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Running head: MEASURING HUNGER AND SATIETY IN CHILDREN

Measuring Hunger and Satiety in Primary School Children: Validation of a New Picture Rating Scale

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Abstract

1
2
3 Measuring hunger and satiety in children is essential to many studies of childhood eating behaviour
4 and obesity. Despite this, few validated measures currently exist that allow children to make
5 accurate and reliable ratings of their hunger/satiety. Three studies aimed to address this issue by
6 validating the use of a new categorical rating scale, Teddy the Bear, in the context of estimated and
7 real eating episodes. Forty-seven 6-8 year old primary school pupils participated in Study 1, which
8 used a between-participant design. Results from this study indicated that the majority of children
9 were able to use the scale to make estimated hunger/satiety ratings for a character in a story using
10 the scale. No significant differences in the ratings of hunger/satiety of children measured before and
11 after lunch were observed and likely causes are discussed. To account for inter-individual differences
12 in hunger/satiety perceptions Study 2 employed a within-participant design. Fifty-four 5-7 year olds
13 participated in this study and made estimated hunger/satiety ratings for a story character and real
14 hunger/satiety ratings before and after lunch. The results from this study indicated that the majority
15 of children were able to use the scale to make estimated and real hunger and satiety ratings.
16 Children were also found to be significantly hungrier before compared to after lunch. As it was not
17 possible to establish what types of food and in what quantity children ate for lunch a third study was
18 carried out in a controlled laboratory environment. Thirty-six 6-9 year olds participated in Study 3
19 and made hunger/satiety ratings before and after ingesting an ad libitum snack of known
20 composition and quantity. Results indicate that children felt hungrier before than after the snack
21 and that pre-snack hunger/satiety, as well as changes in hunger/satiety, were associated with ad
22 libitum snack intake. Overall, the studies indicate that our new categorical rating scale has potential
23 for use with primary school children. Implications of our findings and possible contexts for its
24 application are discussed.

25

26 Keywords: Hunger, Satiety, Rating Scale

27 Measuring Hunger and Satiety in Primary School Children: Validation of a New Picture Rating Scale

28

29 Being able to accurately assess hunger and satiety in children is essential to many studies in the
30 field of childhood eating behaviour. Studies measuring snack intake with the Eating in the Absence
31 of Hunger paradigm rely on children's self-reported hunger and satiety. Other studies rely on
32 children being in a fasted or non-fasted state to later establish factors like children's abilities to
33 compensate for different caloric preloads. Despite this, few validated measures exist that are known
34 to accurately reflect children's own perceptions of their hunger and satiety.

35 Some studies into childhood eating behaviour have relied on visual analogue scales commonly
36 applied in research with adults and adolescents to establish hunger and satiety in children aged 8-
37 12. Roemmich, Wright, and Epstein (2002) asked children to rate their hunger/satiety using a
38 100mm visual analogue scale with the anchors "very hungry/very full". Nevertheless, the paper did
39 not present any indication of children's comprehension of this scale or of changes in hunger/satiety
40 ratings prior to and after snack intake. Developmental research suggest that children need to be able
41 to seriate their perceptions of hunger and satiety from hungry to full correctly before being able to
42 use a visual analogue scale correctly and reliably (Shields, Palermo, Powers, Grewe, & Smith, 2003).
43 Keller et al. (2006) found that the majority of children in their sample aged 4-5 years were able to
44 use an age-appropriate visual analogue scale to reflect changes in estimated fullness, after having
45 received a considerable amount of training. This suggests that abilities to seriate may be present
46 from an earlier age, but that tasks relying on the application of seriation techniques may be
47 dependent on training. It is therefore likely that ratings of hunger and satiety on an abstract visual
48 analogue scale demand greater cognitive abilities than those commonly present in untrained
49 children aged 7 years or younger (Shields, Palermo et al., 2003). Research by Shields et al. indicated
50 that child age and IQ, used as an indicator of cognitive ability, were the best predictors of
51 kindergarteners' abilities to correctly make ratings using a visual analogue scale. As more than 50%
52 of children aged 5-7 years who participated in their study failed to use the visual analogue scale

53 correctly, the authors suggest that alternative rating scales should be used when working with
54 children aged 7 years or younger. In a further study carried out by Shields, Cohen, Harbeck-Weber,
55 Powers, and Smith (2003) the ability of children aged 5-14 years to correctly mark a VAS and
56 understand the concept of a VAS for pain experiences was tested. Shields, Cohen et al. (2003) report
57 that only one third of the 106 children who participated in their study were able to correctly use and
58 understand the VAS, with age being the best predictor of performance. Importantly, there were no
59 differences in children's abilities to understand to use and understand the VAS based on whether
60 they received a basic or a more intensive amount of training to use it. Pilot work with three 7-8-year
61 olds in our own lab indicated that even children of this older age-range children found abstract visual
62 analogue scales difficult to use and that their ratings did not correspond with verbal explanations of
63 their current hunger/satiety perceptions.

64 Previously developed hunger and satiety rating scales for use with children have generally
65 consisted of figures with manipulated stomach regions as children have been found to reliably
66 associate this body region with feelings of hunger and satiety (Faith, Kermanshah, & Kissileff, 2002).
67 Fisher and Birch (1999) used cartoon figures with varying amounts of food in their stomachs to
68 assess 3-6 year-old children's reported hunger and satiety in the context of an EAH paradigm. The
69 authors only included the data of those children who reported being full after a meal and who had
70 access to snacks afterwards, in their analyses. It remains unclear though how many children were
71 excluded due to a failure to understand the scale.

72 Research by Faith et al. (2002) and Keller et al. (2006) has also focused on the development of
73 measures assessing estimated hunger and satiety. Faith et al. (2002) developed a range of
74 silhouettes to assess satiety in children aged 4-6 years. Silhouettes were gender specific and
75 contained various amounts of food in the stomach regions, allowing children to make judgements of
76 estimated fullness. Based on the research by Faith et al., Keller et al. (2006) developed an analogue
77 scale (Freddy), which consisted of a cardboard cut-out doll, with an adjustable stomach, allowing
78 children to dynamically regulate estimated hunger and satiety. This scale has shown good

79 applicability to estimated hunger and satiety states in children aged 4-5 years and has also been
80 used in the context of real eating episodes. Kissileff, Keller, Lofink, Torres, and Thornton (2008)
81 evaluated the ability of 5-6 year-olds to use the scale to reflect increases in satiety in response to 15
82 individual 15ml portions of a yoghurt shake and found that after two training/testing sessions the
83 majority of the 11 children who participated in their study were able to indicate greater fullness in
84 response to intake.

85 To address the lack of hunger/satiety rating scales that can be used in the context of estimated as
86 well as real eating episodes, we developed a new picture rating scale, "Teddy the Bear", consisting of
87 five pictures of Teddies which had varying amounts of food in their stomachs and which were
88 accompanied by descriptive vignettes. The purpose of the scale was to allow children to make
89 accurate ratings of their current feelings of hunger/satiety. Our studies therefore aimed to establish
90 whether the Teddy scale could be used to measure hunger/satiety in primary school children aged 5-
91 9 years. We assessed children's comprehension of the scale while examining possible effects of age
92 and gender (Study 1) and also assessed the scale's ability to reflect changes in estimated
93 hunger/satiety states (Study 1) and with respect to a real eating episode (Study 2). Additionally we
94 established whether the scale was able to reflect changes in hunger/satiety in the context of the
95 ingestion of an ad libitum snack in a controlled environment (Study 3).

96

97 Study 1

98 Method

99 *Participants*

100 Forty-seven children aged 6 years to 8 years participated in this study. The sample consisted of 27
101 females and 20 males, who were predominantly White British. Children were typically developing
102 and attended years three and four of a primary school in Birmingham, UK. The index of multiple
103 deprivation (2010) for the school and the surrounding areas indicated that the sample of children

104 participating in this study is likely to be drawn from the most deprived 50% of English communities
105 (Index of Multiple Deprivation, 2012).

106 *Measure*

107 For the purpose of this study a picture rating scale, aimed at assessing hunger and satiety was
108 developed. The scale consisted of five black and white cartoon bear silhouettes. Varying amounts of
109 “food” were represented by black ovals in each bears’ stomach area, which increased in size
110 proportionally as the amount of food consumed and the satiety of the bear increased. Each of the
111 five bear silhouettes was accompanied by a label placed above the silhouette, which described the
112 bear’s level of hunger and satiety, starting from 1 (*very hungry*) to 5 (*not hungry at all/very full*) (see
113 Figure 1).

114

115 Figure 1 about here

116

117 *Procedure*

118 The study was conducted over one school day starting at 09:00 and ending at 15:10. Children
119 were tested at school on a one-to-one basis, within a quiet corner of the classroom. Children were
120 asked if they would like to do some work with the researcher and, if they agreed, children were told
121 the story about Teddy the Bear (story outline below). The story had an interactive element; children
122 were asked to rate Teddy’s hunger at two points during the story, while also rating their own
123 currently perceived hunger/satiety state. Each child’s participation lasted for no more than 10
124 minutes. The researcher recorded whether children took part in the study in the morning after
125 breakfast but before a mid-morning snack, in the morning after a mid-morning snack and before
126 lunch or in the afternoon after lunch. Children were given a sticker as a thank you for taking part and
127 returned to their seats following their participation. This study was approved by the Ethical Review
128 Committee of the University of Birmingham.

129 *Story.* The scale's appropriateness to accurately reflect estimated states of hunger/satiety was
130 evaluated through a fictional story, which revolved around "Teddy the Bear". In the story Teddy
131 went to the park, and after spending the whole day there playing he realised that he was very
132 hungry and consequently returned home to prepare and eat a large meal after which he felt very
133 full. (For the full story please see Appendix A)

134 *Stage 1.* Familiarisation with the scale. Initially the researcher introduced the child to the scale by
135 looking at the pictures of Teddy and reading the labels accompanying each picture of Teddy with the
136 child. The child was made aware of the differences between each picture and label and the
137 researcher checked child comprehension by asking the child to tell the researcher how hungry and
138 how full s/he thought the different Teddy bears were.

139 *Stage 2.* Application of scale to estimated hunger and real hunger. The researcher read the story
140 to the child and asked the child to show how hungry s/he thought Teddy was at two time points
141 during the story once prior to a large meal and once after consuming it, by using the scale. Children
142 were also asked to rate how hungry they felt themselves currently by using the scale (see Appendix
143 B for script).

144 *Statistical Analysis*

145 SPSS version 20 statistical software was used to analyse the data. The criterion alpha for significance
146 was .05. Bar graphs were inspected and indicated that the majority of data were not normally
147 distributed; only children's ratings of their own hunger were normally distributed. Nonparametric
148 tests were therefore conducted on all variables except for children's ratings of their own hunger.
149 Initially, children's ratings of hunger/satiety were examined. Spearman's correlations were carried
150 out to examine whether child age was significantly related to children's ratings of hunger/satiety.
151 Additionally, Mann-Whitney U tests were carried out to see if there were differences in children's
152 ratings of Teddy's hunger/satiety based on child gender, while an independent samples t-test was
153 used to establish differences in children's own hunger ratings based on gender. Finally, a Wilcoxon
154 Signed Rank test was used to assess whether children's ratings of Teddy's hunger differed before

155 and after Teddy had a meal, while an independent samples t-test was used to assess whether there
156 were any differences in hunger/satiety levels in children tested before or after lunch.

157

158 Results

159 *Children's ratings of hunger/satiety*

160 Children's ratings of Teddy's hunger/satiety prior to a meal ranged from "Really hungry" (1) to
161 "Not too hungry and not too full" (3) (Median [*Mdn*] hunger rating=1, Interquartile Range [*IQR*]=0).
162 Children's ratings of Teddy's hunger/satiety after a meal ranged from "Really hungry" (1) to "Really
163 full" (5) (*Mdn* hunger rating=5, *IQR*=0). 89.4% ($n=42$) of children correctly rated Teddy as hungry
164 prior to a meal by selecting "Really hungry" (1) or "Slightly hungry" (2) on the picture rating scale in
165 accordance with the story. Furthermore, 91.5% of children ($n=43$) correctly rated Teddy as full after
166 a meal by selecting "Quite full" (4) or "Really full" (5). The data of children who were unable to
167 correctly rate Teddy's hunger/satiety before and after a meal ($n=1$) were excluded from all further
168 analyses. Children's ratings of their own hunger/satiety at the time of testing ranged from "slightly
169 hungry" (2) to "not too hungry and not too full" (3).

170

171 *The impact of age and gender on hunger/satiety ratings*

172 Spearman's correlation analyses were carried out to examine whether child age was related to
173 children's hunger/satiety ratings. Analyses indicated that age did not significantly correlate with
174 children's ratings of Teddy's hunger/satiety before a meal, $r_s(44)=.0$, $p=0.999$ and after a meal,
175 $r_s(44)=-.137$, $p=.364$. Child age was also not related to children's ratings of their own hunger/satiety
176 levels $r_s(44)=.067$, $p=.659$.

177 Mann-Whitney U tests were carried out to examine the effect of gender on hunger/satiety
178 ratings. The tests indicated that females consistently rated Teddy to be hungrier before a meal than
179 males. No other differences in children's ratings of hunger/satiety based on gender were found (see
180 Table 1).

181

182

Table 1 about here

183

184 *Differences in pre-and post-meal hunger/satiety ratings for Teddy and children's own hunger*

185 A Wilcoxon Signed Rank test was carried out to examine whether there was a significant

186 difference in children's ratings of Teddy's hunger/satiety before and after Teddy had a meal. In

187 support of our hypotheses the test revealed that children rated Teddy to be significantly more

188 hungry prior to a meal ($Mdn=1$, $IQR=0$) than after a meal ($Mdn=5$, $IQR=0$), ($Z=6.042$, $p<.001$).189 Additionally, an independent samples *t*-test was carried out to assess whether children's ratings of

190 their own hunger differed before and after having had lunch. Contrary to our hypotheses children's

191 hunger ratings made before lunch ($M=2.47$, $SD=1.23$) did not differ from their ratings made after192 lunch ($M=2.45$, $SD=1.3$), ($t(44)=-.057$, $p=.955$).

193

194

Discussion

195 The results of Study 1 indicate that children are able to use the new picture rating scale to

196 estimate hunger/satiety in Teddy following the descriptions of a hunger and satiety state in a story.

197 In fact around 90% of children correctly estimated hunger and satiety in Teddy, suggesting that the

198 majority of children aged 6-8 years are able to understand and use this scale appropriately. It is

199 unclear however, whether children are able to use the scale as effectively when reporting their own

200 hunger/satiety. Children's hunger/satiety levels did not differ whether they were tested before or

201 after lunch. These results are perhaps unsurprising, as it was not possible to determine the time at

202 which children had consumed breakfast, if they consumed it at all, and what their breakfast

203 consisted of. This meant that there were large variations in children's hunger/satiety ratings in the

204 morning. Additionally, some children consumed a mid-morning snack at 10.30 am, which is likely to

205 have diminished hunger ratings of those children tested after a snack but before lunch. Furthermore,

206 we expected large inter-individual differences in children's hunger and satiety ratings throughout
207 the day based on the between-subjects design of this study.

208 Therefore, to address this study's inability to clarify whether the Teddy scale can be successfully
209 used to measure change in children's hunger/satiety in the context of a real eating episode, Study 2
210 employed a within-subjects design. Some research suggests that girls are more sensitive to
211 researcher demands (Hoffman, 1972). We therefore carried out gender specific analyses of child
212 ratings to establish whether boys and girls differed systematically in their ratings of Teddy's
213 hunger/satiety and of their own hunger. The results of Study 1 indicated that there was only one
214 gender difference in children's hunger/satiety ratings; females were found to rate Teddy as hungrier
215 prior to a meal than males. As this gender difference was only observed for one of the three ratings
216 it is likely to be due to chance and not to a pervasive gender difference. A further study into gender
217 differences in children's hunger/satiety ratings of Teddy may help to clarify the meaning and
218 importance of this finding. Age was not related to any of the children's hunger ratings, suggesting
219 that age was not systematically related to the children's use of the scale, and that the scale is
220 appropriate for research focusing on estimated hunger/satiety ratings with children aged 6-8 years.

221

222

Study 2

223 The results from Study 1 indicated that children were able to use the scale to rate hunger/satiety.
224 Study 1 also suggested that the scale is able to detect changes in estimated/imagined hunger/satiety
225 in response to the story about Teddy the Bear. Nevertheless, it is unclear whether the scale is able to
226 reflect changes in real hunger/satiety. To test this, Study 2 aimed to further assess the use of the
227 picture rating scale to measure hunger/satiety in primary school children aged 5 to 7 years. To
228 address the impact of inter-individual differences in hunger ratings on the scale's ability to reflect
229 variations in hunger, a within-participant design was used to assess differences in children's hunger
230 ratings before and after lunch. We also trialled a group methodology in study 2, to establish whether

231 the scale can be administered effectively to classroom groups rather than requiring one-to-one
232 interaction.

233

234 Method

235 *Participants*

236 Fifty-four children aged 5 years to 7 years participated in this study. The sample consisted of 25
237 females and 29 males, which were predominantly White British. Children were typically developing
238 and attended years three and four of a primary school in Birmingham, UK. The index of multiple
239 deprivation (2010) for the school and the surrounding areas indicated that the sample of children
240 participating in this study is likely to be drawn from the most deprived 50% of English communities
241 (Index of Multiple Deprivation, 2012).

242 *Measures*

243 The previously described Teddy picture rating scale was used (see Method section Study 1, Figure
244 1). Additionally children were asked to provide their age and gender on the provided form.

245 *Procedure*

246 The study was conducted over one school day with two groups of children making hunger and
247 satiety ratings before and after their lunch break at 11.40 and 13.05, respectively. Each one of the
248 two participating classrooms was addressed as a whole and both classrooms were tested in
249 succession over a 15 minute period before lunch and after lunch. Children were seated at their
250 desks, given sheets including questions about their age and gender and including the Teddy rating
251 scale. The Teddy rating scale was repeated on two separate pages so that children could not see the
252 hunger/satiety ratings they made before lunch when they made their hunger/satiety ratings after
253 lunch. Children were told to work on their sheets individually at both time-points. Before lunch, the
254 researcher initially introduced the children to the scale by looking at the pictures and reading the
255 labels accompanying each picture with the children. The children were made aware of the
256 differences between each picture and label. The researcher then read the story about Teddy

257 (described in study 1) and children were asked to make two hunger/satiety ratings for Teddy by
258 circling the bear, which most closely resembled the hunger/satiety states described in the story. This
259 was done to assess children's comprehension of the scale and their ability to correctly use the scale
260 to indicate estimated hunger/satiety. Finally, children were asked to rate their own current
261 hunger/satiety state. After lunch children made one further rating of their own current
262 hunger/satiety state using the scale (see Appendix B for script). The classroom teachers and teaching
263 assistants aided the researcher by ensuring that children attended to the researcher and by
264 addressing questions children had. This study was approved by the Ethical Review Committee of the
265 University of Birmingham.

266 *Statistical analysis*

267 SPSS version 20 statistical software was used to analyse the data. The criterion alpha for
268 significance was .05. Bar graphs were inspected and indicated that the data was not normally
269 distributed. Initially, children's ratings of hunger/satiety were examined. Spearman's correlations
270 were carried out to examine whether child age was significantly related to children's ratings of
271 hunger/satiety; additionally, Mann-Whitney U tests were carried out to assess the effect of gender
272 on children's ratings. Wilcoxon Signed Rank tests were carried out to see whether children's ratings
273 of Teddy's hunger before and after a meal and whether children's ratings of their own hunger before
274 and after lunch differed.

275

276 Results

277 *Children's ratings of hunger/satiety*

278 Children's ratings of Teddy's hunger/satiety before a meal ranged from "Really hungry" (1) to
279 "Really full" (5) (*Mdn* hunger rating=1, *IQR*=0.5), while after a large meal their ratings of Teddy's
280 hunger/satiety ranged from "Really hungry" (1) to "Really full" (5) (*Mdn* hunger ratings=5, *IQR*=1).
281 87% of children ($n=47$) correctly rated Teddy as hungry prior to the meal, by selecting "Really
282 hungry" (1) or "Slightly hungry" (2) on the picture rating scale, while 90.8% of children ($n=49$)

283 correctly rated him as full after the meal, by selecting “Quite full” (4) or “Really full” (5) on the
 284 picture rating scale. The data of children who were unable to correctly rate Teddy’s hunger/satiety
 285 before and after a meal ($n=3$) were excluded from all further analyses. Children’s abilities to
 286 successfully rate hunger/satiety for Teddy did not depend on their age ($U=108$, $z=1.303$, $p=.255$) or
 287 gender ($\chi^2(1, N=54)=.53$, $p=.467$).

288 Children’s ratings of their own hunger/satiety before lunch ranged from “Really hungry” (1) to
 289 “Really full” (5) (Mdn hunger rating=1, $IQR=2$), while their hunger/satiety ratings ranged from “Really
 290 hungry” (1) to “Really full” (5) (Mdn hunger rating=4, $IQR=2$) after lunch. We calculated
 291 hunger/satiety change by subtracting post-meal hunger ratings from pre-meal hunger ratings.
 292 Hunger change scores ranged from -3 to +4, with the average hunger change score being $Mdn=2$
 293 ($IQR=4$), indicating that on average children’s ratings of their own hunger moved up two pictures on
 294 the Teddy rating scale, reflecting a decrease in hunger following lunch.

295

296 *Effects of age and gender on children’s ratings*

297 Spearman’s correlation analyses were carried out to examine whether child age significantly
 298 correlated with children’s ratings of hunger/satiety. Analyses indicated that age did not significantly
 299 correlate with children’s ratings of Teddy’s hunger/satiety before a meal, $r_s(49)=-.049$, $p=.735$, while
 300 it did correlate with children’s ratings of Teddy’s hunger/satiety after a meal, $r_s(49)=-.306$, $p=.029$.
 301 Child age was not related to children’s ratings of their own hunger/satiety before lunch $r_s(49)=-.068$,
 302 $p=.638$ or after lunch $r_s(49)=-.068$, $p=.635$.

303 Mann-Whitney U tests were carried out to examine the effect of gender on hunger/satiety
 304 ratings. The tests indicated that there were no significant differences in children’s ratings of Teddy’s
 305 hunger/satiety prior to and after consuming a meal based on gender. Additionally, child gender did
 306 not affect children’s ratings of their own hunger/satiety before or after lunch (see Table 2).

307

308

Table 2 about here

309

310 *Differences in hunger ratings before and after Teddy's meal and the children's lunch*

311 A Wilcoxon Signed Rank test was carried out to examine whether there was a significant
312 difference in children's ratings of Teddy's hunger/satiety before and after Teddy had a meal. The
313 data for all children, including those who were unable to make accurate ratings of Teddy's hunger
314 before/after a meal were included in this analysis only. The test indicated that children rated Teddy
315 to be significantly more hungry prior to a meal ($Mdn=1$, $IQR=0.5$) than after a meal ($Mdn=5$, $IQR=1$),
316 ($Z=6.089$, $p<.001$). Finally, a Wilcoxon Signed Rank test was carried out to examine whether there
317 was a significant difference in children's ratings of their own hunger/satiety before and after lunch.
318 In line with our hypotheses, children rated themselves as significantly hungrier before lunch ($Mdn=1$,
319 $IQR=2$) compared to after lunch ($Mdn=4$, $IQR=2$), ($Z=4.729$, $p<.001$).

320

321

Discussion

322 The results of Study 2 supported the results of Study 1; children were able to use the scale to
323 make judgements about estimated hunger/satiety in Teddy following a story describing a state of
324 hunger and satiety. Around 89% of children correctly rated Teddy as hungry or full when these states
325 were described in the story. Furthermore, gender did not significantly impact on children's ratings of
326 their own hunger/satiety or estimated hunger/satiety for Teddy. Nevertheless, child age was related
327 to children's ratings of Teddy's hunger in this study, as younger children rated Teddy to be fuller
328 after a meal. These findings may reflect differences in food quantity perception related to age. In the
329 story children heard Teddy consumes a large amount of food; younger children may have perceived
330 the amount of food ingested by Teddy to be larger than older children. This had not been observed
331 in the previous study, and as only one of the ratings children had to make was related to child age,
332 this result may be due to chance, although slightly younger children were included in this sample.

333 Importantly, the results indicate that the scale is able to reflect changes in hunger/satiety in the
334 context of a real eating episode. Children rated themselves as significantly hungrier before lunch

335 compared to after lunch. This suggests that the non-significant findings of Study 1 were likely due to
336 inter-individual differences in children's hunger/satiety ratings as well as to the uncertainty
337 regarding children's consumption of breakfasts and mid-morning snacks. The within-participant
338 design of Study 2 therefore overcomes this particular limitation of Study 1. In Study 2 all children
339 consumed a mid-morning snack at the same time and had an equal amount of time until lunch.

340 All children were tested as a group, at the same time, avoiding any hunger/satiety rating
341 variations due to differences in the time since their last meal. The differences in children's
342 hunger/satiety ratings before and after lunch are therefore likely to be an accurate reflection of the
343 changes in their hunger/satiety perceptions due to the ingestion of their pre-packed lunch foods.
344 Unfortunately, we were unable to establish what each child's lunch consisted of, but pre-post lunch
345 hunger/satiety ratings are likely to correspond loosely with the caloric load of their lunch foods. This
346 would also explain the individual variability in post-lunch hunger/satiety ratings.

347

348 Study 3

349 The results of Study 1 and Study 2 indicated that children were able to use the Teddy picture
350 rating scale to reflect large changes in hunger/satiety in the context of imagined and real eating
351 episodes. Nevertheless, one major limitation of Study 2 was the absence of information regarding
352 children's lunch foods. We were unable to establish how much and what types of food children ate
353 during their lunch break. This caveat meant that we were unable to establish whether our scale is
354 sensitive to changes in hunger in satiety. We aimed to address this limitation in Study 3, by
355 providing children with an ad libitum snack of known composition and quantity. We hypothesized
356 that pre-snack hunger/satiety ratings would be associated with snack ingestion as hungrier children
357 would consume larger amounts of the ad libitum snack. Additionally, we anticipated that snack food
358 intake would be related to a change in rated hunger/satiety in that children who consumed greater
359 amounts of the snack foods would show a greater decrease in hunger compared to children who
360 consumed less of the snack foods.

361 Method

362 *Participants*

363 Thirty-six typically developing children aged 6 to 9 years participated in this laboratory based
364 study. The sample consisted of 19 females and 17 males, who were predominantly White British.
365 The sample consisted of predominantly middle class participants as indicated by parental education
366 level (61.1% of parents had been educated up to a first degree level).

367 *Measures*

368 The previously described Teddy picture rating scale was used (see Method section Study 1, Figure
369 1). Additionally child age and gender as well as parental education were provided by parents.

370 *Procedure*

371 Children and their parents were invited to the Babylab at the University of Birmingham, UK. The
372 study was conducted between April 2012 and July 2013. Participating children and their parents
373 visited the Babylab between 10:00 and 15:00. Parents were told that their children should arrive in a
374 non-fasted state, having consumed all meals and snacks as they usually would prior to attending the
375 Babylab. Children participated individually. Initially the researcher introduced the child to the scale
376 by looking at the pictures and reading the labels accompanying each picture with the child. The child
377 was made aware of the differences between each picture and label. The child was then asked to
378 indicate his/her own hunger using the scale. After this initial hunger/satiety rating the child received
379 a standardised snack consisting of 250g of green grapes, 200g of carrot sticks, 200g of chewy sweets,
380 150g of chocolate chip cookies, 70g of ready salted crisps and 80g of salted pretzels. The child was
381 informed that s/he would be left alone with the snack foods for 10 minutes while the researcher had
382 to do some work in her office. The child was told that s/he could eat as much or as little of the snack
383 foods as s/he liked. The child was monitored from an adjacent room over the 10-minute snack-
384 period. The child made a second hunger/satiety rating two minutes after the end of the snack-period
385 (see Appendix B for script). All snack foods were weighed prior to and immediately after the snack-

386 period. Parents provided written consent prior to their child's participation. This study was approved
387 by the Ethical Review Committee of the University of Birmingham.

388 *Statistical Analysis*

389 SPSS version 20 statistical software was used to analyse the data. The criterion alpha for
390 significance was .05. Bar graphs were inspected and indicated that the data was not normally
391 distributed. The calories that children consumed from each individual snack food were calculated
392 and the overall intake of the snack food in calories was established. Children's ratings of
393 hunger/satiety were examined. Spearman's correlations were carried out to examine whether child
394 age was significantly related to children's ratings of hunger/satiety; additionally, Mann-Whitney U
395 tests were carried out to assess the effect of gender on children's ratings. Wilcoxon Signed Rank
396 tests were carried out to see whether children's ratings of their own hunger before and after an ad
397 libitum snack differed and additionally Spearman's correlations were carried out to assess whether
398 intake in calories was related to baseline hunger/satiety and hunger change.

399

400 Results

401 *Children's ratings of hunger/satiety and ad libitum snack intake*

402 Children's ratings of their own hunger before an ad libitum snack ranged from "Really hungry" (1)
403 to "Really full" (5) (*Mdn* hunger rating=2, *IQR*=2), while their hunger/satiety ratings after an ad
404 libitum snack ranged from "Really hungry" (1) to "Quite full" (4) (*Mdn* hunger rating=2.25, *IQR*=1).
405 We calculated hunger/satiety change by subtracting post-snack hunger ratings from pre-snack
406 hunger ratings. Hunger change scores ranged from -2 to +4 (average hunger change score *Mdn*=0.25
407 [*IQR*=1]). Examining hunger change scores in detail indicated that 3 children reported an increase in
408 hunger following the snack, 15 children reported no change, while 18 children reported a decrease
409 in hunger (see Figure 2 for more detail). The amount of calories children consumed of an ad libitum
410 snack ranged from 79.35 kcal to 765.87 kcal (*Mdn*=268.95, *IQR*=236.14).

411

412 Figure 2 about here

413

414 *Effects of age and gender on children's ratings of hunger/satiety and on ad libitum snack intake*

415 Spearman's correlation analyses were carried out to examine whether child age significantly
416 correlated with children's ratings of hunger/satiety and hunger change. Analyses indicated that age
417 did not significantly correlate with children's ratings of their own hunger/satiety before an ad libitum
418 snack $r_s(34)=-.004$, $p=.982$ or after an ad libitum snack $r_s(34)=.175$, $p=.307$. Child age was also not
419 associated with hunger change $r_s(34)=.165$, $p=.335$ or with the intake of an ad libitum snack
420 $r_s(34)=.125$, $p=.468$.

421 Mann-Whitney U tests were carried out to examine the effect of gender on hunger/satiety
422 ratings and on ad libitum snack intake. The tests indicated that there were no differences in
423 children's pre- or post-snack hunger/satiety ratings, their hunger change or their ad libitum snack
424 intake based on gender (See Table 3). As there were no gender differences in children's ratings and
425 their intake all further analyses were carried out for the sample as a whole.

426

427 Table 3 about here

428

429 *Differences in hunger ratings before and after ad libitum snack intake and associations between*
430 *hunger/satiety ratings and intake*

431 A Wilcoxon Signed Rank test was carried out to examine whether there was a significant
432 difference in children's ratings of their own hunger/satiety before and after an ad libitum snack. In
433 line with our hypotheses, children rated themselves as significantly hungrier before consuming the
434 snack ($Mdn=2$, $IQR=2$) than after consuming the snack ($Mdn=2.25$, $IQR=1$), ($Z=191.5$, $p=.007$).

435 Additionally, Spearman's correlations were carried out to assess whether hunger ratings and hunger
436 change were associated with ad libitum snack intake. These analyses indicated that there was a
437 significant negative correlation between pre-snack hunger/satiety rating and ad libitum snack intake

438 $r_s(34)=-.418, p=.006$, suggesting that those children who felt fuller before consuming an ad libitum
439 snack ingested fewer calories than those children who felt hungrier before consuming the snack (see
440 Figure 3). An inspection of Figure 3 suggested that the reported associations may be driven by a
441 potential outlier; a child who arrived at the lab reporting feeling very full and who consumed few
442 calories during the snack session. To assess whether the reported association was driven by this
443 outlier the analysis was repeated removing the data from this child. The analyses indicated that the
444 relationship between pre-snack hunger remained significant $r_s(33)=-.401, p=.017$. While caloric intake
445 was not related with post snack hunger/satiety rating $r_s(34)=-.147, p=.197$ it was positively
446 correlated with hunger change $r_s(34)=.301, p=.037$, indicating that children who ate more of the ad
447 libitum snack indicated a greater decrease in hunger than those children who consumed less of the
448 snack (see Figure 3).

449

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Figure 3 about here

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Discussion

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Study 3 aimed to establish whether our new Teddy picture rating scale was able to reflect changes in hunger and satiety that were related to the intake of an ad libitum snack. The results of Study 3 are in line with findings from Study 1 and Study 2. The results of this final study give some indication that children may be able to use the scale to reflect changes in hunger and satiety in line with their intake. A replication of this final study and its findings in a larger sample, under controlled administration of test foods would be desirable and would allow firmer conclusions regarding the scale's ability to reflect changes in hunger and satiety in relation to intake. The results of the study do not just indicate that child intake is associated with pre-snack hunger ratings, but also suggest that changes in children's ratings of hunger and satiety are proportionate to their intake. Additionally, we found no age or gender effects in the final study, further supporting our previous

463 suggestions that individual age and gender effects observed in Study 1 and Study 2 are likely to be
464 due to chance rather than to pervasive age or gender effects.

465

466 Overall Discussion

467 The majority of primary school children are able to self-report feelings of hunger/satiety using a
468 new picture rating scale. In Study 1 and Study 2, which included large samples of children, around
469 90% of children were able to make correct judgements of hunger and satiety for Teddy. Similar
470 levels of accuracy in estimated hunger and satiety ratings have previously been reported by Faith et
471 al. (2002), who measured children's abilities to rate hunger and satiety with gender specific
472 silhouettes. While Faith et al. did not assess children's ratings of hunger and satiety for real eating
473 episodes, Study 2 and study 3 indicate that children, individually and in a group setting, are able to
474 rate their own hunger and satiety in an eating context, using the new scale. Study 3 additionally
475 shows that children's ratings of hunger/satiety are related to their intake of an ad libitum snack.

476 Study 2 and Study 3 also show that the majority of children were able to make ratings of hunger
477 and satiety with very little training and instruction, which indicates that the scale could be used in
478 studies in which the time for instruction and testing is limited. Our results indicate that children's
479 ratings of hunger and satiety were largely unaffected by child gender and child age, suggesting that
480 the scale can be used for samples of males and females aged 5-9 years.

481 It could be argued that children were simply mimicking the ratings they made for Teddy before
482 and after the meal he ate, and that they were not using the scale to rate their own satiety
483 perceptions. Nevertheless, it appears unlikely that children's ratings of their own hunger were
484 significantly affected by their ratings of Teddy's hunger. In Study 1, children only rated their own
485 hunger at one time point, but made two ratings of Teddy's hunger prior to that. In Study 2 children
486 heard the story of Teddy only before lunch and made their own hunger ratings immediately after
487 making ratings of Teddy. The final rating of Teddy's hunger that was made by children in Study 1 and
488 Study 2, was rating Teddy as very full. Nevertheless, our results indicate that the vast majority of

489 children rated themselves as very hungry to hungry immediately after making this rating for Teddy,
490 indicating that their own ratings were not influenced or primed by their previous rating of high
491 fullness for Teddy. In Study 2 children did not hear the story about Teddy before making their
492 second hunger/satiety rating after lunch. Instead they were simply asked to rate how hungry or full
493 they were feeling at this moment. Here their ratings would not have been influenced by any
494 immediately preceding rating of Teddy. In Study 3 children received instructions on how to use the
495 scale, but did not hear the story about Teddy the Bear avoiding any risk of children mimicking a
496 previous rating. Additionally, in all three studies specific emphasis was placed on children thinking
497 about their “own hunger” and on how their tummies felt “right now”.

498 In study 3 the time span between the end of the 10 minute snack period and children’s
499 subsequent ratings of hunger was very short and it is possible that the development of fullness
500 perceptions may take longer to develop. Although we are reassured that this period was sufficient
501 for an initial perception of fullness to develop, as overall children felt hungrier before the snack than
502 after the snack the relationship between intake and fullness perception may have been stronger if
503 there had been a greater delay between intake and fullness rating.

504 As previously suggested by Faith et al. (2002), children were able to reliably make choices about
505 hunger and satiety that exceeded a binary choice option (hungry/full). Children’s ratings of pre- and
506 post-meal and snack hunger were not limited to ratings of “really hungry” (1) and “really full” (5) but
507 spanned across all five response categories.

508 Research with adults and children has indicated that visual analogue scales are more sensitive to
509 subtle changes in bodily states than categorical rating scales like the Teddy Scale (Joyce, Zutshi,
510 Hrubes, & Mason, 1975). One limitation of our scale is therefore its reduced ability to capture more
511 subtle changes in hunger and satiety states changes (Flaherty, 1996; Keller et al., 2006).
512 Nevertheless, categorical rating scales have been shown to be less affected by issues such as
513 reliability when administered repeatedly to measure fluctuating states such as mood or hunger
514 (Dovey, 2010; McCormack, Horne, & Sheather, 1988). Our own findings as well as findings by Faith et

515 al. (2002) indicate that children are able to make hunger and satiety estimates and ratings using
516 categorical scales. Additionally, categorical scales seem to be easy to use, requiring little instruction
517 compared to visual analogue scales (Keller et al. 2006).

518 Not all children who participated in our studies were able to make accurate ratings of estimated
519 hunger and satiety in Teddy. It is possible that these children had not yet developed the cognitive
520 skills and competencies necessary to use a categorical rating scale. It is important to note that those
521 children who failed to make correct ratings did not differ in age or gender from those children who
522 made accurate ratings. As only few children failed to use the scale correctly it may be appropriate to
523 assume that these children did not pay adequate attention during the introduction of the scale or
524 that they did not follow the story due to being distracted or bored. Finally, it may also be feasible
525 that these children would have benefitted from further instruction or practice.

526 A further limitation to this study is that children were not asked to make partial satiety estimates
527 of Teddy's hunger. Research has indicated that these ratings are much more difficult for children to
528 make and that these ratings are also less reliable. One suggestion for future research and validations
529 of the Teddy scale would therefore be to ask children to make ratings at various time-points during
530 Teddy's meal and during a real meal.

531 The generalizability of our findings is limited as our sample consisted of predominantly White
532 British children. Based on the Index of Multiple Deprivation calculated for the school and its
533 surrounding areas and on parents' reports of their education level we can also assume that children
534 had low to middle class family backgrounds. It is therefore essential to assess the applicability of our
535 scale to more ethnically and socioeconomically diverse samples in future studies.

536

537 Conclusions

538 Overall, our results indicate that the newly developed hunger and satiety rating scale "Teddy the
539 Bear" can be used by the majority of primary school children to make ratings of hunger and satiety
540 regarding estimated and real eating episodes. The scale's ability to capture associated changes in

541 hunger and satiety needs to be further investigated. The scale may be useful for researchers aiming
542 to establish hunger and satiety states and changes in children. Furthermore, the scale may be useful
543 for interventions focusing on improving children's awareness of hunger and satiety in order to foster
544 healthier eating behaviour as well as teaching children at risk for overweight/obesity about the
545 appropriate timing of the initiation and termination of eating episodes.

546

547 Acknowledgements

548 We would like to thank the school and all the pupils for their participation.

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Appendix A

Last Sunday, Teddy went to the park to watch the birds and squirrels play in the sun. Teddy spent all morning walking around the park and sitting underneath the trees watching the birds and squirrels play. As time went by Teddy started to feel very hungry, it had been a long time since he had eaten his breakfast. Teddy's belly was rumbling and he couldn't wait to get back home to have his lunch. He started to walk home thinking of all the food he would love to eat (Child rating). After Teddy got home he started to make his lunch. He got out bread, cheese and salad, crisps, cookies and chocolate and poured himself a large glass of juice/milk. He then started to slice little tomatoes, cucumber, and some onion to put on his sandwich. He then buttered the bread, sliced the cheese and put it all together. It was a huge sandwich. Teddy started to eat the sandwich; he also ate a whole bag of crisps, and drank some of his juice/milk. After finishing the sandwich and crisps Teddy also ate loads of biscuits and chocolate and drank the rest of the juice/milk. His belly was so full Teddy could barely move. He was definitely not hungry anymore (Child Rating).

Appendix B

Script for children's own hunger ratings Study 1:

"Now that you've heard about the story of Teddy the Bear I was wondering if you could tell me about how hungry you are feeling right now. If you think about your own tummy and how empty or full it is right now, which Teddy would you say shows me how hungry or how full you are feeling. There is no right or wrong answer; this is just about how you feel." (Brief pause followed by restating all the scale points).

Script for children's own hunger ratings Study 2:

Before lunch/First rating - "Now that you've heard about the story of Teddy the Bear I was wondering if you could tell me about how hungry you are feeling right now. If you think about your own tummy and how empty or full it is right now, which Teddy would you say shows me how hungry or how full you are feeling. There is no right or wrong answer; this is just about how you feel." (Brief pause followed by restating all the scale points).

After lunch – If you think about your own tummy and how empty or full it is right now, which Teddy would you say shows me how hungry or how full you are feeling. There is no right or wrong answer; this is just about how you feel." (Brief pause followed by restating all the scale points).

Script for children's own hunger ratings Study 3:

Before snack - "I was wondering if you could tell me about how hungry you are feeling right now. If you think about your own tummy and how empty or full it is right now, which Teddy would you say shows me how hungry or how full you are feeling. There is no right or wrong answer; this is just about how you feel." (Brief pause followed by restating all the scale points).

After lunch – If you think about your own tummy and how empty or full it is right now, which Teddy would you say shows me how hungry or how full you are feeling. There is no right or wrong answer; this is just about how you feel." (Brief pause followed by restating all the scale points).

Table 1

Differences in Hunger/Satiety ratings between Males (N=20) and Females (N=27)

Variable	Males	Females	Test statistics	Significance
Teddy's hunger pre-meal	<i>Mdn</i> =1 (<i>IQR</i> =0)	<i>Mdn</i> =1 (<i>IQR</i> =1)	<i>U</i> =195.5, <i>z</i> =-2.07	<i>p</i> =.039; F>M
Teddy's hunger post-meal	<i>Mdn</i> =5 (<i>IQR</i> =0)	<i>Mdn</i> =5 (<i>IQR</i> =0)	<i>U</i> =240, <i>z</i> =-.71	<i>p</i> =.478
Child's current hunger ¹	<i>M</i> =2.2 (<i>SD</i> =1.4)	<i>M</i> =2.65 (<i>SD</i> =1.13)	<i>t</i> =1.22	<i>p</i> =.23

¹The variable "Child's current hunger" was normally distributed. Mean and SD are therefore provided and an independent samples *t*-test was carried out.

Table 2

Differences in Hunger/Satiety ratings between Males (N=28) and Females (N=23)

Variable	Males	Females	Test statistics	Significance
Teddy's hunger pre-meal	<i>Mdn</i> =1 (<i>IQR</i> =0)	<i>Mdn</i> =1 (=0)	<i>U</i> =316.5, <i>z</i> =-.145	<i>p</i> =.885
Teddy's hunger post-meal	<i>Mdn</i> =5 (<i>IQR</i> =0.75)	<i>Mdn</i> =5 (<i>IQR</i> =1)	<i>U</i> =360.5, <i>z</i> =.917	<i>p</i> =.359
Child's hunger pre-lunch	<i>Mdn</i> =1 (<i>IQR</i> =2)	<i>Mdn</i> =1 (<i>IQR</i> =2)	<i>U</i> =337.5, <i>z</i> =.326	<i>p</i> =.744
Child's hunger post-lunch	<i>Mdn</i> =3.5 (<i>IQR</i> =2)	<i>Mdn</i> =4 (<i>IQR</i> =2)	<i>U</i> =286.5, <i>z</i> =-.706	<i>p</i> =.48

Table 3

Differences in Hunger/Satiety ratings and ad libitum snack intake between Males (N=17) and Females (N=19)

Variable	Males	Females	Test statistics	Significance
Child's hunger prior to ad libitum snack	<i>Mdn</i> =1.5 (<i>IQR</i> =1.5)	<i>Mdn</i> =2 (<i>IQR</i> =1)	<i>U</i> =103.5, <i>z</i> =-1.93	<i>p</i> =.066
Child's hunger after ad libitum snack	<i>Mdn</i> =2 (<i>IQR</i> =1)	<i>Mdn</i> =2.5 (<i>IQR</i> =1)	<i>U</i> =141, <i>z</i> =-.681	<i>p</i> =.531
Hunger change (post snack-pre-snack)	<i>Mdn</i> =0.5 (<i>IQR</i> =1)	<i>Mdn</i> =0 (<i>IQR</i> =1)	<i>U</i> =191.5, <i>z</i> =.996	<i>p</i> =.346
Ad libitum snack intake (calories)	<i>Mdn</i> =259.95 (<i>IQR</i> =345.96)	<i>Mdn</i> =277.946 (<i>IQR</i> =204.86)	<i>U</i> =186, <i>z</i> =.776	<i>p</i> =.452

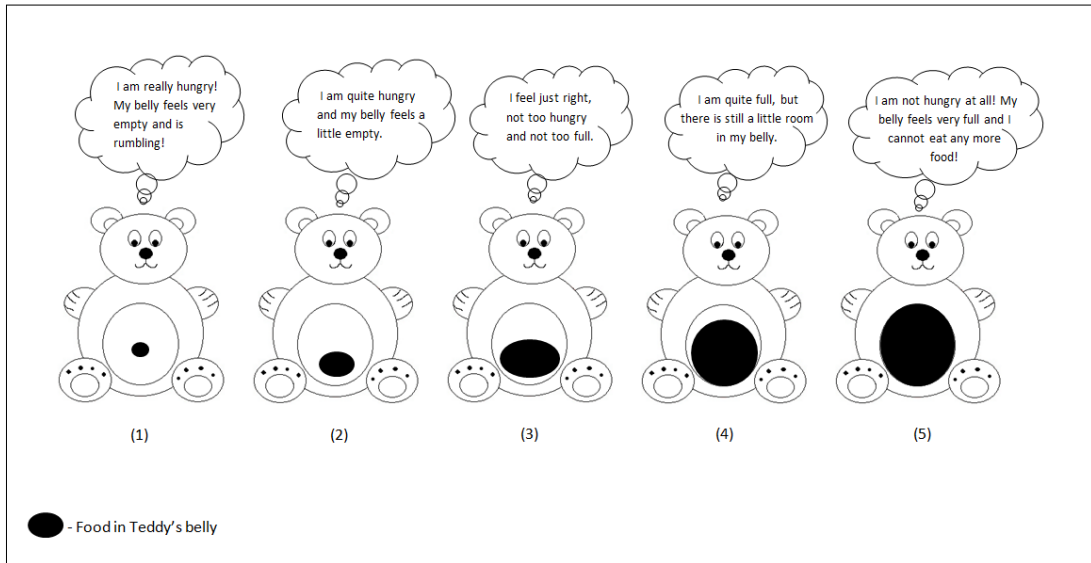


Figure 1. Hunger and Satiety Rating Scale: Teddy the Bear

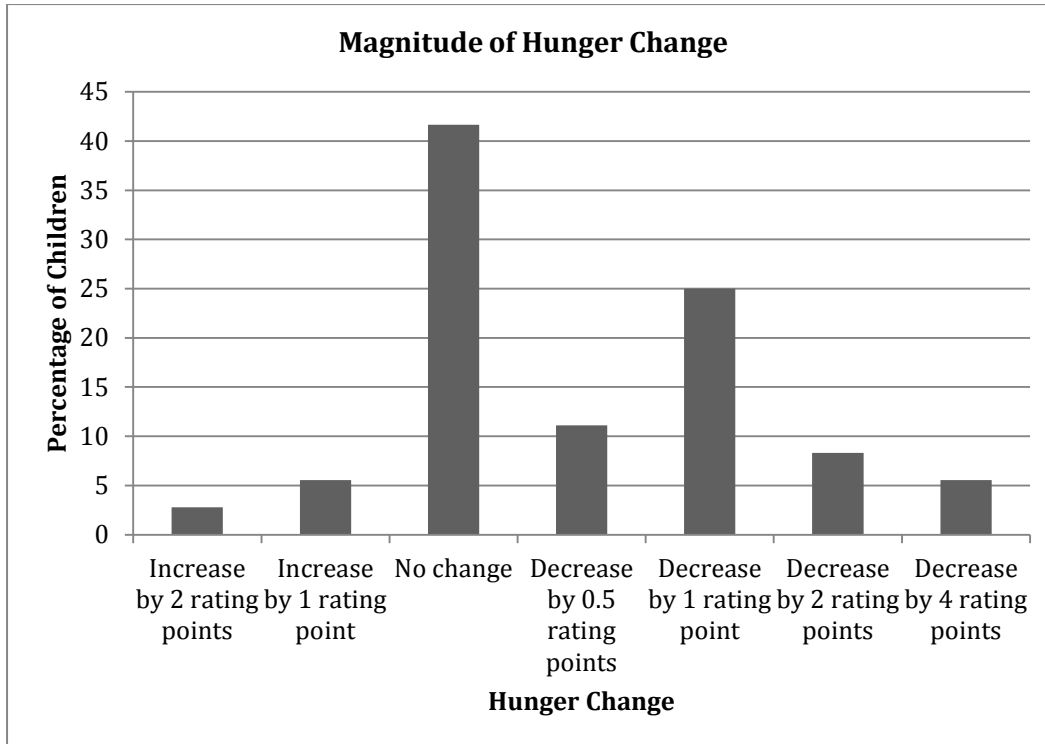


Figure 2. Percentage of children whose hunger remained the same, increased or decreased after consuming a snack and magnitude of the associated change in hunger

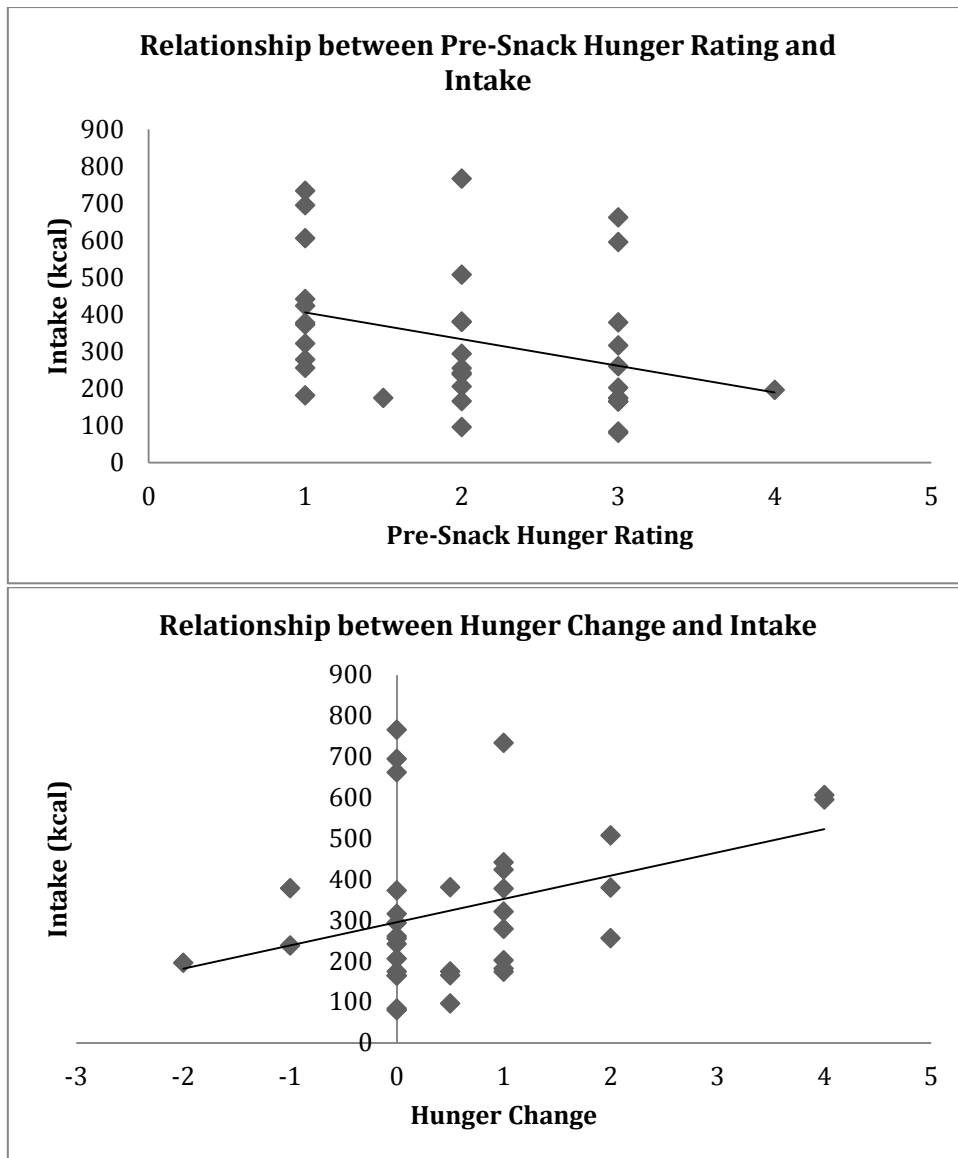


Figure 3. Plots of the relationships between pre-snack hunger rating and subsequent ad libitum snack intake and hunger change rating and ad libitum snack intake