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2 Using pictorial nudges of fruit and vegetables on tableware to increase children's fruit and
3 vegetable consumption

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19

20 *Abstract*

21 Children's fruit and vegetable consumption is lower than recommended. Increasing
22 consumption is important for children's health. Nudges influence children's eating behaviour,
23 but less is known about the influence of a pictorial nudge on tableware on children's fruit and
24 vegetable consumption. Two studies examined this. Study 1 examined whether a pictorial
25 fruit nudge (a grape image) on a plate influenced children's fruit (grape) consumption relative
26 to a control condition (no image). In a between-subjects design, children (n=63, Mean
27 age=8.9 years, SD=1.41, 38 females, 25 males, 73% had a healthy-weight) were randomly
28 assigned to one of two conditions (fruit nudge vs. control). Study 2 examined the influence of
29 a large portion pictorial nudge (a large portion carrot image) vs. a small portion pictorial
30 nudge (a small portion carrot image) vs. control (no nudge) on children's vegetable (carrot)
31 consumption. In a between-subjects design, children (n=59, Mean age=8.57 years, SD=2.13,
32 31 females, 28 males, 85% had a healthy-weight) were randomly assigned to a condition. In
33 Study 1 children consumed significantly more fruit in the pictorial nudge condition than the
34 control condition. In Study 2 children ate significantly more vegetables in the large portion
35 pictorial nudge condition than the other two conditions. The small portion pictorial nudge did
36 not affect children's vegetable consumption relative to control. The results indicate that
37 pictorial nudges on tableware influence children's fruit and vegetable consumption, and the
38 portion size of this type of nudge may be key to whether it influences children's eating
39 behaviour.

40 *Keywords:* nudging; eating behaviour; children; portion size

41

42 *Introduction*

43 Children do not eat a sufficient amount of fruit and vegetables. In 2016 only 16% of children
44 aged 5-15 years old in England ate the recommended five or more portions of fruit and
45 vegetables per day (Research 2017). Fruit and vegetable consumption is associated with a
46 reduction in the risk of a number of chronic diseases (Boeing et al. 2012; Hu et al. 2014; Wang
47 et al. 2014a). A meta-analysis showed that the risk of all-cause mortality decreased by 5% for
48 each additional serving of fruit and vegetables, up to five portions per day (Wang et al. 2014b).
49 Since eating behaviours track from childhood into adolescence and adulthood (Birch et al.
50 2009; Birch and Fisher 1998), increasing fruit and vegetable consumption at an early age is
51 important.

52

53 Nudging is a potential strategy for increasing children's fruit and vegetable consumption. The
54 term nudging was originally coined by Thaler and Sunstein (Thaler and Sunstein 2008) and
55 was defined as "any aspect of the choice architecture that alters people's behaviour in a
56 predictable way without forbidding any options or significantly changing their economic
57 incentives". More recently Hollands et al (Hollands et al. 2013) developed an operational
58 definition of nudging in relation to changing health-related behaviour. Hollands et al (Hollands
59 et al. 2013) defined nudging as "interventions that involve altering the properties or placement
60 of objects or stimuli within micro-environments with the intention of changing health-related
61 behaviour". A recent review of 39 systematic reviews and meta-analyses showed that a variety
62 of nudges influence eating behaviour and promote healthier eating in adults and children (Bauer
63 and Reisch 2019). For example, children were more likely to select oranges when the oranges
64 were sliced than when they were whole (Swanson, Branscum, and Nakayima 2009), and were
65 more likely to take a serving of fruit when a verbal prompt ("would you like fruit or juice with

66 your lunch?") was used by the canteen staff than when no prompt was used (Schwartz 2007).
67 Furthermore, serving vegetables while children waited in the school dinner line increased
68 consumption of vegetables (Elsbernd et al. 2016), and the addition of a model-related label
69 ("new carrot/broccoli recipe, special mix for super heroes") increased the likelihood that
70 children would choose the new vegetable dish (Morizet et al. 2012).

71

72 Another type of nudge which has been shown to influence children's vegetable consumption
73 is the placement of images of food on a school dinner tray (Reicks et al. 2012). Reicks et al
74 (Reicks et al. 2012) placed images of carrots and green beans on a school dinner tray on one
75 occasion and found that children selected and consumed more carrots and green beans when
76 the images were present on their tray in comparison to a control day when no images were
77 present. However, this is the only study to our knowledge which has examined the influence
78 of pictorial nudges on tableware on children's eating behaviour. Therefore, since consumption
79 of both fruit and vegetables is beneficial for health (Boeing et al. 2012), examining the
80 influence of pictorial nudges on children's fruit consumption would be of value. Furthermore,
81 from this previous research (Reicks et al. 2012) it is not clear how the pictorial nudges
82 influenced children's eating behaviour. One possibility is that the portion size of the nudge
83 image may affect the amount that children eat. Research has consistently shown that children
84 eat more when served a large portion of food than when served a small portion (Birch, Savage,
85 and Fisher 2015; Fisher et al. 2007; Hetherington and Blundell-Birtill 2018), which is known
86 as the portion size effect. Pictorial nudges on tableware may act in a similar way to a portion
87 served on a plate, whereby a pictorial nudge of a large portion of a food may encourage children
88 to eat more of that food compared to a pictorial nudge containing an image of a small portion.

89 Understanding whether pictorial nudges elicit the portion size effect will be informative for the
90 development of pictorial nudges to increase children's fruit and vegetable consumption.

91

92 In this paper we aimed to understand the influence of pictorial nudges on children's fruit and
93 vegetable consumption. In study 1 we examined whether a pictorial fruit nudge influenced
94 children's fruit consumption. We expected that the pictorial nudge would influence children to
95 increase their consumption of fruit relative to control (no image on a plate). In study 2 we
96 examined whether the portion size of a pictorial vegetable nudge influenced children's
97 vegetable consumption. We expected that if the nudge influenced children's vegetable
98 consumption through eliciting the portion size effect, then children in the large portion nudge
99 condition would consume more vegetables than children in the other two conditions, and
100 children in the small portion condition would consume more vegetables than children in the
101 control condition.

102

103 *Study 1*

104 *Method*

105 *Design*

106 Children attended a single experimental session on an individual basis in their primary
107 school. Children were randomly assigned (using the online random number generator
108 <http://www.randomizer.org>) to one of two conditions (fruit nudge vs. control) in a between-
109 subjects design. In both conditions children were given a plastic white plate (22cm diameter)
110 and a plastic white bowl containing green seedless grapes (approximately 150 grams). In the

111 fruit nudge condition a laminated photographic image of green grapes¹ was placed on the
112 plate (this image was placed on the plate at the start of fruit nudge condition session and was
113 loose and not stuck to the plate). No image was present on the plate in the control condition
114 (see Figure 1 for images of the two conditions). The plate and the bowl were weighed using
115 digital scales pre and post-consumption to measure children's consumption.

116

117 *Ethics*

118 Study 1 and study 2 were approved by Coventry University Research Ethics Committee
119 (P69532 and P67529), and have been performed in accordance with the ethical standards laid
120 down in the 1964 Declaration of Helsinki and its later amendments. Fully-informed parental
121 consent was provided, and children who had food allergies, or a history of food allergies were
122 unable to participate in both studies. Children assented to take part on the day of the study.

123

124 *Questionnaire measures*

125 *Manipulation check*

126 To examine whether children noticed the image on their plate (manipulation check) children
127 were presented with the question 'You were given a plate to eat off, what did your plate look
128 like?' with two image options; a plate containing no image or a plate containing an image of
129 grapes.

130

¹ The photographic nudge image constituted a large portion and weighed approximately 240 grams. The image was taken of a plate full of grapes, however the image was edited so that only the grapes can be seen.

131 *Liking of the test food*

132 Liking of grapes was assessed using a smiley face Likert-style scale by asking ‘How much do
133 you like grapes?’ with five response options ranging from ‘not at all’ to ‘a lot’, based on a
134 question previously used by Sharps & Robinson (2015).

135

136 *zBMI*

137 In both studies, height was measured to the nearest 0.5cm using a Stadiometer (Seca 213,
138 Seca GmbH & Co.) and weight was measured to the nearest 0.1kg using a digital scale (Seca
139 813, Seca GmbH & Co.). BMI was calculated as weight (kg)/height (m²). Using
140 internationally recognised criteria for children (Cole and Lobstein 2012), healthy-weight,
141 overweight and obesity were defined based on age and sex-specific BMI cut-off points
142 equivalent to adult BMI of 25-30 kg/m² respectively.

143

144 *Procedure*

145 Children were tested individually during weekdays at a primary school. Children sat at a table
146 in a quiet area of the school and were told a cover story (children were informed that the
147 researcher was interested in how well they played a game). The researcher explained that
148 they needed to ‘sort out the game’ so the child could have a snack while they waited. The
149 child was presented with a plate (which either contained a fruit nudge or no nudge depending
150 on the condition), and a bowl of grapes. The child was informed that they could help
151 themselves to as much as they liked, and the researcher asked the child to put however much
152 they wanted to eat onto the plate and eat from the plate. The child was left alone for 7
153 minutes. On return the researcher removed the plate and bowl and presented the child with

154 the game, which involved matching pairs of animals. The child was left for 3 minutes to play
155 the game. The researcher then congratulated the child on their performance on the game to
156 corroborate the cover story, and asked the child the questionnaire measures, and measured
157 their height and weight. All children were debriefed once all the children had been tested in
158 that school.

159

160 *Analysis strategy*

161 Pearson's correlations were conducted to examine whether any of the variables (age, zBMI,
162 and liking of grapes) correlated with grape consumption. Variables which significantly
163 correlated with grape consumption were included as covariates. A one-way ANCOVA was
164 conducted to examine the influence of condition on grape consumption. Gender was included
165 in the ANCOVA to examine whether it moderated the effect of condition on grape
166 consumption. For the manipulation check, children's responses were scored based on whether
167 or not they correctly identified the image on their plate and a percentage of correct responses
168 was calculated.

169

170 *Results*

171 *Participants*

172 65 children aged 6-11 years were recruited from one primary school in the Midlands. A
173 power calculation using g-power indicated that for a medium-large effect size at 80% power
174 ($\alpha = .05$), a minimum of 60 children were required. One child was excluded due to fasting on
175 the day of testing, and one child did not correctly identify their plate in the manipulation
176 check, so the final sample consisted of 63 children (Mean age = 8.9 years, SD = 1.41, 38

177 females, 25 males, 73% had a healthy-weight). See Table 1 for mean grape consumption, age,
178 zBMI and gender distribution across the two conditions.

179

180 *Manipulation check*

181 98.5% of children correctly identified their plate.

182

183 *Co-variates and moderators*

184 Grape liking significantly correlated with grape consumption [$r = .45$, $n = 63$, $p = < .001$] and
185 was included as a covariate in the ANCOVA. zBMI and age did not significantly correlate
186 with grape consumption and therefore were not controlled for in the analysis ($ps > .05$).

187 Gender did not moderate the effect of condition on children's grape consumption ($p > .05$).

188

189 *Grape consumption*

190 There was a significant main effect of condition on grape consumption [$F(1, 60) = 6.06$, $p =$
191 $.02$, $\eta^2 = .09$]. Children in the fruit nudge condition consumed significantly more grapes
192 than children in the control condition. See Table 1 for means and range, and Figure 1 for
193 means and standard error.

194

195 *Study 2*

196 *Method*

197 *Design*

198 As in study 1, children were randomly assigned (using the online random number generator
199 <http://www.randomizer.org>) to a condition in a between-subjects design. Children were either
200 assigned to the large portion nudge condition, the small portion nudge condition, or the
201 control condition. Children in all conditions were given a plastic white plate and a plastic
202 white bowl containing raw carrot batons (approximately 130 grams). In the large portion
203 nudge condition the plate contained a laminated photographic image of a large portion of
204 carrots, in the small portion nudge condition the plate contained a photographic image of a
205 small portion of carrots, and in the control condition there was no image (see Figure 1 for
206 images of the conditions)²³. The plate and bowl were weighed pre and post-consumption to
207 measure children's carrot consumption.

208

209 *Questionnaire measures*

210 *Manipulation check*

211 To examine whether children noticed the image on their plate (manipulation check) children
212 were presented with the question 'You were given a plate to eat off, what did your plate look
213 like?' with three image options; a plate containing no image, a plate containing an image of a
214 small portion of carrots, or a plate containing an image of a large portion of carrots.

215

² The large portion nudge image was taken of a large plate of raw carrot batons and weighed 240 grams. The small portion nudge image was taken of three carrot batons on a plate and weighed 27 grams. The images were edited so that the plate was not visible.

³ The current recommendation for children's portion sizes is what children can fit into their cupped hand and there are no recommended portion sizes in grams due to differences in children's age, gender and physical activity levels. Therefore, we aimed to create a visibly small portion and a visibly large portion nudge. The small portion pictorial nudge is the equivalent of approximately one third of the recommended portion for adults (which is 80 grams per portion), while the large portion is the equivalent of three times the adult recommended portion.

216 *Typical Fruit and Vegetable consumption and liking of the test food*

217 To ensure that children's habitual fruit and vegetable consumption did not systematically
218 influence their behaviour, children's typical fruit and vegetable consumption was measured
219 using the Day in the Life Questionnaire (DILQ). The DILQ is a valid and reliable twenty-four
220 hour recall measure for use in children (Edmunds and Ziebland 2002). Liking of carrots was
221 assessed using a smiley face Likert-style scale by asking 'How much do you like carrots?'
222 with five response options ranging from 'not at all' to 'a lot'. This was based on a question
223 used by Sharps and Robinson (Sharps and Robinson 2015).

224

225 *zBMI*

226 Children's zBMI was calculated in the same way as Study 1.

227

228 *Procedure*

229 Children were tested individually and were sat at a table in a private section of a larger room
230 at a family science event. The researcher explained the cover story that they had designed a
231 plate and wanted the child's opinion. The researcher presented the child with the plate (either
232 containing a large or small portion nudge or no nudge depending on condition) and asked the
233 child questions about the plate (their opinion on the colour, texture and size). The researcher
234 then explained that they wanted the child to design their own plate but that they were going to
235 have a break first. The researcher placed the plate and the bowl containing the carrots in front
236 of the child. As in study 1 the researcher informed the child that they could eat as much as
237 they wanted, and asked the child to put whatever they wanted to eat onto the plate and eat
238 from the plate. The child was left child alone for 7 minutes. After 7 minutes, the researcher

239 returned and removed the plate and the bowl and presented the child with a worksheet where
240 they could design their own plate. The child was left alone for 3 more minutes to design their
241 plate to corroborate the cover story. On return, the researcher congratulated the child on their
242 plate design and the child completed the questionnaire measures with the researcher. Children
243 were debriefed at the end of their participation in the study.

244

245 *Analysis strategy*

246 As in study 1 Pearson's correlations were conducted to examine whether any of the variables
247 (age, zBMI, typical fruit and vegetable intake, and liking of carrots) correlated with the carrot
248 consumption. Variables which significantly correlated with carrot consumption were included
249 as covariates. A one-way ANCOVA was conducted to examine the influence of condition on
250 carrot consumption. Gender was included as a moderator in the ANCOVA to examine
251 whether gender moderated the effect of condition on children's carrot consumption. As in
252 study 1, for the manipulation check children's responses were scored based on whether or not
253 they correctly identified the image on their plate and a percentage of correct responses was
254 calculated.

255

256 *Results*

257 *Participants*

258 75 children aged 5-13 years participated in the study which took place at a family science
259 event in the Midlands, United Kingdom. Based on the results of study 1, we conducted a
260 power calculation for a medium-large effect size at 80% power, with $\alpha = .05$. A minimum of
261 74 children were required. This study took place in a private section of a larger room, and

262 children completed the study individually. Parents were asked not to be present during the
263 study, however, in ten cases, the parents remained present, and these children were excluded.
264 Six children were excluded as they did not correctly identify their plate in the manipulation
265 check. The final sample consisted of 59 children (Mean age = 8.57 years, SD = 2.13, 31
266 females, 28 males, 85% had a healthy-weight). See Table 1 for mean carrot consumption,
267 age, zBMI and gender distribution across the conditions.

268

269 *Manipulation check*

270 91% of children correctly identified the image on their plate.

271

272 *Co-variates*

273 Carrot liking significantly correlated with carrot consumption [$r = -.52$, $n = 59$, $p < .001$] and
274 was included as a covariate in the ANCOVA. There were no other significant correlations
275 between carrot consumption and age, zBMI, and usual fruit and vegetable consumption ($ps >$
276 $.05$), and gender did not moderate the effect of condition on children's carrot consumption (p
277 $> .05$).

278

279 *Carrot consumption*

280 There was a significant main effect of condition on carrot consumption [$F(2, 55) = 3.42$, $p =$
281 $.040$, $\eta^2 = .11$]. Children in the large portion nudge condition ate significantly more carrots
282 than children in the other two conditions, but there was no significant difference between the

283 small portion nudge condition and the control condition. See Table 1 for means and range,
284 and Figure 1 for means and standard error.

285

286 *General discussion*

287 Across two studies we examined the influence of pictorial nudges (photographic images of
288 fruit or vegetables on tableware (a plate) on children's fruit and vegetable consumption. In
289 study 1 children consumed more grapes when exposed to a pictorial fruit nudge (an image of
290 grapes on a plate) in comparison to the control condition (no image on the plate). In study 2,
291 children increased their consumption of carrots when exposed to a large portion pictorial
292 nudge (an image of a large portion of carrots on a plate) in comparison to a small portion
293 pictorial nudge (an image of a small portion of carrots on a plate) and control (no image). The
294 results build on the work by Reicks et al (2012) through providing the first evidence that a
295 pictorial nudge influences children's fruit consumption. These results also demonstrate for
296 the first time, that the portion size of a pictorial nudge may be key to whether pictorial nudges
297 on tableware influence children's eating behaviour.

298

299 The results of study 2 are consistent with the portion size literature (Hetherington and
300 Blundell-Birtill 2018; Small et al. 2013) and indicate that the pictorial nudges in these studies
301 may have influenced children's vegetable consumption through the portion size effect. The
302 portion size effect has been suggested to occur due to the portion acting as a cue or social
303 norm about the appropriate amount to eat (Versluis and Papies 2016). Thus, in study 2 the
304 large portion pictorial nudge may have indicated that eating a large amount of vegetables was
305 appropriate. The results of study 1 may also be explained by the portion size effect. Although
306 we did not measure the impact of different portion size nudges on children's fruit

307 consumption in study 1, the pictorial fruit nudge constituted a large portion and may have
308 communicated that the appropriate course of action was to eat a large amount of grapes. In
309 study 2, the small portion pictorial nudge did not increase children's vegetable consumption
310 relative to the control condition, which may be due to the small portion nudge producing a
311 ceiling effect. According to the normative model of social influence (Herman and Polivy
312 2005), people look to cues in the environment to determine the appropriate amount to eat
313 without eating excessively. Therefore, the small portion pictorial nudge may have set the
314 limit for the appropriate amount to eat and the children may have felt that they should not eat
315 more than this. A related explanation is that eating 3-4 carrot batons (approximately 30
316 grams) is the norm for children, as demonstrated by children in the control condition eating
317 this amount. The small portion nudge, which weighed 27 grams and constituted 3 carrot
318 batons, may have reinforced this norm and guided children's behaviour. However, we did not
319 measure normative perceptions regarding children's beliefs about the amount of vegetables
320 eaten by other children, or what they perceived to be the appropriate amount to eat. This
321 would be a valuable addition in future studies and would allow for the investigation of
322 whether the nudge communicates normative information. Furthermore, in these studies we
323 only examined large or small pictorial portion size nudges, therefore, it would be valuable to
324 understand how nudges which depict the recommended portion size influence children's fruit
325 and vegetable consumption.

326

327 The results of these studies may also be explained by how visually appealing the pictorial
328 nudges were. Research has shown that visually appealing food promotes consumption
329 (Jansen, Mulkens, and Jansen 2010; Van Kleef et al. 2014). For example, van Kleef (Van
330 Kleef et al. 2014) found that presenting whole wheat rolls in a fun shape almost doubled

331 consumption of whole wheat bread, while Jansen et al (Jansen, Mulkens, and Jansen 2010)
332 showed that children ate more fruit when it was presented in a visually appealing way (e.g. a
333 variety of fruit on cocktails sticks stuck in a melon, vs. the same fruit on a plain plate). Thus,
334 in the present studies the fruit nudge in study 1 may have been more appealing than the
335 control condition (no image), and the large portion nudge in study 2 may have been more
336 appealing than the small portion nudge and control. However, this explanation is speculative
337 since we did not collect any information about whether children found one of the plates more
338 visually appealing than the other, and future studies are needed to address this.

339

340 Due to the novelty of this approach it is important to gain a deeper understanding of how
341 pictorial nudges influence children's eating behaviour. In the present studies the pictorial
342 nudge presented to the children was the same as the food on offer and children were only
343 offered one food option. Therefore, it is not clear whether these nudges may influence
344 children's food choice, encouraging children to select the food depicted in the nudge over
345 options of varying healthfulness. It is also not clear whether an image of fruit or vegetables
346 may generalise and influence children's consumption of other types of fruit and vegetables
347 (for example, whether an image of carrots may influence consumption of broccoli or is
348 specific to carrot consumption). In the present studies, children participated alone, however,
349 in a real-world setting such as the home environment, it is likely that parents would be
350 present. Therefore, examining the impact of pictorial nudges with present parents would be
351 an important avenue for future research. Furthermore, since the research to date has only
352 examined the influence of pictorial nudges on one occasion, examining the longer-term
353 impact of this type of nudge would be of value. Understanding these factors would enable a

354 greater understanding of how and when pictorial nudges influence children's eating
355 behaviour, and would be informative for interventions using the nudge approach.

356

357 In conclusion, the results of these studies provide the first evidence that pictorial nudges
358 influence children's fruit consumption, and indicate that the portion size of the pictorial
359 nudge may be key to whether children are influenced. Future research investigating whether
360 pictorial nudges communicate normative information, whether they influence children's food
361 choice or are specific to the image depicted, and whether the influence of pictorial nudges
362 persist over time, would be of value.

363

364 *Conflict of interest*

365 On behalf of all authors, the corresponding author states that there is no conflict of interest.

366

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369

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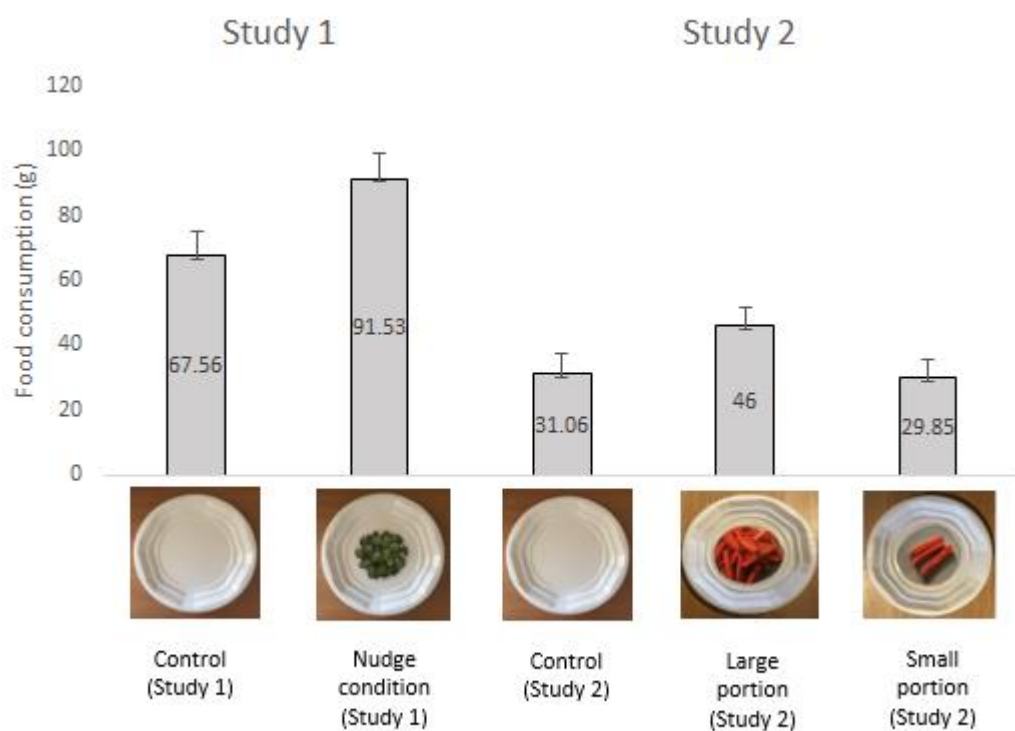
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453 **Fig. 1** Mean (and standard error) food consumption and pictorial nudge images for studies 1
454 and 2.



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1 Table 1. Mean (Min-Max) food consumption, age, gender, zBMI, and study food liking in studies 1 and 2.

Condition	Study 1			Study 2	
	Fruit nudge (n = 32)	Control (n = 31)	Large portion nudge (n = 22)	Small portion nudge (n = 20)	Control (n = 17)
Food consumption ¹	91.53 (0.0 – 153.0)	67.56 (0.0 -151.0)	46.00 (0.0 – 127.0)	29.85 (0.0 – 81.0)	31.06 (0.0 – 76.0)
Age ²	8.97 (6.40 – 11.04)	8.80 (6.11 – 11.08)	8.75 (5.10 – 12.60)	8.54 (5.11 – 12.80)	8.38 (5.11 – 12.80)
Gender	17 Females 15 Males	21 Females 10 Males	12 Males 10 Females	9 Males 11 Females	7 Males 10 Females
zBMI	0.27 (-3.25 – 2.97)	0.09 (-2.61 – 1.75)	0.22 (-2.14 – 2.37)	0.12 (-2.15 – 2.56)	-.20 (-2.09 – 1.62)
Study food liking	4.34 (1.00 – 5.00)	4.39 (1.00 – 5.00)	2.41 (1.00 – 5.00)	2.20 (1.00 – 5.00)	2.18 (1.00 – 5.00)

2 ¹Food consumption is reported in grams.

3 ²Age is reported in years.

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