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Exposure to models' positive facial expressions whilst eating a raw vegetable increases children's acceptance and consumption of the modelled vegetable

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1 **Abstract**

2 Research has shown that seeing positive facial expressions (FEs) towards food increased
3 children's desire to eat foods rated as disliked. However, the effect of adults' positive FEs
4 whilst eating a raw vegetable on children's acceptance and intake of nutritious foods that are
5 less preferred (e.g., vegetables) remains to be established. This study aimed to examine the
6 effect of models' FEs eating raw broccoli on children's acceptance and intake of raw broccoli.
7 111 children aged 4-6 years (64 male, 47 female) were randomised to watch a video of
8 unfamiliar adult models eating raw broccoli with a positive or neutral facial expression (FE),
9 or a non-food control video. Children's acceptance and intake of raw broccoli was assessed.
10 Data about parent and child characteristics was provided by parents. There was a main effect
11 of FE type on children's frequency of tastes ($p = .03$) and intake of broccoli ($p = .02$). Children
12 who were exposed to models eating broccoli with positive FEs had greater frequency of tastes
13 ($p = .04$) and intake of broccoli ($p = .03$), than children in the control condition, but not
14 compared to children in the neutral FE condition ($p > .05$). There was no effect of positive FEs
15 on children's willingness to try broccoli ($p > .05$). These findings suggest that observing others
16 enjoy a commonly disliked vegetable can encourage children's tastes and intake of the
17 vegetable. Thus, exposing children to others enjoying vegetables could be a useful strategy for
18 encouraging healthier eating in children. Further work is needed to determine whether a single
19 exposure is sufficient and whether these effects are sustained over time.

20 **Keywords:** Children, Facial expressions, Modelling, Vegetable intake, Vegetable acceptance¹

21

¹ Abbreviations used: FE, facial expression; FEs, facial expressions; F&V, fruit and vegetable; CEBQ, Children's Eating Behaviour Questionnaire; CFNS, Child Food Neophobia Scale.

22 1. Introduction

23 Globally, children typically consume fewer vegetables than recommended (Health
24 Survey for England, 2018; Keats et al., 2018; Kupka et al., 2020), which is of concern
25 because vegetables are a key source of vitamins and phytochemicals (Slavin & Lloyd, 2012),
26 and adequate consumption is associated with reduced risk of adult chronic diseases (Boeing
27 et al., 2012). Vegetables are often bitter in taste and innately less preferred (Wardle & Cooke,
28 2008), thus encouraging vegetable intake by children is challenging. Since poor dietary
29 behaviour during childhood can persist into adulthood, it is important to identify methods of
30 increasing children's vegetable acceptance as early as possible to establish healthy dietary
31 behaviours (Craigie et al., 2011).

32 Social learning plays a role in guiding children's eating behaviour; children may
33 observe and model another's eating behaviour (Bandura, 1977). Modelling appears to reduce
34 food neophobia in children, as children consume more novel food after observing an adult
35 model eating the food (Adessi et al. 2005; Harper & Sanders, 1975). Through vicarious
36 learning, children may imitate a behaviour after observing positive consequences (Bandura,
37 1977), e.g., a model's conveyance of food enjoyment using a statement (e.g., "this is
38 yummy") can increase children's F&V acceptance (Appleton et al., 2019; Hendy &
39 Raudenbush, 2000). For example, preschool children have been found to be more accepting
40 of novel fruit when teachers made enthusiastic comments about the fruit (Hendy &
41 Raudenbush, 2000). Furthermore, 7–10-year-old children showed higher liking and carrot
42 intake after observing characters mention their liking of carrots (Appleton et al., 2019). This
43 demonstrates that positive information about a models' enjoyment of food has a greater
44 impact on encouraging children's acceptance of the modelled fruit or vegetable than
45 modelling alone.

46 Food enjoyment is also conveyed through facial expressions (FEs). Children may look
47 to others for guidance when exposed to new foods they are unsure about. Smile signals from
48 adults can encourage children's approach behaviour to an unfamiliar toy (Klunnert et al., 1986),
49 thus observing positive FEs towards eating food may encourage approach and acceptance of
50 novel food. Limited research exploring the effect of models' FEs towards food on the eating
51 behaviour of others shows that exposure to positive FEs can influence eating behaviour
52 (Barthomeuf et al., 2012; Barthomeuf et al., 2009). Exposing adults and children to static
53 images of adults looking at a bowl of food with a pleasure, disgust, or neutral FE has shown
54 that adults' pleasure and neutral FE towards food increases adults' and children's desire to eat
55 foods rated as disliked (Barthomeuf et al., 2012; Barthomeuf et al., 2009). Thus, observing
56 adults enjoying, or at least not disliking, typically less preferred but nutritious foods, such as
57 vegetables, may be a useful strategy to increase children's vegetable acceptance and intake.
58 Determining whether positive FEs are particularly useful for increasing disliked food
59 desirability, in comparison to neutral FEs, remains to be established. Also, static images do not
60 represent the dynamic nature of FEs whilst eating. Thus, video stimuli are a more ecologically
61 valid method for participants to observe others' FEs whilst eating.

62 This study examined the effect of adults' FEs whilst eating raw broccoli on children's
63 acceptance and intake of a typically less preferred vegetable. Children aged 4-6 years were
64 examined because emotion recognition develops significantly between 3-4 years (Pons et al.,
65 2004), and 4-6-year-olds have the capacity to understand and cooperate with online
66 procedures. Furthermore, food neophobia peaks between 2-6 years, thus children aged 4-6
67 years are less likely to try new foods, particularly vegetables (Dovey et al., 2008).
68 Investigating others' FEs in isolation (e.g., without statements about food tastiness) will
69 improve understanding of the role of FEs in modelling of eating and contribute to developing
70 strategies to help children learn pleasure from nutritious foods (Marty et al., 2018). Based on

71 previous literature, it was hypothesised that children's acceptance (willingness to try, and
72 frequency of tastes) and intake of raw broccoli would be higher after exposure to models
73 eating raw broccoli with positive FEs, compared to models consuming raw broccoli with
74 neutral FEs, or a non-food control video.

75 **2. Method**

76 **2.1. Participants**

77 A power calculation (G*Power 3; Faul et al., 2007) indicated that to detect a
78 significant main effect of condition with $d = 0.6$, (based on research examining intervention
79 effects on children's vegetable intake; Farrow et al., 2019), 80% power, $\alpha = 0.05$, 108
80 children were required. In total, 117 4-6-year-olds and their parents were recruited from the
81 UK via online advertisements and social media between October 2020 and February 2021.
82 Children with food allergies, food intolerances, or medical conditions affecting eating
83 behaviour were excluded. Ethical approval was obtained from Aston University Research
84 Ethics Committee (#1688). Parents provided informed consent for their own and their child's
85 participation and children provided verbal assent.

86 **2.2. Design**

87 In a between-subjects design, children were randomly assigned to one of three
88 conditions (positive, neutral or control) in which they were shown one of three stimuli (see
89 2.3.6. for details).

90 **2.3. Measures**

91 *2.3.1. Children's vegetable acceptance and intake*

92 Children's acceptance and intake of raw broccoli was measured after the
93 manipulation. Raw broccoli was used due to its bitter taste, and bitterness is innately less
94 preferred (Wardle & Cooke, 2008). Broccoli is also likely to be unfamiliar to children in its

95 raw form. Broccoli acceptance was measured as the willingness to try broccoli and the
96 frequency of tastes of broccoli. Willingness to try broccoli was assessed by measuring
97 children's greatest observed engagement with broccoli on a 7-point scale (Table 1; Blissett et
98 al., 2012; Blissett et al., 2016). For example, if a child placed raw broccoli in their mouth but
99 did not swallow it, placed in mouth (score = 5) was recorded as the greatest observed
100 engagement. If the child verbally refused the broccoli but then went on to touch it, touched
101 (score = 3) was recorded as the greatest observed engagement. Higher engagement scores
102 indicated greater willingness to try broccoli. The frequency of children's tastes (defined as
103 any occurrence of oral exposure to the broccoli) was determined by counting the number of
104 times broccoli was placed in mouth, swallowed but refused, and swallowed and accepted.
105 Broccoli intake was measured as the grams of broccoli consumed; parents weighed the
106 broccoli in grams pre- and post- intake and reported the weights to the researcher.

107 *2.3.2. Demographics and Lifestyle Questionnaire*

108 Demographic information was gathered; child sex and age, and parent gender, age,
109 ethnicity, education level and number of children was assessed (Blissett et al., 2019). Parents
110 reported their child's height and weight, to calculate BMI. BMI z scores (zBMI) were used in
111 analyses to adjust for sex and age. Information about parent and children's food allergies,
112 food intolerances, or medical conditions affecting eating behaviour were used to exclude
113 participants. Parent and child habitual F&V intake was assessed, to check for differences
114 between conditions (e.g., "how many servings of vegetables do you/ your child normally eat
115 a day?" and "think back carefully, how many servings of vegetables did you/ your child eat
116 yesterday?"; Thomas et al., 2016). Parents reported if their child had tried raw broccoli
117 before, to assess children's familiarity with raw broccoli.

118 *2.3.3. Children's Eating Behaviour Questionnaire (CEBQ; Wardle et al., 2001)*

119 Four subscales of the CEBQ measured children's typical eating behaviour (Wardle et
120 al., 2001): food responsiveness (5 items, e.g., 'my child is always asking for food'),
121 enjoyment of food (4 items, e.g., 'my child loves food'), satiety responsiveness (5 items, e.g.,
122 'my child gets full up easily') and food fussiness (6 items, e.g., 'my child refuses new food at
123 first'). Parent responses are on a scale of 1 to 5 where 1 = never and 5 = always. Food
124 approach (enjoyment of food and food responsiveness) and food avoidance (satiety
125 responsiveness and food fussiness) have been associated with food acceptance, so were
126 measured to check for differences in scores between conditions and associations with
127 outcome measures (Blissett et al., 2019; Cooke et al., 2004; Fildes et al., 2015). The CEBQ
128 has been found to be a reliable and valid measure in children (Carnell et al., 2007; Wardle et
129 al., 2001). In this study, subscales had good internal consistency ($\alpha = 0.79-0.89$).

130 *2.3.4. Child Food Neophobia Scale (CFNS; Pliner, 1994)*

131 A reduced 6-item CFNS measured children's food neophobia (e.g., 'my child does not
132 trust new foods'; Pliner, 1994). Parent responses are on a 7-point Likert scale ranging from 1
133 (disagree strongly) to 7 (agree strongly). Food neophobia has been associated with lower
134 F&V intake and variety in children, so was measured to examine associations with outcome
135 measures and differences in children's neophobia between conditions (Cooke et al., 2003;
136 Perry et al., 2015). The CFNS has been found to be a reliable and valid measure (Cooke et
137 al., 2006; Pliner, 1994; Perry et al., 2015). Cronbach's alpha in this study was 0.94.

138 *2.3.5. Randomisation checks*

139 Parents completed several questionnaires about their child's characteristics: sensory
140 processing, anxiety, empathy, and autistic traits. Children differ in these traits, which have
141 been associated with selective eating behaviours (see Supplementary Material 1). These traits
142 were examined to check participants did not differ in these measures between conditions.

143 *2.3.6. Experimental Stimuli*

144 Each of the three stimuli comprised 6 randomised video clips of unfamiliar adult
145 models (M video clip length = 10.6 seconds; SD = 1.95). Overall, stimuli lasted
146 approximately 1 minute in length (positive = 62 seconds; neutral = 57 seconds; control = 60
147 seconds). Each of the 6 video clips in the stimuli featured a model facing forward, eating one
148 piece of raw broccoli, and displaying a positive FE (positive condition) or neutral FE (neutral
149 condition). Each control video clip showed a model putting pens away into a pencil case
150 whilst expressing a neutral FE (control condition). See Supplemental videos 1-3 for examples
151 of positive, neutral and control clips. Videos had no sound, to remove its potential influence
152 on eating behaviour. Models were adults (3 men, 3 women) aged 20-26-years-old,
153 comprising White and Asian ethnicities (White British = 4; Asian British = 2). Each stimulus
154 featured the same 6 models. A pilot study (n = 20 adults) and FaceReader 7.0 software
155 showed that stimuli conveyed the intended valence.

156 **2.4. Procedure**

157 Parents completed an online questionnaire about their own and their child's
158 characteristics. Parents were then contacted via email to arrange an online video session. For
159 the session, parents were asked to prepare a bowl of raw broccoli (roughly 30g, 5 florets) and
160 to record the weight. Sessions took place between 10am – 7pm, on any day of the week
161 suitable for participants, using the online platform Zoom. Screen share was used to show
162 children the study materials. First, parents reported the time since their child had last eaten.
163 Children gave verbal consent and rated their hunger using the Teddy Picture Rating Scale
164 (from 1 'very hungry' to 5 'not hungry at all/ very full'; Bennett & Blissett, 2014). Children
165 then watched the randomly assigned video (positive, neutral or control) and after, were asked
166 to report how they thought the models felt about eating broccoli or putting pens away, using a
167 3-point smiley face scale (positive, neutral, or negative), to check that they were engaged
168 during the video. Next, children were told they would be given a snack to try if they would

169 like to and that the researcher would turn off their camera and microphone whilst they were
170 given the snack. When ready to move on from the snack, children were told to put their
171 thumb up, and then the researcher would return. Parents then gave their child the raw broccoli
172 snack, which was consumed ad libitum. Parents were told not to pressure or encourage their
173 child to eat the snack. Children's interaction with the broccoli was video recorded through
174 Zoom. Parents reweighed the broccoli and told the researcher the pre- and post- broccoli
175 weights (parents were asked to covertly weigh the broccoli each time, to avoid influencing
176 their child's eating behaviour). Finally, parents and children could ask questions and were
177 debriefed and thanked for their participation. Children received a certificate and parents
178 received a £5 online shopping voucher after participating. Sessions lasted approximately 10
179 minutes.

180 **2.5. Video analysis**

181 Recorded videos of the children consuming broccoli were used to analyse willingness
182 to try broccoli and the frequency of tastes. Also, to adjust for potential differences in parental
183 behaviour between conditions, the frequency of parental prompts to eat were recorded, which
184 were defined as any direction from the parent towards the child trying the food (e.g.,
185 encouragement: "do you want to try it?", or pressure to eat: "eat this now"). All videos were
186 coded in full by a single observer (KLE), from the time of presentation of the broccoli to the
187 time the child indicated they were ready to move on (M duration = 97.8s, SD = 94.5, range =
188 8.0 – 434.0s). A proportion (10%) of the videos were coded by a second coder (JB). Intra-
189 class correlation coefficients indicated excellent inter-rater reliability: parental prompts =
190 0.92; greatest engagement = 0.97; frequency of tastes = 0.99.

191 **2.6. Statistical analysis**

192 SPSS Version 26 was used for statistical analyses. Differences between conditions on
193 child sex (Chi-square tests), demographic measures and habitual F&V intake (one-way

194 ANOVA) were assessed. Child hunger was correlated with outcome measures as a potential
195 covariate (Pearson's correlations). One-way ANOVA examined differences between
196 conditions in CEBQ subscales, food neophobia and randomisation check measures. CEBQ
197 subscales and food neophobia scores were correlated with outcome measures as potential
198 covariates (Pearson's correlations). The frequency of parental prompts was examined for
199 differences between conditions (one-way ANOVA). One-way ANOVA/ANCOVA explored
200 the main effect of condition on broccoli acceptance and intake and Bonferroni t-tests
201 followed up significant main effects of condition.

202 **3. Results**

203 **3.1. Sample characteristics**

204 In total, 117 parents and children participated. Participants were excluded due to
205 inadequate experimental control (e.g., not following instructions or the presence of siblings
206 eating broccoli; $n = 5$) and intake data not being provided ($n = 1$). Hence, the final sample
207 included 111 participants. Parents (109 women, 2 men) had a mean age of 37.1 years (range
208 = 28-50). Parental ethnic background was 93.7% White, 2.7% Indian and 3.6% mixed
209 ethnicities. Parental highest educational level achieved: 1.8% GCSE (or equivalent), 12.6% A
210 level (or equivalent), 40.5% undergraduate degree, 44.1% postgraduate qualification and
211 0.9% 'other'. Children (64 males, 47 females) had a mean age of 5.5 years (65.6 months;
212 range = 49 – 83 months) and a mean BMI z-score of 0.20 (range = -3.99 – 3.70). BMI z-
213 scores could not be calculated for 5 children due to missing height and weight data from
214 parents. Sample characteristics were analysed; there were no significant differences between
215 conditions in parent or child demographics, habitual F&V intake, hunger rating or the number
216 of minutes since the child had last eaten (all $ps > .05$; Table 2). Child sex did not differ
217 significantly between conditions ($X^2(2, N = 111) = 1.01, p = .58$). Child hunger did not
218 correlate with broccoli intake ($r(109) = -0.10, p = 0.30$), willingness to try ($r(104) = -0.05, p$

219 = 0.61), or frequency of tastes ($r(96) = -0.04, p = 0.72$). Parental prompts were not
220 significantly associated with broccoli intake ($r(102) = -0.02, p = 0.86$). There were no
221 significant differences between conditions on CEBQ subscales, food neophobia (all $ps > .05$;
222 Table 3) or randomisation checks (all $ps > .05$; Supplemental Table 1). Finally, correlations
223 revealed that the CEBQ subscales and food neophobia scores were not significantly
224 associated with dependent variables, except for a significant negative relationship between
225 parental ratings of child food fussiness and broccoli intake ($r = -0.21, p < 0.05$; Table 4). Few
226 parents prompted their child to eat (positive $n = 10$; neutral $n = 10$; control $n = 8$). Parents
227 who prompted their child did so no more than 4 times in each condition, and number of
228 parental prompts did not differ between conditions ($F(2, 103) = 0.22, p = .80$). Most children
229 (67.6%) correctly identified how the models felt (positive = 87.2%; neutral = 55.3%; control
230 = 58.8%). Excluding children who did not accurately identify how the models felt, did not
231 change the overall pattern of results below.

232 **3.2. Acceptance of raw broccoli**

233 5 participants were excluded from video analysis due to recordings being inadequate
234 for measuring children's willingness to try raw broccoli (e.g., could not see child's
235 interaction with the broccoli), thus the sub-sample for this analysis consisted of 106 children.
236 Sixty-seven percent of children swallowed at least one bite of the raw broccoli. One-way
237 ANOVA showed there was no significant main effect of condition on the willingness to try
238 broccoli ($F(2, 103) = 1.78, p = .18, \eta_p^2 = .03$; Figure 1).

239 13 participants were excluded from video analysis due to inadequate recording for
240 measuring children's frequency of tastes (e.g., could not determine the number of oral
241 exposures), thus the sub-sample for this analysis consisted of 98 children. For the frequency
242 of tastes, one-way ANOVA revealed a significant main effect of condition ($F(2, 95) = 3.67, p$
243 = .03, $\eta_p^2 = .07$; Figure 2), whereby frequency of tastes was significantly higher in the

244 positive compared to the no-food condition ($p = .04$), but not the neutral condition ($p = .11$).

245 Neutral and no-food conditions did not differ significantly ($p = 1.00$).²

246 **3.3. Broccoli intake**

247 Raw broccoli was novel for 87.4% of participants. Few children had tried raw
248 broccoli before (positive $n = 4$; neutral $n = 4$; control $n = 6$) and excluding these children did
249 not change the overall pattern of results below. One-way ANCOVA controlling for food
250 fussiness showed that there was a significant main effect of condition on broccoli intake ($F(2,$
251 $107) = 3.90, p = .02, \eta_p^2 = .07$; Figure 3). Bonferroni corrected t-tests showed that broccoli
252 intake was significantly higher in the positive, compared to the no-food condition ($p = .03$),
253 but not the neutral condition ($p = .10$). Neutral and no-food conditions did not differ
254 significantly in their effects on broccoli intake ($p > 0.05$).

255 **4. Discussion**

256 This study aimed to test the effect of models' FEs whilst eating raw broccoli on
257 children's acceptance and intake of raw broccoli. The findings indicate that 4-6-year-old
258 children who were exposed to unfamiliar adult models expressing positive FEs whilst eating
259 broccoli had significantly more tastes and intake of raw broccoli than children who were
260 exposed to a no-food control video. However, contrary to the hypotheses, models' FEs whilst
261 eating broccoli did not significantly influence initial willingness to try broccoli.

262 Children who were exposed to adults showing enjoyment whilst eating broccoli
263 consumed on average more than double the amount of broccoli in the positive condition
264 (11g), than children in the control condition (5g). This finding is consistent with research
265 which showed that exposure to pleasure FEs from adult models increased children's desire to
266 eat disliked foods (Barthomeuf et al., 2012) and builds on this by demonstrating that

² $p = 1.00$ due to Bonferroni correction

267 observing positive FEs whilst eating food can increase children's actual intake of a typically
268 less preferred nutritious food.

269 One explanation for the beneficial effect of positive FEs whilst eating could be that
270 conveying food enjoyment gives the observer information about the safety and palatability of
271 food. This is particularly important when food is novel for children, to protect from ingestion
272 of harmful foods (Dovey et al., 2008). Raw broccoli was novel for most participants, thus
273 children may have eaten more broccoli after watching adults enjoy eating it, because they
274 believed it was enjoyable to eat. However, it is unlikely that eating behaviour was influenced
275 by the perceived safety of food, as most children were willing to try raw broccoli regardless
276 of condition and they were in a safe environment at home. Thus, information about food
277 tastiness rather than safety may be more influential for children in this age range and context.

278 Unlike intake and frequency of tastes, children's willingness to try broccoli was not
279 significantly influenced by models' FEs. One explanation could be a lack of sensitivity in the
280 measure; most children tried and swallowed the broccoli, irrespective of condition, meaning
281 they scored highly on the scale, even if they consumed little. However, the frequency of
282 tastes was influenced by models' FEs; children showed greater frequency of tastes of broccoli
283 after exposure to models enjoying broccoli, a behaviour which is clearly linked with greater
284 broccoli intake. Thus, positive FEs appear useful for increasing children's tastes and intake of
285 broccoli and given that positive modelling can reduce food neophobia in children (Hendy &
286 Raudenbush, 2000; Greenhalgh et al., 2009), which is associated with lower intake and
287 variety of vegetables (Cooke et al., 2003; Perry et al., 2015), positive modelling may be a
288 useful intervention tool to increase vegetable acceptance. However, since most children tried
289 the broccoli, examining the moderating effect of food neophobia in future work, in a sample
290 which includes more reticent eaters, may help to determine whether positive FEs increase
291 vegetable acceptance and intake for children who are less willing to try vegetables.

292 There was no difference in children’s broccoli intake or the frequency of tastes
293 between positive and neutral conditions. It is possible that children modelled the adults’
294 eating behaviour simply because they observed the models eating the food, as found
295 previously (Addessi et al., 2005; Harper & Sanders, 1975). However, because there was no
296 significant difference between neutral and control conditions, the presence of positive FEs
297 whilst eating food was more important for influencing children’s eating behaviour than mere
298 presence of the model eating. Recruiting a larger sample to increase power would help to
299 elucidate this point. Nonetheless, these findings demonstrate the importance of observing
300 others having a positive eating experience on children’s eating and highlight the need to
301 include appropriate control conditions to establish the effectiveness of positive FEs for
302 increasing vegetable intake.

303 This study was conducted remotely using an online platform (Zoom), due to
304 restrictions during the COVID-19 pandemic. This approach was shown to be a viable
305 methodology for examining children’s eating and had several advantages. Firstly, it enabled
306 recruitment of families from across the UK, instead of limiting recruitment to local families
307 with time and capacity to travel. Secondly, remote testing reduced the time burden for
308 researcher and participants: there was no travel time and testing could occur outside of the
309 working day. Thirdly, children engaged well in the online study, possibly due to familiarity
310 with using online platforms since the COVID-19 pandemic, and being relaxed in their own
311 home, providing greater ecological validity of eating environment. Fourth, parents and
312 children followed instructions well, and recording eating episodes using Zoom produced
313 good quality video recordings. A further strength of the study was improvement on the use of
314 static images (Barthomeuf et al., 2012; Barthomeuf et al., 2009) by using video stimuli,
315 which allowed children to observe dynamic FEs whilst eating. Indeed, exposure to videos of
316 positive peer modelling have been found to increase preschool children’s intake of a

317 modelled vegetable (Staiano et al., 2016), thus, video stimuli are an effective method for
318 exposing children to individuals FEs whilst consuming food.

319 However, the remote method used in this study had some limitations, such as
320 excluding data from sessions where siblings ate broccoli alongside the participant, because
321 siblings can influence children's eating (Salvy et al., 2008). Another limitation was the
322 presence of, and comments from the parents. However, the number of parental prompts did
323 not differ between conditions, so were unlikely to have affected the results. Limitations were
324 also that most parents were white mothers with a university education, thus did not represent
325 families where F&V is often low. Since parent and child habitual F&V intake was reasonably
326 high, children may have been more likely to try raw broccoli due to familiarity with
327 vegetables (e.g., cooked broccoli) and bitter tastes. Therefore, this study may underestimate
328 the effect of positive FEs on vegetable intake by children who are less familiar with
329 vegetables. Overall, this suggests that more work is needed to establish whether the present
330 findings apply to individuals who need these interventions the most.

331 This study is the first to demonstrate that exposing 4-6-year-old children to video
332 stimuli of unfamiliar adults expressing positive FEs whilst eating raw broccoli, more than
333 doubles children's intake of raw broccoli. Given this, exposure to adults enjoying food may
334 be a useful strategy for encouraging healthier eating behaviour in children. The emphasis on
335 food pleasure from others can help children to learn pleasure from nutritious foods (Marty et
336 al., 2018), which is an important focus for public health campaigns (Haines et al., 2019).
337 These initial findings could be the basis of a simple intervention encouraging parents to show
338 food enjoyment using FEs, during family eating occasions. However, more work is needed to
339 establish whether these effects are sustained over time, whether a single exposure to positive
340 modelling is adequate, and whether the effect would be similar for familiar but disliked
341 foods.

342 **Acknowledgements**

343 The authors' responsibilities were as follows – all authors contributed to the design of the
344 research. KLE conducted the research, analysed data, and drafted the primary manuscript.
345 JMT, SH and JB contributed to the writing of the manuscript and its editing. All authors have
346 approved the final article.

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Table 1: 7-point scale of children's willingness to try broccoli

Behaviour Category	Description of Behaviour	Example
(1) Physical refusal	Any occurrence of the child physically refusing the broccoli	Turning head away from offered broccoli
(2) Verbal refusal	Any occurrence of the child verbally refusing the broccoli	Child said "I don't want it"
(3) Touched	Any occurrence of the child physically touching the broccoli, but no further interaction with it	Picks up broccoli but puts it back in the bowl
(4) Smelled	Any occurrence of the child smelling the broccoli, such as by picking it up and bringing it to the nose, but no further interaction with it	Smelling the broccoli after picking it up
(5) Placed in mouth	Any occurrence of the child placing the broccoli to or inside the mouth, but no further interaction or its consumption	Putting broccoli into the mouth without biting it, holding it inside the mouth, but refused to swallow
(6) Swallowed but refused	Any occurrence of the child chewing and swallowing some of the broccoli but	Biting off a piece of broccoli, chewing and

	refused further or expressed dislike	swallowing it but refuse another bite
(7) Swallowed and accepted	Any occurrence of the child chewing and swallowing some of the broccoli without a negative reaction	Biting off a piece of broccoli, chewing and swallowing it and eating another piece

Table 2: Mean (SD) sample characteristics for participants in each condition (one-way ANOVA)

		Positive (n = 39)	Neutral (n = 38)	No-Food (n = 34)	<i>F</i>	<i>p</i>
Parent	Age (years)	37.55 (4.04)	36.92 (4.19)	36.74 (3.99)	0.41	0.67
	Vegetable intake	2.88 (1.34)	3.16 (1.15)	2.54 (1.14)	2.28	0.11
	Fruit intake	2.15 (1.05)	1.92 (1.11)	1.91 (1.22)	0.57	0.57
Child	Males (%)	64.10	52.60	55.90	-	-
	Age (months)	67.97 (9.42)	63.61 (10.70)	64.97 (10.32)	1.87	0.16
	BMI (z-score)	0.21 (1.41)	0.12 (1.57)	0.29 (1.35)	0.12	0.89
	Vegetable intake	2.59 (1.17)	2.36 (1.16)	2.37 (1.15)	0.49	0.61
	Fruit intake	2.83 (1.05)	2.41 (0.92)	2.47 (0.87)	2.21	0.12
	Hunger rating	2.82 (1.28)	2.79 (1.40)	3.03 (1.24)	0.35	0.70
	Minutes since child last ate	100.64 (71.07)	82.95 (84.31)	87.06 (77.89)	0.55	0.58

Table 3: Mean (SD) individual differences for child participants in each condition (one-way ANOVA)

	Positive (n = 39)	Neutral (n = 38)	No-Food (n = 34)	<i>F</i>	<i>p</i>
CEBQ Enjoyment of Food	3.91 (0.67)	3.89 (0.59)	3.88 (0.73)	0.02	0.98
CEBQ Satiety Responsiveness	2.82 (0.64)	2.75 (0.68)	2.86 (0.56)	0.29	0.75
CEBQ Food Fussiness	2.80 (0.69)	3.03 (0.60)	2.78 (0.74)	1.52	0.22
CEBQ Food Responsiveness	3.12 (0.83)	2.89 (0.60)	2.99 (0.80)	0.90	0.41
CFNS	22.33 (9.14)	24.82 (8.19)	22.76 (9.82)	0.82	0.45

Note. Children's Eating Behaviour Questionnaire (CEBQ); Child Food Neophobia Scale (CFNS).

Table 4: Pearson Correlation coefficients for broccoli intake, willingness to try, frequency of tastes and CEBQ subscales

	1	2	3	4	5	6	7
1. Broccoli intake	-						
2. Willingness to try	.49**						
3. Frequency of tastes	.62**	.45**					
4. Enjoyment of Food	.17	.16	.07				
5. Satiety	-.12	-.18	-.05	-.68**			
Responsiveness							
6. Food Fussiness	-.21*	-.18	-.12	-.66**	.45**		
7. Food Responsiveness	.07	.01	-.002	.52**	-.46**	-.29**	
8. Food Neophobia	-.18	0.14	-.12	-.62**	.43**	.86**	-.31**

* $p < .05$, ** $p < .01$.

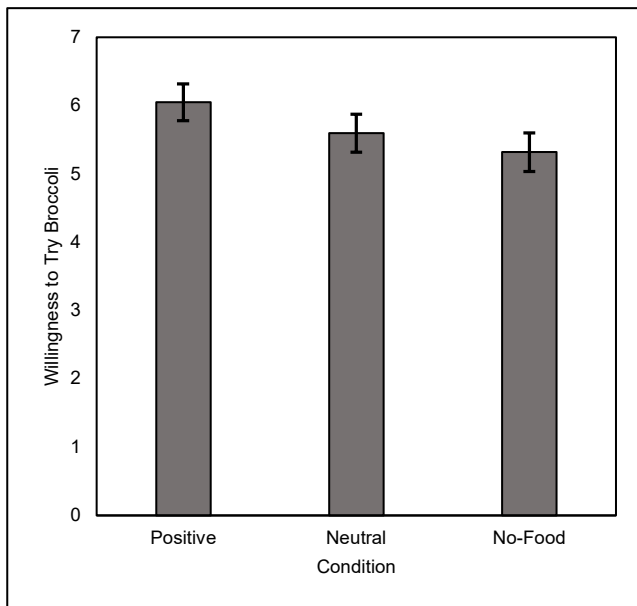
Figures

Figure 1: Mean willingness to try raw broccoli split by condition (standard error).

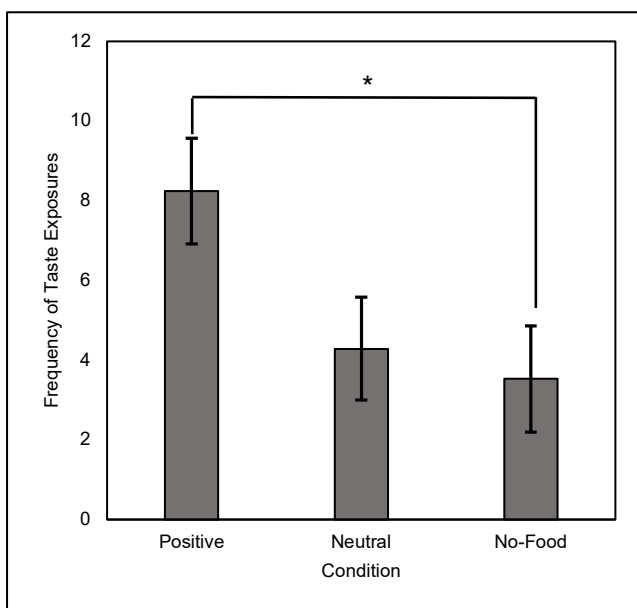


Figure 2: Mean frequency of tastes split by condition (standard error). * $p < .05$.

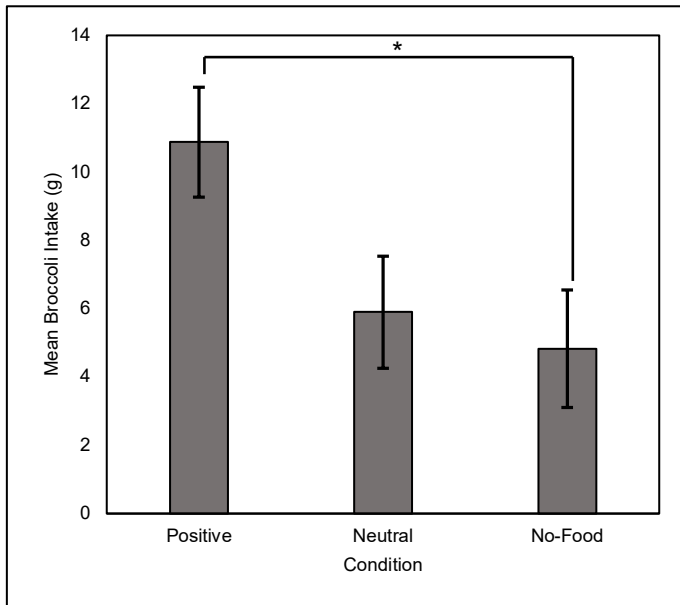


Figure 3: Estimated marginal means of amount (g) of broccoli consumed split by condition (standard error). * $p < .05$.