vartanian, Spanos, Herman & Polivy, 2017). Using a different study design,
67 Myers, Brunstrom, Rogers & Holtzman (2019) also found that members of the Samburu
68 tribe in Kenya who ate two separate sized portions of food on alternate days, had difficulties
69 identifying on which day they had consumed the larger of the two portions.

70 However, several other studies suggest that consumers do show some awareness of
71 external influences on food intake. Keenan, Childs, Hetherington, Rogers, & Brunstrom
72 (2018) used a computerised version of ‘a method of constant stimuli’ to estimate how much
73 participants intended to consume of three separate foods. After being served either a large or
74 small portion of one of these foods and eating until comfortably full, participants were asked
75 to indicate if they believed that had eaten less or more than the amount they had earlier
76 identified as their intended intake amount. Most participants could accurately identify if they
77 had eaten less or more than their intended intake amount, indicating some level of awareness.
78 Similarly, Robinson and Field (2015) analysed data from a study examining the influence that
79 social norms have on food intake (Robinson, Sharps, Price, & Dallas, 2014). After eating,
80 participants were asked whether they believed the amount they had consumed was socially
81 influenced. In total, 34% of participants believed they had been influenced. Critically, these
82 participants appeared to be correct: the amount of food consumed by participants who
83 reported social influence, was affected by the amount eaten by other people. In contrast, for
84 those reporting no social influence, there was no evidence that their food intake had been
85 influenced by the amount others had eaten. Together, these findings indicate that participants
86 in laboratory studies are to some extent aware of how much they consume when influenced
87 by external factors.

88 A potential explanation for these contradictory results could lie in the different types
89 of questions used to address awareness of external influences on food intake. Several of the
90 studies showing that people unknowingly over-consume have asked participants how the
91 amount they ate compared to their typical portion, as opposed to directly asking about
92 awareness of having been influenced by an external factor. Several other studies have asked
93 participants post-meal to select the reason for the amount of food they consumed from a list
94 including internal cues (e.g. hunger) and external cues (e.g. portion size, social factors)

95 (Vartanian, Herman, & Wansink, 2008; Vartanian Sokol, Herman, & Polivy, 2013;
96 Vartanian, Spanos, Herman & Polivy, 2017; Vartanian, Reily, Spanos, Herman, & Polivy;
97 2017). In general, factors such as taste or liking are selected as the most important influences
98 on meal intake, whilst external factors like how much others ate, are rarely selected, when
99 this method is adopted. In contrast, in Keenan, Childs, Hetherington, Rogers, & Brunstrom
100 (2018) participants were directly asked if they were aware of having eaten more or less than
101 their initial plan. Similarly, in Robinson & Field (2015) participants were directly asked
102 whether the amount they ate was influenced by the information they saw about the number of
103 cookies other participants had eaten and a sizeable proportion of participants reported having
104 been influenced by the number of cookies other participants had eaten. However, it should be
105 noted that participants in Myers, Brunstrom, Rogers & Holtzman (2019) were asked a
106 similar direct question about which day they believed they had consumed the larger portion
107 but still struggled to answer correctly, raising uncertainty about whether it is the nature of the
108 question asked

109 A further factor that may play a role in whether or not consumers report that their
110 food intake has been influenced by external factors is social desirability. Vartanian, Reily,
111 Spanos, McGuirk, Herman and Polivy (2017) concluded that consumers may acknowledge
112 the influence of external cues on food intake under specific conditions. Namely, that
113 consumers will report external influence for self-serving purposes; e.g. to justify over-eating.
114 Moreover, Vartanian and colleagues report empirical data that supports this proposition; in
115 one study participants who believed they had overeaten were more likely to acknowledge the
116 influence of portion size than participants who believed they had not overeaten (Vartanian,
117 Reily, Spanos, Herman & Polivy, 2017). Thus, although it is clear from these studies that
118 consumers will sometimes report external influence on their food intake, whether or not

144 strategy made use of data from the large portion condition only¹ of Robinson, te Raa &
145 Hardman (2015). We hypothesised that if consumers are aware of external influences on their
146 food intake, a sizeable proportion should report that they were influenced by portion size. We
147 also examined whether reports of being influenced by portion size were associated with the
148 amount of food participants consumed. We hypothesised that if participant reports of being
149 influenced were accurate, awareness should be most common among participants who ate
150 large quantities when served a large portion of food.

151

152

Method

Original Study

154 For a detailed description of the method and results of the original study, see Robinson, te
155 Raa, & Hardman (2015). In the original study 88 participants (44 male and 44 female) were
156 recruited from the University of Liverpool and surrounding area in exchange for a small
157 monetary reward. The main aim of the study was to examine whether pre-meal intentions
158 (how much of a meal a person intends to eat) relate to actual meal intake. The study
159 advertisement described the study as being about cognitive ability and mood in order to
160 distract participants from the true aims of the study. Participants were informed that a lunch-
161 time meal would be provided and they must have no history of any food allergies. The study
162 was approved by the University's ethics board.

163

Procedure

165 Participants arrived for a lunchtime laboratory session and were seated in a cubicle alone. To
166 corroborate the cover story of cognitive ability and mood participants first completed mood
167 ratings, followed by a word search task that lasted 5 minutes. After this participants were
168 served a standard sized sandwich and asked to indicate how much (as a percentage) of the

169 sandwich they intended to eat. After consuming the sandwich, participants were served either
170 a smaller (approximately 75 grams, 62 kcals) or a larger portion of vanilla ice cream
171 (approximately 175 grams, 145 kcals) in a bowl. Participants rated how much of the ice
172 cream they intended to eat and were then told that they could eat as much or as little as they
173 wanted. The bowl was weighed and re-weighed after consumption in order to calculate the
174 amount eaten. After this, participants were provided with a final questionnaire which
175 included questions about their experience during the study, including ‘would you say that the
176 amount of food you ate was influenced by the portion size of the food you were given?’ with
177 five response options: ‘strongly disagree’, ‘disagree’, ‘unsure’, ‘agree’, ‘strongly agree’.
178 Next, participants were asked to write down why they were (or were not) influenced.
179 Participants then had their height and weight measured before being debriefed, reimbursed
180 and thanked for their time.

181

182 *Planned analysis (a-priori)*

183 In order to characterise the numbers of participants reporting vs. not reporting being
184 influenced by portion size, participants were first categorised as reporting they were
185 influenced by portion size if they selected ‘strongly agree’ or ‘agree’ in response to the
186 question asking them whether their food intake was influenced by portion size. Conversely,
187 participants selecting ‘strongly disagree’ or ‘disagree’ were categorised as believing they had
188 not been influenced. Participants who selected ‘unsure’ were categorised as being unsure.
189 We planned to use a chi-square to examine whether the number of participants in each
190 response category differed to chance expectation.

191 To examine whether participants reported being influenced by portion did eat more
192 from a large portion size we planned linear regression analysis. Reporting of the influence of
193 portion size on food intake was the dependent variable (continuous data). Ice cream intake (in

194 grams) was entered as a predictor variable and gender was also included as a predictor
195 variable in the model because males consumed more than females in the original study.

196 Finally, for those participants that did report having been influenced, we examined the
197 reasons why they believed they had been influenced. Two independent coders read
198 participants' responses and identified any common explanations for the influence of portion
199 size. Next, they independently coded each response to calculate the number of participants
200 endorsing any of the commonly endorsed explanations. If there were any inconsistencies in
201 coding, the two coders reached agreement on discussion.

202

203

Results

Participant Characteristics

204 The study sample size was determined by the number of participants that participated in the
205 original experiment. Three of the 44 participants who were served the large portion of ice
206 cream did not answer the question about the influence of portion size, resulting in a final
207 sample of 41 participants (21 males, 20 females). The sample had a mean age of 33.2 years
208 (SD = 12.2), and mean BMI of 25.6 kg/m² (SD = 4.3).

210

Reports of being influenced by portion size

211 Of the 41 participants, 56.1% (23/41) believed they had been influenced, 14.6% (6/41) were
212 unsure, and 29.2% (12/41) did not believe they had been influenced by portion size. A chi-
213 square test was significant ($\chi^2(2) = 10.88, p = .004$) indicating that the proportion of
214 participants reporting influence, no influence or uncertainty about having been influenced
215 significantly differed to chance expectation.

217

Relationship between food intake and reporting of having been influenced by portion size

219 Of the 175 grams of ice cream served, mean ice cream consumption was 102.7 grams (SD =
220 51.3). The overall regression model was significant (Adjusted $R^2 = .12$, $p = .037$). As
221 predicted, participants who reported being aware that the size of the portion had influenced
222 their intake, tended to eat more than those who reported no influence (standardised $B = .43$, p
223 = .035). Gender did not significantly predict reports of having been influenced by portion size
224 (standardised $B = .05$, $p = .81$). The unadjusted association between reports of being
225 influenced by portion size and ice cream intake was $r = .40$, $p = .010$.

226

227 *Explanations for why participants were influenced by portion size*

228 One common theme was identified in participants' responses for why they were influenced
229 by portion size; multiple participants reported that they were used to 'plate clearing' or trying
230 to 'eat everything' served. When coding the presence of this explanation in each participant's
231 response, the two independent coders had good inter-rater reliability (96.2% agreement) and
232 agreed on the inconsistencies through discussion. In total, 34.8% (8/23) of participants
233 endorsed this explanation for why their food intake had been influenced by portion size.

234

235

Discussion

236 In Study 1 we found that after being served a large portion of ice cream, a sizeable proportion
237 of participants (56%) reported that they believed the amount they ate had been influenced by
238 portion size. Moreover, participants who ate the most ice cream from the large portion were
239 more likely to report having been influenced. In addition, when asked to explain why they
240 thought their food intake had been influenced by portion size, a number of participants
241 reported that this was because they wanted to try and clear their plate when eating. Thus,
242 Study 1 provides evidence that consumers may be aware of how an external factor like
243 portion size can increase their food intake. However, in this study participants reported on

244 having been influenced shortly after eating. It is plausible that participants' reports may have
245 been in part caused by motivated reasoning, as opposed to 'genuine' awareness. For example,
246 some participants may have believed they had overeaten, and could have attributed their
247 intake to the portion size they were provided with to alleviate feelings of guilt (Vartanian,
248 Reily, Spanos, Herman, & Polivy, 2017). A second potential issue with the method adopted
249 in the present study is that participants were asked prior to eating how much they intended to
250 eat and this may have influenced subsequent post-consumption responses about having been
251 influenced by portion size. We addressed these concerns in Study 2 by examining
252 participants' awareness of external influences on food intake when asked about how much
253 they thought they would be likely to eat in future hypothetical eating scenarios. In Study 2, as
254 well as examining awareness of the influence of portion size, we also examined awareness of
255 a range of other external influences on food intake.

256

257 **STUDY 2**

258 **Overview**

259 In a recent study Vartanian, Reily, Spanos, McGuirk, Herman, & Polivy (2017) asked
260 participants to predict how much they and others would consume when eating in the presence
261 of someone else or when served a larger portion. They were asked to imagine how these
262 external cues might influence intake on their own, or in conjunction with internal cues (e.g.
263 hunger, taste). Participant predictions were influenced by both internal (e.g., taste, hunger)
264 and external factors (portion size / social influence). In the present study we asked
265 participants directly about the potential influence of external factors on food intake and
266 extended these findings by surveying participants on a wider number of external factors that
267 have been empirically shown to increase food intake; portion size (Rolls, Roe, Kral, Meengs,
268 & Wall, 2004) social influence (Robinson, Tobias, Shaw, Freeman, & Higgs, 2011) food

269 variety (Rolls, Vanduijvenvoorde, & Rolls, 1984) and distraction whilst eating (Robinson et
270 al., 2013).

271 Participants were asked whether they believed that the presence of that factor would
272 affect their food intake, in what way the external factor would affect their food intake and
273 why. In addition, to gauge whether participants were confident in their responses, we asked
274 participants to report how certain they felt about each response. We also included a ‘dummy’
275 external factor that would be unlikely to have any meaningful effect on food intake (being sat
276 at a square vs. round table), as this would allow us to further examine whether participants
277 awareness is accurate; i.e. if participants are genuinely aware when reporting on the influence
278 of external factors that influence their food intake, we hypothesised that very few participants
279 should report that the ‘dummy’ external factor would affect their food intake.

280 In addition, we examined individual differences. Previous research has shown that
281 individuals are more likely to acknowledge social influences on their own intake if they
282 report being responsive to social cues (Spanos Vartanian, Herman, & Polivy, 2014). Here, we
283 reasoned that if reports of awareness of external influence on food intake are accurate, then
284 consumers who are influenced by external factors when normally eating should be most
285 likely to identify that their food intake would be influenced in the eating scenarios. Thus, we
286 also included self-report trait measures of external eating in Study 2. However, we were
287 aware of a number of recent studies questioning the validity of self-report trait measures of
288 eating behaviour and whether they accurately characterise what people actually do, as
289 opposed to their beliefs about how they behave (Adriaanse, Prinsen, de Witt Huberts, de
290 Ridder, & Evers, 2016; Evers, de Ridder, & Adriaanse, 2009). Thus, we tentatively predicted
291 that higher scores on trait measures of external eating behaviour would be associated with
292 participants being more likely to report external influences on food intake.

293

294

295

Method

296 *Participants*

297 Participants were recruited from the student and staff population of the University of
298 Liverpool. Participation was incentivized by entering participants into a small cash prize
299 draw. The study was advertised as being about opinions towards eating behaviours and
300 specified that participants were required to be 18 or older and not currently taking any
301 medication which may influence their appetite. To ensure more than adequate statistical
302 power in all our planned analyses ($f = 0.25$, $p < .05$, 80% power) we aimed to recruit a
303 minimum of 100 participants during a data collection period of 8 weeks. One hundred and
304 fifty eight participants started the survey, but 20 participants did not complete the survey. The
305 final sample consisted of 138 participants; 103 were female and 35 male, with a mean age of
306 37.4 (SD = 12.6) and a mean BMI of 24.95 (SD = 4.44) kg/m². The study was approved by
307 the University of Liverpool's Institute of Psychology, Health and Society research ethics
308 board.

309

310 *Questionnaire*

311 After providing electronic informed consent, participants were shown (in a random order)
312 five dining scenarios on separate pages of the online survey. For each scenario (see section
313 '*Eating scenarios*'), participants read a brief summary of the scenario, and were then
314 presented (in fixed order) with four response options on the same page: the external factor
315 would make them consume more, the external factor would make them consume less, the
316 external factor would have no influence on amount consumed, and unsure. Participants were
317 then asked how certain they were about their response about whether they would be
318 influenced, on a 5-point scale ranging from 'very uncertain' to 'very certain'. Next,

319 participants were asked to explain why they believed they would (would not) be influenced
320 by the external factor. After this, participants were asked to provide demographics, including
321 self-reported weight and height (to calculate BMI). To measure self-reported trait
322 responsiveness to external vs. internal cues when eating, participants then completed the
323 ‘external eating’ scale of the Dutch Eating Behaviour Questionnaire (van Strien, Frijters,
324 Bergers, & Defares, 1986), the ‘uncontrolled eating’ subscale from the revised three Factor
325 Eating Questionnaire (Karlsson, Sjöström, & Sullivan, 2000) and the ‘reliance on internal
326 hunger/satiety’ questions from the Intuitive Eating Scale (Tylka, 2006). Finally, debriefing
327 information was provided and participants were thanked for their time.

328

329 *Eating scenarios*

330 For the portion size scenario participants were asked: ‘Imagine you are dining out at a
331 restaurant. You order a meal and when the waiter brings over your order, the portion size of
332 the meal is very large. Do you think that being served a very large portion would affect how
333 much you eat?’, response options: ‘Yes, I would eat more if served a larger portion, as
334 opposed to a smaller portion’, ‘Yes, I would eat less if served a larger portion, as opposed to
335 a smaller portion’, ‘No, being served a larger portion would have no effect on how much I
336 eat’, ‘I am unsure whether a large portion would have any effect on how much I eat’. For the
337 social influence scenario participants were asked ‘Imagine you are eating with a friend and
338 they select and consume a very large amount of food. Do you think a friend eating a large
339 amount would affect how much you eat?’ For the variety scenario participants were asked
340 ‘Imagine that you are at a friend’s house for a buffet. If there was a wide variety of different
341 food items on option at the buffet, do you think this would affect how much you would eat?’
342 For the distraction scenario participants were asked ‘Do you think you would eat more if you
343 were snacking whilst watching TV, compared to snacking with no distraction?’ Finally, for

344 the table shape ‘dummy’ scenario, participants were asked ‘Imagine you are eating at a
345 restaurant and you are seated at a square table rather than a round table; do you think this
346 would influence how much you eat?’ For the wording of the individual response options for
347 each of the scenarios see *supplementary material*.

348

349 *Planned analysis (a-priori)*

350 For participants’ reports of external influence in each eating scenario, we planned to use a
351 chi-square test to determine whether the number of participants in each response category
352 (‘not influenced’, ‘influenced to eat more’, ‘influenced to eat less’, ‘unsure’) differed to
353 chance expectation. To determine whether participants were certain or uncertain about how
354 their food intake would (not) be influenced, we conducted a one sample t-test comparing the
355 certainty ratings for each scenario with a test value of 3 (equal to the midpoint of the scale).
356 To examine whether the individual difference measures were associated with accurate
357 reporting of external influence, we correlated (Pearson’s r) trait external eating with the total
358 number of times a participant reported that their food intake would be increased by either
359 portion size, social influence, food variety and/or distraction whilst eating (resulting in a 5
360 point scale from 0-4). Finally, two independent coders read participants’ responses and
361 identified any common explanations for each of the external factors. If any common
362 explanations were identified, the two coders independently coded each response for the
363 presence of the identified theme.

364

365 **Results**

366 *Reporting of influence of external factors*

367 We found consistent evidence that participants believed their intake would be influenced by
368 external factors, and that larger portion sizes (73% of participants), social influence (40%),

369 food variety (75%) and distraction (59%) would cause them to increase their food intake. On
 370 average, participants reported that 2.5 of the four external factors (SD = 1.1) would increase
 371 their food intake and 97.1% (134/138) of participants reported that their food intake would be
 372 increased by one or more of the four external factors. Conversely, when asked about a
 373 ‘dummy’ external factor that should not affect food intake (table shape), very few participants
 374 (5%) believed this would affect their food intake. Participants who did not report that an
 375 external factor would increase their food intake, tended to report that they would be
 376 unaffected or were unsure, rather than reporting that the external factor would decrease their
 377 intake. See Table 1.

378

379 *Certainty*

380 Participants’ ratings of their certainty in their report of each external factor’s influence were
 381 significantly greater than the midpoint of the scale indicating that participants tended to be
 382 certain about their responses. See Table 2.

383

384 **Table 1:** Frequencies of participants reporting influence of external factors on food intake

	<i>Beliefs about external influence on food intake</i>				<i>Chi-square test results</i>
	<i>Would not affect</i>	<i>Uncertain</i>	<i>Would decrease</i>	<i>Would increase</i>	
Portion size	25 (18.1%)	5 (3.6%)	7 (5.1%)	101 (73.2%)	$\chi^2 (3) = 177.94, p < .001$
Social influence	60 (43.5%)	17 (12.3%)	6 (4.3%)	55 (39.9%)	$\chi^2 (3) = 63.45, p < .001$
Food variety	20 (14.5%)	6 (4.3%)	8 (5.8%)	104 (75.4%)	$\chi^2 (3) = 190.00, p < .001$
Distraction	35 (25.4%)	17 (12.3%)	5 (3.6%)	81 (58.7%)	$\chi^2 (3) = 96.78, p < .001$
Table shape	86 (62.3%)	45 (32.6%)	4 (2.9%)	3 (2.2%)	$\chi^2 (3) = 135.80, p < .001$

385 Values denote number of participants (percentages in parentheses)

386

387

388 **Table 2:** Participants' certainty of the influence of external factors on their food intake

	<i>N</i>	<i>Certainty</i> ^a	<i>One sample t-test results</i>
Portion size	138	4.09 (.74)	$t(137) = 17.26, p < .001$
Social influence	138	3.69 (.90)	$t(137) = 9.00, p < .001$
Food variety	138	3.96 (.84)	$t(137) = 13.47, p < .001$
Distraction	138	3.93 (.73)	$t(137) = 14.90, p < .001$

389 ^a denotes mean score on 1 (very uncertain) to 5 (very certain) response scale. SDs in brackets

390

391 *Trait external eating*

392 The three trait measures of external eating (the external eating subscale from the Dutch
 393 Eating Behaviour Questionnaire; the uncontrolled eating subscale from the Three Factor
 394 Eating Questionnaire; the reliance on internal hunger/satiety questions from the Intuitive
 395 Eating Scale) were correlated and principal component analysis indicated that they loaded
 396 onto a single factor. Thus, we z-scored each of the three scale scores and summed these to
 397 produce a single composite measure of external eating, whereby a high score denoted higher
 398 trait external (as opposed to internal) eating. The number of scenarios in which participants
 399 believed their food intake would be increased by an external factor was significantly
 400 correlated with trait external eating ($r = .48, p < .001$). This relationship remained significant
 401 when accounting for participant BMI and gender in follow up linear regression models ($p <$
 402 $.05$).

403

404 *Explanations for why external factors would influence food intake*

405 Initial agreement between two coders was high for each of the scenarios (> 90%). The most
 406 common theme for why participants believed they would eat more when served larger portion
 407 sizes was the desire to plate clear 39% (39/101), e.g. 'I would want to clear my plate'. The
 408 most common theme for why an eating partner consuming a large amount of food would
 409 increase food intake was because of social norms; 44% (24/55), e.g. 'makes it seem more

410 acceptable to eat more if everyone else is'. For the variety scenario participants tended to
411 report that variety would increase their food intake because of enjoyment of trying different
412 food items; 65% (68/104), e.g. 'I like to taste lots of different things'. Finally, the most
413 common theme for why participants believed they would eat more when watching television
414 was because they believed they would be distracted and lose track of how much they had
415 eaten; 49% (40/81), e.g. 'not really thinking about how much I have eaten as distracted'.

416

417

GENERAL DISCUSSION

418 In two studies we examined whether consumers are aware of the external factors that
419 influence their food intake. In Study 1 we re-analysed data from a previous study (Robinson,
420 te Raa, & Hardman, 2015) in which participants served a large portion consumed
421 significantly more food than those served a standard portion and participants were also asked
422 to report whether they believed portion size had influenced their intake. A sizeable number of
423 participants served the large portion of ice cream (59%) believed that their food intake had
424 been influenced by portion size, whereas a minority of participants did not believe they had
425 been influenced. Participants who ate the most from the large portion of food were most
426 likely to report that they had been influenced. A limitation of Study 1 was that awareness of
427 the influence of portion size was measured retrospectively. We addressed this limitation in
428 Study 2 by asking participants to indicate whether external factors that have been shown
429 empirically to increase food intake (e.g. portion size, social influence, food variety,
430 distraction) would be likely to affect how much they would eat in hypothetical eating
431 scenarios. Large numbers of participants reported that they would be influenced by external
432 factors known to affect food intake and participants tended to correctly believe that these
433 external factors would increase their food intake.

434 In Study 2 we also examined whether trait self-report measures of external eating
435 were associated with the degree to which participants reported awareness that their food
436 intake would be influenced by external factors. We found that participants who scored highly
437 on trait 'external' eating behaviour measures were more likely to identify that portion size,
438 social influence, food variety and distraction would affect their food intake. This finding
439 could be interpreted as evidence that consumers show genuine awareness of when external
440 factors will increase their food intake, because we would expect that awareness should be
441 most common among those that are regularly externally influenced when eating. However, it
442 has been argued that self-report trait eating behaviour questionnaires measure beliefs about
443 behaviour, rather than how people actually behave (Evers et al., 2009; Evers et al., 2011).
444 Thus, the correlation we observed may in part be caused by the trait measures of external
445 eating and the hypothetical external eating scenarios used in Study 2 both measuring the same
446 underlying construct or 'belief'. Thus, this correlational finding should be interpreted
447 cautiously.

448

449 *Previous Research*

450 Previous research has suggested that consumers are unaware of the external or environmental
451 factors that influence their food intake (e.g., Vartanian, Herman & Wansink, 2008; Vartanian,
452 Sokol, Herman, & Polivy, 2013). Here we found that a sizeable proportion of participants
453 reported being aware of the influence of external factors on their food intake. One possible
454 explanation for this difference could be the methods used to assess awareness of external
455 influences. In the present study and in Keenan, Childs, Hetherington, Rogers & Brunstrom
456 (2018) and Robinson and Field (2015), participants were asked directly about the influence of
457 a specific external factor. Other studies have often involved asking participants how their
458 intake compared to their typical intake (e.g. Vartanian, Herman & Wansink, 2008). As

459 identified by Vartanian, Reily, Spanos, Herman and Polivy (2017) responses to this measure
460 might be influenced by social desirability, with participants acknowledging the influence of
461 external cues when they are motivated to do so; for example, as a way of justifying
462 overconsumption. Asking a direct question might reduce the presence of this form of bias.
463 Another factor that might explain why past studies have found participants to be unaware of
464 the influence of external factors on their intake is that many have focused on social influence
465 (Vartanian Herman & Wansink, 2008; Vartanian, Sokol, Herman, & Polivy., 2013; Spanos,
466 Vartanian, Herman, & Polivy., 2014; 2015). In Study 2 we found that although participants
467 tended to report awareness of external influences on food intake, this was less pronounced
468 when reporting on social influence. For example, 73% of participants reported that they
469 would be influenced by portion size when eating, whereas this number was 40% for social
470 influence. One explanation of this finding is that people feel embarrassed to report that they
471 would conform to the actions of others, so may wish to deny social influence. This
472 explanation is consistent with the findings of Spanos et al (2015): participants thought it was
473 more socially acceptable to eat more in response to larger portions than because of social
474 influence. However, it is also plausible that the extent to which participants report they would
475 be and/or were influenced by different external factors may reflect how powerful these
476 different external factors are in shaping food intake. For example, there may be a subset of
477 people whose food intake is not strongly socially influenced and this results in fewer people
478 identifying that social influence affects their food intake (Robinson & Field, 2015). Indeed,
479 there is evidence that personality traits relating to social approval predict whether a person is
480 likely to be susceptible to social influence on eating and drinking behaviour (Caudill & Kong,
481 2001; Litt, Stock, & Lewis, 2012; Robinson et al., 2011). Further work to understand the
482 factors that determine whether consumers accurately report on the external factors that
483 influence their food intake would be informative.

484

485 *Implications*

486 The results of the present studies indicate that consumers are likely to be aware of the types
487 of external factors that cause them to eat more, so this casts doubt on whether intervention
488 approaches that aim to educate consumers about external influences on food intake will
489 reduce over-eating. This observation is in line with studies showing that educating consumers
490 about the influence of external factors on eating behaviour (such as social influence and
491 portion size) does not reduce the effect that these factors subsequently have on food intake
492 (Bevelander, Engels, Anschutz, & Wansink, 2013; Cavanagh, Vartanian, Herman, & Polivy,
493 2014). If consumers are aware that external factors like large food portion sizes increase their
494 food intake but still eat more in response to these external cues, the most powerful approach
495 to reducing over-eating is likely to be one that targets the external factor directly. For
496 example, rather than reminding consumers about the influence that large portion sizes of
497 commercially available food products can have on food intake, we suggest that the most
498 effective intervention approach will be to reduce the size of commercially available food
499 portion sizes.

500

501 *Strengths and Limitations*

502 A strength of the present research was that we addressed our research question using two
503 methodological approaches (laboratory and survey data) and findings were consistent across
504 both studies. Although other research has examined awareness after a meal (Robinson &
505 Field, 2015; Keenan et al., 2018), we did not measure awareness during a meal. It could be
506 argued that measurement of awareness during a meal would provide even stronger evidence
507 for or against consumer awareness of the external factors that influence food intake.
508 However, taking such measurements during a meal may affect intra-meal eating behaviour

509 and also make it difficult to determine whether it is the external factor being manipulated or
510 mere measurement of awareness. In the present study we predominantly asked about external
511 factors likely to increase food intake and it would therefore be valuable to examine whether a
512 similar pattern of results is observed for factors likely to decrease food intake. It is also
513 possible that media coverage could have influenced how individuals responded to the
514 hypothetical scenarios used in the present study. If any participants were conscientious
515 readers of health news, they may have been exposed to stories highlighting how external
516 factors influence intake. Likewise, socially desirable responding or ‘demand characteristics’
517 are potential issues with survey research and although our results suggest that people report
518 that they believe their food intake would be influenced by external factors in the present
519 study we did not validate these reports. However, nearly all participants reported that they
520 would not be influenced by an external factor that we know would be very unlikely to affect
521 food intake and this indicates validity of participant reports from this study. Likewise, when
522 asked why they would be influenced by specific external factors, participants often provided
523 reasons that are consistent with the mechanisms of action thought to explain why these
524 factors are likely to affect food intake (e.g. TV viewing causing overeating via distraction),
525 which suggests participants reports may reflect accurate awareness.

526

527 *Conclusions*

528 Across two studies, we find evidence that consumers show awareness of the influence that
529 external factors have on their food intake.

530

531

NOTES

532 ¹ In this paper we focused on the relationship between food intake and awareness of the
533 influence of portion size for participants in the large portion size condition from Robinson, te

534 Raa & Hardman (2015) due to practical considerations concerning statistical power. For a
535 detailed justification and descriptive statistics of data from the standard portion size
536 condition, please see *Online Supplementary Materials*.

537

538

539

REFERENCES

540 Adriaanse, M. A., Prinsen, S., de Witt Huberts, J. C., de Ridder, D. T., & Evers, C. (2016). 'I
541 ate too much so I must have been sad': Emotions as a confabulated reason for
542 overeating. *Appetite*, *103*, 318-323. doi:10.1016/j.appet.2016.04.028

543 Bellisle, F., Dalix, A. M., & Slama, G. (2004). Non food-related environmental stimuli
544 induce increased meal intake in healthy women: comparison of television viewing
545 versus listening to a recorded story in laboratory settings. *Appetite*, *43*(2), 175-180.
546 doi:10.1016/j.appet.2004.04.004

547 Bellisle, F., Lucas, F., Amrani, R., & Lemagnen, J. (1984). Deprivation, Palatability and the
548 Micro-Structure of Meals in Human-Subjects. *Appetite*, *5*(2), 85-94.

549 Bevelander, K. E., Engels, R. C. M. E., Anschütz, D. J., & Wansink, B. (2013). The effect of
550 an intervention on schoolchildren's susceptibility to a peer's candy intake. *European*
551 *Journal of Clinical Nutrition*, *67*(8), 829-835. doi:10.1038/ejcn.2013.122

552 Caudill, B. D., & Kong, F. H. (2001). Social approval and facilitation in predicting modeling
553 effects in alcohol consumption. *Journal of Substance Abuse*, *13*(4), 425-441.

554 Cavanagh, K., Vartanian, L. R., Herman, C. P., & Polivy, J. (2014). The effect of portion size
555 on food intake is robust to brief education and mindfulness exercises. *Journal of*
556 *Health Psychology*, *19*(6), 730-739. doi:10.1177/1359105313478645

557 Evers, C., de Ridder, D. T., & Adriaanse, M. A. (2009). Assessing yourself as an emotional
558 eater: mission impossible? *Health Psychology, 28*(6), 717-725. doi:10.1037/a0016700

559 Evers, C., Stok, F. M., Danner, U. N., Salmon, S. J., de Ridder, D. T., & Adriaanse, M. A.
560 (2011). The shaping role of hunger on self-reported external eating status. *Appetite,*
561 *57*(2), 318-320.

562 French, S. A., Mitchell, N. R., Wolfson, J., Harnack, L. J., Jeffery, R. W., Gerlach, A. F.,
563 Blundell, J. E., & Pentel, P. R. (2014). Portion size effects on weight gain in a free
564 living setting. *Obesity, 22*(6), 1400-1405. doi:10.1002/oby.20720

565 Hollands, G. J., Shemilt, I., Marteau, T. M., Jebb, S. A., Lewis, H. B., Wei, Y., Higgins, J., &
566 Ogilvie, D. (2015). Portion, package or tableware size for changing selection and
567 consumption of food, alcohol and tobacco. *Cochrane Database Systematic Reviews,*
568 *(9)*, CD011045. doi:10.1002/14651858.CD011045.pub2

569 Karlsson, J., Persson, L. O., Sjöström, L., & Sullivan, M. (2000). Psychometric properties
570 and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men
571 and women. Results from the Swedish Obese Subjects (SOS) study. *International*
572 *Journal of Obesity and Related Metabolic Disorders, 24*, 1715–1725.

573 Keenan G. S., Childs L., Rogers, P. J., Hetherington, M. M., & Brunstrom, J. M. (2018). The
574 portion size effect: Women demonstrate an awareness of eating more than intended
575 when served larger than normal portions, *Appetite, 120*, 54-60, doi:
576 10.1016/j.appet.2018.03.009.

577 Levitsky, D. A., & Youn, T. (2004). The more food young adults are served, the more they
578 overeat. *The American Society for Nutritional Sciences, 134* (10), 2546-2549.

- 579 Litt, D. M., Stock, M. L., & Lewis, M. A. (2012). Drinking to Fit in: Examining the Need to
580 Belong as a Moderator of Perceptions of Best Friends' Alcohol Use and Related Risk
581 Cognitions Among College Students. *Basic and Applied Social Psychology*, 34(4),
582 313-321. doi:10.1080/01973533.2012.693357
- 583 Myers, K. P., Brunstrom, J. P., Rogers, P. J., & Holtzman, J. D. (2019). Portion size
584 influences intake in Samburu Kenyan people not exposed to the Western obesogenic
585 environment. *Appetite*, 133, 212-216. doi.org/10.1016/j.appet.2018.11.007
- 586 Parmenter, K., Waller, J., & Wardle, J., (2000) Demographic variation in nutrition knowledge
587 in England. *Health Education Research*, 15(2), 163–174.
588 doi.org/10.1093/her/15.2.163
- 589 Raynor, H. A., & Epstein, L. H. (2001). Dietary variety, energy regulation, and obesity.
590 *Psychological Bulletin*, 127(3), 325-341. doi:10.1037//0033-2909.127.3.325
- 591 Remick, A. K., Polivy, J., & Pliner, P. (2009). Internal and External Moderators of the Effect
592 of Variety on Food Intake. *Psychological Bulletin*, 135(3), 434-451.
593 doi:10.1037/a0015327
- 594 Robinson, E., Aveyard, P., Daley, A., Jolly, K., Lewis, A., Lycett, D., & Higgs, S. (2013).
595 Eating attentively: a systematic review and meta-analysis of the effect of food intake
596 memory and awareness on eating. *American Journal of Clinical Nutrition*, 1-15.
597 doi:10.3945/ajcn.112.045245
- 598 Robinson, E., & Field, M. (2015). Awareness of social influence on food intake. An analysis
599 of two experimental studies. *Appetite*, 85, 165-170. doi:10.1016/j.appet.2014.11.019

- 600 Robinson, E., Sharps, M., Price, N., & Dallas, R. (2014). Eating like you are overweight: the
601 effect of overweight models on food intake in a remote confederate study. *Appetite*,
602 82, 119-123. doi:10.1016/j.appet.2014.07.019
- 603 Robinson, E., te Raa, W., & Hardman, C. A. (2015). Portion size and intended consumption.
604 Evidence for a pre-consumption portion size effect in males? *Appetite*, 91, 83-89.
605 doi:10.1016/j.appet.2015.04.009
- 606 Robinson, E., Thomas, J., Aveyard, P., & Higgs, S. (2014). What everyone else is eating: a
607 systematic review and meta-analysis of the effect of informational eating norms on
608 eating behavior. *Journal of the Academy of Nutrition and Dietetics*, 114(3), 414-429.
609 doi:10.1016/j.jand.2013.11.009
- 610 Robinson, E., Tobias, T., Shaw, L., Freeman, E., & Higgs, S. (2011). Social matching of food
611 intake and the need for social acceptance. *Appetite*, 56(3), 747-752.
- 612 Rolls, B. J., Morris, E. L., & Roe, L. S. (2002). Portion size of food affects energy intake in
613 normal-weight and overweight men and women. *Journal of the Academy of Nutrition
614 and Dietetics*, 76, 1207-1213.
- 615 Rolls, B. J., Roe, L. S., Kral, T. V., Meengs, J. S., & Wall, D. E. (2004). Increasing the
616 portion size of a packaged snack increases energy intake in men and women. *Appetite*,
617 42(1), 63-69. doi:10.1016/S0195-6663(03)00117-X
- 618 Rolls, B. J., Roe, L. S., Meengs, J. S., & Wall, D. E. (2004). Increasing the portion size of a
619 sandwich increases energy intake. *Journal of the American Dietetic Association*,
620 104(3), 367-372. doi:10.1016/j.jada.2003.12.013
- 621 Rolls, B. J., Vanduijvenvoorde, P. M., & Rolls, E. T. (1984). Pleasantness Changes and
622 Food-Intake in a Varied 4-Course Meal. *Appetite*, 5(4), 337-348.

- 623 Sadoul, B. C., Schuring, E. A. H., Mela, D. J., & Peters, H. P. F. (2014). The relationship
624 between appetite scores and subsequent energy intake: An analysis based on 23
625 randomized controlled studies. *Appetite*, *83*, 153-159.
626 doi:10.1016/j.appet.2014.08.016
- 627 Spanos, S., Vartanian, L. R., Herman, C. P., & Polivy, J. (2014). Failure to report social
628 influences on food intake: Lack of awareness or motivated denial? *Health*
629 *Psychology*, *33*(12), 1487-1494. doi:10.1037/hea0000008
- 630 Spanos, S., Vartanian, L. R., Herman, C. P., & Polivy, J. (2015). Personality, perceived
631 appropriateness, and acknowledgement of social influences on food intake.
632 *Personality and individual differences*, *87*, 110-115
- 633 Temple, J., Giacomelli, A. M., Kent, K. M., Roemmich, J. N., & Epstein, L. H. (2007).
634 Television Watching Disrupts Habituation and Increases Energy Intake in Children.
635 *Annals of Behavioral Medicine*, *33*, S105-S105.
- 636 Tylka, T. L. (2006). Development and psychometric evaluation of a measure of intuitive
637 eating. *Journal of Counselling Psychology*, *53*, 226-240.
- 638 van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating
639 Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external
640 eating behavior. *International Journal of Eating Disorders*, *5*(2), 295-315.
- 641 Vartanian, L. R., Herman, C. P., & Wansink, B. (2008). Are we aware of the external factors
642 that influence our food intake? *Health Psychology*, *27*(5), 533-538. doi:10.1037/0278-
643 6133.27.5.533

644 Vartanian, L. R., Sokol, N., Herman, C. P., & Polivy, J. (2013). Social models provide a
645 norm of appropriate food intake for young women. *PloS One*, *8(11)*, e79268.
646 doi:10.1371/journal.pone.0079268

647 Vartanian, L. R., Spanos, S., Herman, C. P., & Polivy, J. (2015). Modeling of food intake: a
648 meta-analytic review. *Social Influence*, *10(3)*, 119-136.
649 doi:10.1080/15534510.2015.1008037

650 Vartanian, L. R., Reily, N.M., Spanos, S., Herman, C.P., & Polivy, J. (2017). Self-reported
651 overeating and attributions for food intake. *Psychology & Health*, *32(4)*, 483-492.

652 Vartanian, L. R., Spanos, S., Herman, C. P., & Polivy, J. (2017). Conflicting internal and
653 external eating cues: impact on food intake and attributions. *Health Psychology*, *36*
654 *(4)*, 365-369

655 Vartanian, L. R., Reily, N.M., Spanos, S., McGuirk, L. C., Herman, C.P., & Polivy, J.
656 (2017). Hunger, taste and normative cues in predictions about food intake. *Appetite*,
657 *116*, 511-517

658 Zlatevska, N., Dubelaar, C., & Holden, S. S. (2014). Sizing Up the Effect of Portion Size on
659 Consumption: A Meta-Analytic Review. *Journal of Marketing*, *78(3)*, 140-154.

660