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## Validation of the Teddy the Bear Hunger and Satiety Rating Scale in 3-5-year-old children

Katie L Edwards <sup>1,2\*</sup>, Abigail Pickard <sup>1,3</sup>, Claire Farrow <sup>1</sup>, Jacqueline Blissett <sup>1</sup>

### Affiliations

<sup>1</sup> School of Psychology and Institute of Health and Neurodevelopment, Aston University, Birmingham, UK

<sup>2</sup> School of Psychology, University of Birmingham, Birmingham, UK

<sup>3</sup> Department of Clinical Psychology, School of Health in Social Science, University of Edinburgh, Edinburgh, UK

\*Corresponding author: Dr Katie L Edwards ([k.l.edwards@bham.ac.uk](mailto:k.l.edwards@bham.ac.uk)), School of Psychology, University of Birmingham, Birmingham, B15 2TT, UK

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**1 Abstract**

2 Using validated measures to assess children's hunger and satiety is important for eating  
3 behaviour research. Pictorial rating scales, such as the Teddy the Bear Hunger and Satiety  
4 Rating Scale (Bennett & Blissett, 2014), provide a child-friendly approach to assess hunger  
5 and satiety. The Teddy the Bear scale has been validated for use with primary school aged  
6 children (5-9 years); however, the scale has not been validated for use with preschoolers (3-  
7 5 years). Children's hunger ratings may also differ depending on individual characteristics,  
8 for example, their eating profile, but this remains to be examined. Hence, this validation  
9 study included preschool children aged 3-5-years-old ( $N=115$ , 45 male, 70 female) who had  
10 been identified as having either typical ( $n=76$ ) or avid ( $n=39$ ) eating behaviour profiles.  
11 Children consumed a standardised meal and rated their pre- and post- meal hunger using  
12 the Teddy the Bear scale. Differences in pre- and post-meal ratings between children with  
13 typical and avid eating profiles and differences in ratings of boys and girls were also  
14 examined. Findings showed that children reported lower hunger ratings after a standardised  
15 meal, compared to before a standardised meal. There was no difference in hunger ratings  
16 between children's eating profiles. However, exploratory analyses demonstrated that greater  
17 probability of having an avid eating profile was associated with greater change in ratings,  
18 and that greater energy intake was significantly associated with greater change in ratings.  
19 Overall, the Teddy the Bear scale may be a valid measure for assessing preschool children's  
20 hunger and satiety which is sufficiently sensitive to capture changes resulting from ingesting  
21 a meal. However, the scale may be less suitable for use with children aged 3 years.

22 **Keywords:** Children's eating behaviour; Hunger; Satiety; Eating in the absence of hunger

23

## 24 1. Introduction

25           Hunger and satiety are key mechanisms which regulate food intake. According to the  
26 Satiety Cascade (Blundell et al., 1987), hunger refers to the drive to consume (e.g., eating a  
27 meal) and satiety refers to the process which inhibits further eating (e.g., the suppression of  
28 hunger). Children's general sensitivity to internal cues of fullness is often measured via  
29 parent-report on the Satiety Responsiveness subscale of the Children's Eating Behaviour  
30 Questionnaire (CEBQ) (Wardle et al., 2001). Research using the CEBQ has shown that  
31 children differ in their parent-reported satiety responsiveness (Pickard et al., 2023), with  
32 poorer satiety responsiveness associated with greater energy intake (Carnell & Wardle,  
33 2007; Mallan et al., 2014; Syrad et al., 2016) and higher BMI (Kininmonth et al., 2021). Thus,  
34 it is important to accurately measure children's hunger and satiety given the important role  
35 these mechanisms play in appetite regulation. While the CEBQ provides an important  
36 indicator of children's general appetitive traits from a parent perspective, it does not allow the  
37 assessment of 'in the moment' hunger states in children.

38           Pictorial rating scales are often used to assess children's fullness (Bennett & Blissett,  
39 2014; Faith et al., 2002; Fisher & Birch, 1999; Keller et al., 2006). However, there are few  
40 validated measures to examine perceptions of children's own hunger and satiety, specifically  
41 in preschool children who may find it more challenging to understand task instructions and  
42 the concepts of hunger and fullness. Research has developed several pictorial rating scales  
43 to assess young children's hunger and satiety. For example, following an ad-libitum lunch,  
44 preschool children's hunger was measured using a rating scale of three cartoon figures with  
45 an empty, half-empty and full stomach (Fisher & Birch, 1999). However, previous research  
46 has used the scale to exclude children (e.g., only children who reported being "full" were  
47 used in analyses; Fisher & Birch, 1999, 2000, 2002), for sensitivity analyses (Hohman et al.,  
48 2022), or as a covariate (e.g., Miller et al., 2019), rather than in formal analyses to validate  
49 the scale with food intake or individual characteristics. Additionally, Faith and colleagues  
50 (2002) developed a rating scale of child silhouettes with different amounts of 'food' depicted  
51 in their stomachs. Findings showed that 4-6-year-olds could accurately rate their imagined  
52 fullness using the scale. Another rating scale was developed by Keller and colleagues  
53 (2006), which involved an analogue scale of a cardboard cut-out doll ('Freddy Fullness  
54 Scale') with a sliding bar in its stomach to indicate levels of fullness. Children aged 4-5 years  
55 were shown pictures of different portion sizes of fries and a fruit salad and rated the doll's  
56 hypothetical fullness. Most children were found to accurately estimate fullness in response to  
57 different portion sizes. While each scale has been used to measure children's perceived  
58 hunger and satiety, research is yet to fully establish how ratings on these measures relate to  
59 actual food intake or individual characteristics (e.g., appetitive traits). One scale that has

60 been validated with children's food intake is the Teddy the Bear Hunger and Satiety Rating  
61 Scale ('Teddy the Bear'), developed by Bennett and Blissett (2014). The scale includes 5  
62 vignettes of teddy bears, rather than depicting a child, with increasing amounts of 'food' in  
63 their stomachs. A short fictional story was used to check children's understanding of the  
64 scale and showed good accuracy. Findings also showed that children rated themselves as  
65 hungrier before a meal or snack, compared to after a meal or snack. While the scale  
66 appears to accurately reflect perceived hunger and satiety by primary school children (aged  
67 5-9 years), research is yet to validate the Teddy the Bear picture rating scale for use in  
68 younger groups. Establishing this is important given that research has suggested that  
69 pictorial rating scales may be less accurate for use with children under 54 months old (Keller  
70 et al., 2006), therefore, we need to establish whether this scale can be used to accurately  
71 and appropriately measure younger children's hunger and satiety.

72 One factor that may influence children's perceptions of hunger and satiety is a child's  
73 unique eating behaviour profile. Using Latent Profile Analysis on data from the Children's  
74 Eating Behaviour Questionnaire (CEBQ), we identified four distinct eating profiles in UK  
75 preschool children (avid, avoidant, happy and typical), with an avid eating profile conferring  
76 greater risk for the development of obesity (see Pickard et al., 2023 for full details of each  
77 eating profile). Avid eating behaviour is characterised by greater levels of food  
78 responsiveness, enjoyment of food, and emotional over-eating, and lower levels of food  
79 fussiness, satiety responsiveness, and slowness in eating. The most common eating profile,  
80 typical eating behaviour, is characterised by standardised z-scores that were close to zero  
81 for all appetitive traits measured by the Children's Eating Behaviour Questionnaire (Pickard  
82 et al., 2023). Indeed, research has shown that preschool children with avid eating behaviour  
83 have poorer satiety responsiveness compared to children with typical eating behaviour  
84 (Pickard et al., 2023). While this study used parent-report measures of satiety  
85 responsiveness, the findings suggest that children's ability to recognise hunger and satiety  
86 cues may differ depending on their eating profile. Establishing whether differences in  
87 children's report of their hunger differs between eating profiles will determine whether the  
88 Teddy the Bear scale is appropriate for use with all children irrespective of their appetite  
89 traits, or whether children with avid eating behaviour might benefit from more guidance with  
90 recognising their own hunger or fullness.

91 To our knowledge, previously developed pictorial ratings scales remain to be formally  
92 validated using measures of food intake and/or across different populations (e.g., individual  
93 differences in demographics or appetitive traits). While the Teddy the Bear rating scale  
94 appears a useful measure for assessing primary school children's own perceptions of their  
95 hunger and satiety (Bennett & Blissett, 2014), it remains to be validated with younger

96 children who may find it more difficult to understand. Furthermore, parent-report measures  
97 show that the ability to recognise fullness cues differs between preschool children's eating  
98 profiles (Pickard et al., 2023), however, research is yet to examine whether children's own  
99 perceptions of their current hunger state differ between eating profiles. While the Teddy the  
100 Bear scale conceptualises hunger and satiety as opposite ends of the same scale, we refer  
101 to the scale as measuring 'hunger' because we assessed children's drive to consume food.  
102 Hence, this study aimed to validate the Teddy the Bear hunger rating scale for use with  
103 preschool children (3-5 years). Establishing valid and appropriate measures for use across a  
104 range of populations is essential for improving our understanding of the development of  
105 children's eating behaviour. Based on the validation of the scale in older children (Bennett &  
106 Blissett, 2014), it was hypothesised that after eating a standardised meal, children would  
107 report lower hunger ratings, compared to their ratings before eating a standardised meal.  
108 Children with avid eating behaviour are reported to have poorer satiety responsiveness  
109 (Pickard et al., 2023), thus, it was hypothesised that hunger ratings pre- and post- a  
110 standardised meal would be higher for children with avid eating behaviour, compared to  
111 children with typical eating behaviour.

## 112 **2. Method**

113 The data for this study come from a larger experimental laboratory study which  
114 examined the effectiveness of two parental feeding strategies on reducing palatable snack  
115 intake by children with avid and typical eating behaviour (see Edwards et al., 2024, Preprint)  
116 The examination of other research questions which relate to the experimental study have  
117 been pre-registered separately on the Open Science Framework (<https://osf.io/r6789/>). The  
118 current study was pre-registered on the Open Science Framework prior to data collection  
119 (<https://osf.io/mtf36>).

### 120 **2.1. Participants**

121 Preschool children aged 3-5 years old ( $N=132$ ) participated in a laboratory study with  
122 their parents as part of the APPETItE project (Appetite in Preschoolers: Producing Evidence  
123 for Tailoring Interventions Effectively; <https://www.appetite-research.com/>). Participants were  
124 recruited from areas local to Birmingham, UK, via online advertisements, such as social  
125 media, posters, and mailing lists. Local nurseries and primary schools were also contacted  
126 and asked to circulate the study advert to parents. Children who are autistic, or who have  
127 severe learning disabilities or a chronic illness that directly influences their dietary  
128 requirements and eating habits were not eligible to take part. Parents and children with food  
129 intolerances to the study foods, or food allergies were not eligible to participate. Aston

130 University Health and Life Sciences Research Ethics Committee (HLS21132) provided  
131 ethical approval.

## 132 **2.1. Measures**

### 133 **2.1.1. Questionnaires**

134 Before attending the laboratory session, parents provided information about  
135 children's demographics (e.g., age, sex) and completed the Children's Eating Behaviour  
136 Questionnaire (CEBQ) (Wardle et al., 2001). The CEBQ assesses parent-report of children's  
137 appetite traits across eight subscales: Food Responsiveness – eating in response to  
138 external food cues (4 items, e.g., 'Given the choice, my child would eat most of the time');  
139 Satiety Responsiveness – sensitivity to internal fullness cues (5 items, 'My child gets full up  
140 easily'); Enjoyment of Food – subjective pleasure from eating (4 items, e.g., 'My child loves  
141 food'); Food Fussiness – food selectiveness (7 items, e.g., 'My child refuses new foods at  
142 first'); Slowness in Eating – speed of food consumption (4 items, e.g., 'My child eats slowly');  
143 Emotional Overeating – eating more in response to negative emotions (4 items, e.g., 'My  
144 child eats more when worried'); Emotional Undereating – eating less in response to negative  
145 emotions (4 items, e.g., 'My child eats less when upset'); Desire to Drink – desire to  
146 consume drinks (3 items, e.g., 'My child is always asking for a drink'). Data from CEBQ  
147 subscales was used to identify children's avid or typical eating profiles to recruit participants  
148 (see supplementary material 2 for z-scores for CEBQ subscales, split by avid and typical  
149 eating profiles). Using the Latent Profile Analysis solution from our previous study, CEBQ  
150 scores were standardised against CEBQ data from a representative UK sample of 995  
151 preschool children (see Pickard et al., 2023). The Latent Profile Analysis assigns each  
152 participant a probability of belonging to a profile, with values closer to 1.0 indicating higher  
153 likelihood of assignment to a specific profile. Using this approach ensured that we were able  
154 to compare children who showed the distinctive avid eating behaviour profile and compare  
155 them to children with a typical eating profile.

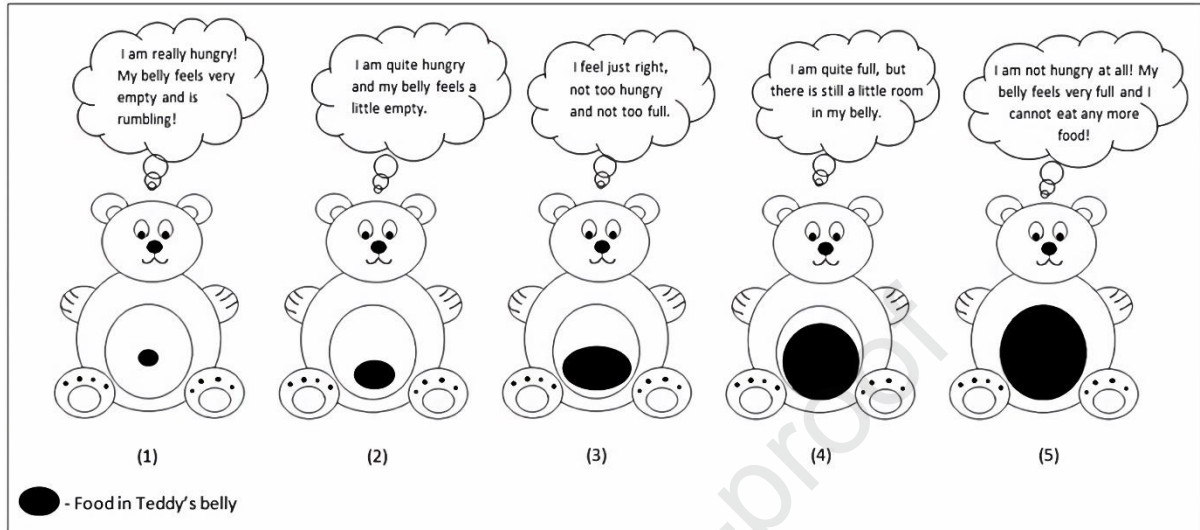
### 156 **2.1.2. Teddy the Bear Hunger and Satiety Rating Scale**

157 The Teddy the Bear hunger and satiety rating scale (Bennett & Blissett, 2014) was  
158 used to assess children's hunger pre- and post- a standardised meal, and to determine  
159 preschool children's understanding of the scale. The scale includes 5 black and white  
160 cartoon bear silhouettes which each have a different amount of 'food' in their stomach, as  
161 indicated by a black oval. Each bear silhouette has a label to describe their hunger, with  
162 lower scores indicating greater hunger and higher scores indicating greater satiety: 1 = very  
163 hungry, 2 = quite hungry, 3 = just right, 4 = quite full, and 5 = very full / not hungry at all (see



164 Figure 1). Primary outcome measures were children's ratings of Teddy's and their own  
 165 hunger and satiety before and after a standardised meal.

166



167

168 **Figure 1.** Teddy the Bear: Hunger and satiety rating scale taken from Bennett & Blissett  
 169 (2014) with permission<sup>1</sup>.

170

### 171 2.3. Procedure

172 Parent-child dyads attended the observational laboratory at the Institute of Health  
 173 and Neurodevelopment, Aston University. Sessions took place from Monday to Saturday  
 174 between 11am and 6pm and lasted approximately 90 minutes. Parents were asked not to  
 175 give their child a meal immediately before the session (i.e., not having lunch before a  
 176 lunchtime session or dinner before a dinnertime session). Upon arrival, children were  
 177 informed about the tasks they would be completing during the session and if willing, provided  
 178 assent for their participation. The researcher introduced children to the Teddy the Bear rating  
 179 scale by reading through each description on the scale and making the child aware of the  
 180 differences between each picture and label. Children were then read a fictional story about  
 181 Teddy the Bear, which asked them to use the scale to rate how hungry Teddy felt at time  
 182 point 1 (before Teddy ate a meal) and at time point 2 (after Teddy ate a large meal). Ratings  
 183 of Teddy's hunger were recorded to assess children's understanding of the scale. See  
 184 supplementary material 1 for the full script.

<sup>1</sup> This image was originally published in *Appetite*, Vol 78, Bennett & Blissett, Measuring hunger and satiety in primary school children, 40-48, Copyright Elsevier (2014).



185 After finishing the story, children were asked to use the scale to rate how hungry or  
186 full they felt. Following this, parent-child dyads were given a standardised meal to consume  
187 until they reached satiety (Blissett et al., 2010; Stone et al., 2023). The meal included a  
188 sandwich (one for children and two for parents) with an optional filling of chicken, cheese, or  
189 hummus. White bread rolls were used for all sandwiches and butter was optional. Each meal  
190 also included 3 apple slices, 5 cucumber batons, 1 cookie, and 5 savoury crackers. Parent-  
191 child dyads were told they could eat as much or as little as they liked from their own plates,  
192 and that they could ask for more food if they wanted, though none did. Pre- and post- meal  
193 weights (in grams) were recorded to calculate children's energy intake (in kilocalories).  
194 Following the meal, researchers reiterated each rating point on the Teddy the Bear scale,  
195 and children were asked to rate how hungry or full they felt using the scale. Parent-child  
196 dyads then completed the rest of the study session. See Edwards et al. (2024, Preprint) for  
197 details of the full laboratory study procedure.

## 198 **2.4. Statistical analysis**

199 Data were analysed using SPSS Version 29. As expected, a Shapiro-Wilk test  
200 showed that Teddy and child hunger ratings were not normally distributed ( $p < .001$ ). While  
201 parametric and non-parametric tests showed the same pattern of results, parametric tests  
202 are presented to allow for the inclusion of covarying variables in main analyses. Differences  
203 in hunger ratings between child age (Pearson's correlations) and sex (independent t-tests)  
204 were examined as potential covariates. Measures that were significantly associated with, or  
205 differed between, outcome variables were included as covariates in main analyses.

206 The main analyses included examining differences in children's hunger ratings before  
207 and after a standardised meal (repeated measures ANCOVA). Whilst our pre-registered  
208 analysis states that an independent samples t-test will examine differences in hunger ratings  
209 between children's eating profiles, a between-subjects ANCOVA was conducted to include  
210 relevant covariates.

211 Exploratory analyses examined the relationship between change in hunger ratings,  
212 calculated as pre-meal minus post-meal hunger ratings, with meal intake, the probability of  
213 children belonging to an avid or typical eating profile, and scores on individual subscales of  
214 the CEBQ (Pearson's correlations). Greater change scores indicate a greater shift from  
215 feeling hungry to full on the rating scale.

## 216 **3. Results**

### 217 **3.1. Sample characteristics**

218 In total, 132 children participated. Three children were excluded from analyses  
 219 because they were identified as having an avoidant eating profile. Children who did not  
 220 provide a response for the Teddy the Bear rating scale at any of the four data recording  
 221 points were deleted listwise ( $n = 14$ ). Hence, the final sample comprised 115 children (70  
 222 females, 45 males). Children had a mean age of 50.58 months (range = 36.6 - 71.4) and  
 223 were identified as having an avid ( $n = 39$ ; 21 females, 18 males) or typical ( $n = 76$ ; 49  
 224 females, 27 males) eating profile. BMI data were available for all children, with a mean z-  
 225 score of 0.48 (SD = 0.91) and a mean waist circumference of 55.91cm (SD = 3.92).

### 226 3.2. Descriptive statistics of children's hunger ratings

227 More than half of children correctly rated Teddy's pre-meal hunger as "very hungry"  
 228 (1) or "quite hungry" (2) ( $n = 65$ ; 56.5%), and Teddy's post-meal satiety as "very full" (5) or  
 229 "quite full" (4) ( $n = 85$ ; 73.9%). Children's ratings of their own pre-meal hunger ranged from 1  
 230 to 5. Most children rated their post-meal hunger as "very full" (5) ( $n = 77$ , 67%). See Table 1  
 231 for children's ratings. However, 17 children (14.9%) reported greater hunger ratings after the  
 232 standardised meal (i.e., a negative change in hunger rating). Excluding these children from  
 233 the main analyses did not change the significance of the results, thus, these participants  
 234 were retained in analyses.

235  
 236 **Table 1.** Frequency (%) of children's ratings of Teddy's hunger and their own hunger, before  
 237 and after a meal

	<u>Teddy the Bear</u>		<u>Child</u>	
	Pre-meal	Post-meal	Pre-meal	Post-meal
1. Very hungry	60 (52.2)	9 (7.9)	33 (28.7)	9 (7.8)
2. Quite hungry	5 (4.3)	12 (10.4)	9 (7.8)	3 (2.6)
3. Just right	9 (7.8)	9 (7.8)	26 (22.6)	15 (13.0)
4. Quite full	6 (5.2)	10 (8.7)	11 (9.6)	11 (9.6)
5. Very full	35 (30.4)	75 (65.7)	36 (31.3)	77 (67.0)

238

### 239 3.3. Covariate analyses

240 Pearson's correlations showed that older children were more likely to rate Teddy as  
 241 being hungry pre-meal ( $r(113) = -.27$ ,  $p = .004$ ) and being less hungry post-meal ( $r(113) =$   
 242  $.27$ ,  $p = .003$ ). Child age was also significantly negatively associated with children's ratings  
 243 of their own pre-meal hunger ( $r(113) = -.31$ ,  $p < .001$ ) and positively associated with their  
 244 own post-meal hunger ( $r(113) = .19$ ,  $p = .05$ ). Differences between 3, 4 and 5-year-olds in

245 pre-and post-meal hunger ratings for Teddy and for themselves were also explored. See  
 246 Figures A-E in supplementary material 3. Children's ratings of Teddy's pre- and post- meal  
 247 hunger, and their own pre- and post- meal hunger, did not differ significantly between child  
 248 sex (all  $p$ 's > .05).

249 Exploratory analyses showed that children's age was significantly positively associated  
 250 with children's energy intake from the standardised meal ( $r(110) = .38, p < .001$ ). There was  
 251 no significant difference in energy intake from the standardised meal between child sex ( $p =$   
 252 .319). See supplementary material 4 for means and t-test values.

### 253 3.4. Main analyses

254 Child age was significantly associated with all outcome measures, thus, was included  
 255 as a covariate in main analyses. A repeated measures ANCOVA revealed that children rated  
 256 Teddy as being significantly hungrier pre- versus post-meal ( $p = .004$ ; Table 2). Children  
 257 were found to rate themselves as being hungrier pre-meal, compared to post-meal ( $p = .006$ ;  
 258 Table 2). See supplementary material 3 for sensitivity analysis.

259

260 **Table 2.** Mean (SD) pre- and post-meal hunger ratings (ANCOVA)

	Pre-meal	Post-meal	$F$	$P$	$\eta_p^2$
Teddy the Bear	2.57 (1.80)	4.13 (1.36)	8.67	.004	.071
Child	3.07 (1.61)	4.25 (1.25)	7.83	.006	.065

261

262 A between-subjects ANCOVA showed that children's ratings of Teddy's pre- and post-  
 263 meal hunger, and their own pre- and post- meal hunger, did not differ significantly between  
 264 child eating profile (all  $p$ 's > .05; Table 3). Exploratory analysis showed that there was no  
 265 significant difference in energy intake from the standardised meal between children's eating  
 266 profiles ( $p = .096$ ). See supplementary material 4 for exploratory analyses. Excluding  
 267 children who reported their own hunger as 'quite full' or 'very full' before the meal did not  
 268 change the pattern of main results, and thus, are not presented.

269

270 **Table 3.** Mean (SD) pre- and post-meal hunger ratings, split by child eating profile (one-way  
 271 ANCOVA)

	Avid (n=39)	Typical (n=76)	$F$	$P$	$\eta_p^2$

<u>Teddy the Bear</u>					
Pre-meal	2.41 (1.83)	2.66 (1.79)	.00	.975	.00
Post-meal	4.41 (1.07)	3.99 (1.47)	.93	.337	.01
<u>Child</u>					
Pre-meal	2.87 (1.75)	3.17 (1.54)	.04	.846	.00
Post-meal	4.51 (1.07)	4.12 (1.32)	1.44	.233	.01
Change in hunger	1.64 (2.10)	0.95 (1.86)	-	-	-

272 **Note.** 1 = Very hungry, 2 = Quite hungry, 3 = Just right, 4 = Quite full, 5 = Very full.

273

### 274 3.4. Exploratory analyses

275 Greater energy intake from the standardised meal was significantly associated with  
276 greater change in hunger ratings ( $r(112) = .33, p < .001$ ).

277 Findings also showed that greater probability of having an avid eating profile was  
278 significantly associated with greater change in hunger ratings ( $r(115) = .19, p = .04$ ). There  
279 was no significant association between the probability of having a typical eating profile and  
280 the change in hunger ratings ( $r(115) = -.17, p = .07$ ).

281 Exploring individual CEBQ subscales, children's enjoyment of food was significantly  
282 positively associated with change in hunger ratings ( $r(115) = .21, p = .023$ ), and children's  
283 slowness in eating was negatively associated with change in hunger ratings ( $r(115) = -.22, p$   
284  $= .017$ ). There was no significant relationship between the change in hunger ratings and the  
285 following CEBQ subscales: food fussiness, food responsiveness, satiety responsiveness,  
286 desire to drink, emotional overeating or emotional undereating (all  $p$ 's  $> .05$ ). See  
287 supplementary material 5 for correlation coefficients.

### 288 4. Discussion

289 This study aimed to validate the Teddy the Bear hunger and satiety rating scale  
290 (Bennett & Blissett, 2014) for use with preschool children aged 3-5-years-old. Consistent  
291 with hypotheses and previous research (Bennett & Blissett, 2014), children were found to be  
292 less hungry following a standardised meal compared to their ratings before eating a  
293 standardised meal. Extending previous research, the current findings demonstrate that  
294 Teddy the Bear may be an appropriate measure for use with preschool children aged 3-5  
295 years, in addition to primary school aged children (Bennett & Blissett, 2014). However, our  
296 exploratory findings suggest that the scale may be less suitable for use with younger  
297 children aged 3 years.

298           Teddy the Bear provides a quick and easy to administer measure of children's hunger  
299 and satiety, with training and assessment taking approximately 5 minutes, which is  
300 substantially less than the Freddy Fullness Scale which takes approximately 25 minutes  
301 (Keller et al., 2006). The Teddy the Bear scale also seems appropriate for use in various  
302 research settings, such as school settings (Bennett & Blissett, 2014) and the controlled  
303 laboratory setting in which these data were collected. Moreover, the scale has been  
304 validated using children's food intake, thus, it appears suitable for use in the eating in the  
305 absence of hunger paradigm and for research which aims to improve children's ability to  
306 recognise fullness cues.

307           While the findings demonstrate that Teddy the Bear may be a valid measure for use  
308 with preschool children, children's age was found to be associated with hunger ratings. This  
309 suggests that older children were better at recognising Teddy's and their own hunger and  
310 satiety. However, it is not clear whether this effect was due to poorer understanding of the  
311 rating scale or poorer ability to recognise hunger cues in younger children. This study  
312 included the use of a fictional story about Teddy the Bear, which may be helpful for training  
313 children to use the scale, however, it is not yet clear whether the story is required for all  
314 preschool children. Nonetheless, while accuracy on Teddy the Bear may be lower for  
315 younger children, our findings suggest that it is a valid measure for assessing group level  
316 changes in hunger and satiety in 3-5-year-olds.

317           Contrary to hypotheses, there was no significant difference in hunger ratings between  
318 children with avid and typical eating behaviour. This could be explained by a lack of  
319 statistical power to examine differences between children's eating profiles given that the  
320 sample size of the avid eating profile subgroup was smaller than planned. This was due to  
321 recruitment challenges because of the smaller proportion of children with avid vs. typical  
322 eating profiles in the population, as well as time constraints with the funded research project.  
323 Findings from exploratory analyses suggest that the degree of children's appetite avidity is  
324 associated with greater change in hunger ratings, which appears to be driven by children's  
325 enjoyment of food. This suggests that children's appetitive traits may influence perceptions  
326 of their own hunger and satiety. It is also possible that parent-reported differences in  
327 children's satiety responsiveness may not accurately reflect children's perceptions of their  
328 own hunger and satiety. Indeed, exploratory analyses showed that parental perceptions of  
329 children's satiety responsiveness were not associated with changes in children's self-  
330 reported hunger ratings. Thus, further research is needed to elucidate the degree to which  
331 children's perceived hunger ratings relate to parent-reported child appetite profiles as well as  
332 individual subscales of the CEBQ.

#### 333 4.1. Strengths and Limitations

334 Strengths of this study include the standardised study procedure meaning that all  
335 children were given approximately the same number of kilocalories and food of the same  
336 palatability. The examination of individual differences in this study demonstrates that  
337 children's ability to use the scale does not depend on child sex or eating profile classification.  
338 However, this study has some limitations. The laboratory setting in which these data were  
339 collected could have influenced children's ratings, for example, only 56.5% of children  
340 correctly rated Teddy's pre-meal hunger. This could be explained by children feeling initially  
341 overwhelmed by the novel laboratory setting and researchers. Furthermore, although  
342 parents were asked not to give their child a meal immediately before the session, it is  
343 possible that there was some variability in the time since children last ate which could have  
344 influenced baseline hunger ratings. This could explain why more than 30% of children  
345 reported being "very full" before eating the meal. It is also possible that there was under- or  
346 overestimation of children's meal intake. For example, there were some mealtimes where  
347 parents were observed to give children their cookie or parent and child shared a sandwich.  
348 However, these instances were captured when recording intake data (i.e., children who were  
349 given an extra cookie and ate it were recorded as consuming 2 cookies = 22g rather than  
350 consuming 1 cookie = 11g). Some children (n = 17) reported greater hunger ratings after the  
351 standardised meal, and on average, these children were 5 months younger than the rest of  
352 the sample. Moreover, 37 children (32.2%) had no change between their pre- and post-meal  
353 hunger ratings (i.e., a change score of 0), with most of these children being aged 3 years old  
354 (n=25, 67.6%). These findings suggest that some younger children may not have  
355 understood the scale, possibly due to the script used to describe the scale or the slight  
356 differences between scale descriptions (e.g., 'really hungry' versus 'quite hungry'), and thus,  
357 children could benefit from further training or adaptations to the script. Indeed, these children  
358 were, on average, 5 months younger than the rest of the sample. Our findings also suggest  
359 that older children may be more accurate at completing the rating scale, thus, it may be less  
360 appropriate for use with younger children (e.g., 3-year-olds). Nonetheless, children's age  
361 was controlled for in main analyses, so it is unlikely to have affected the current results, and  
362 the findings show that most children could use the scale to rate their hunger. Children's  
363 hunger ratings could have been influenced by seeing the scale multiple times, or due to  
364 social desirability whereby children responded in the direction they thought might be 'correct'  
365 (i.e., expecting hunger to reduce after eating). Though these potential influences could not  
366 be examined in the current study, future research which examines practice effects using a  
367 counterbalanced design is needed. It is also possible that the greater post-meal hunger  
368 ratings recorded in this small group of children could reflect a problematic response to

369 eating, for example, poor interoception, binge-eating type behaviours, or simply a desire to  
370 eat more. Whilst this could not be explored in this study, it should be a focus for future  
371 research to explore subgroups of children with more extreme appetites.

## 372 **5. Conclusion**

373 This is the first study to show that the Teddy the Bear Hunger and Satiety Rating  
374 Scale may be a valid measure for examining hunger ratings in preschool aged children (3-5  
375 years). However, our exploratory findings suggest that the scale may be less appropriate for  
376 use with 3-year-olds. Whilst most children correctly identified Teddy's pre- and post-meal  
377 hunger (56% and 74%, respectively), some children may experience difficulties with  
378 interpreting the scale, possibly due to a lack of understanding, thus more research which  
379 examines younger children's understanding of the script and scale descriptions is needed.  
380 Overall, the scale provides a useful measure which can be easily administered in a variety of  
381 settings, such as in schools and the laboratory. Our results suggest that Teddy the Bear is a  
382 valid scale for use with children with avid and typical eating behaviour. However, more  
383 research which recruits larger groups of children with avid eating behaviour is needed to fully  
384 establish this. Using valid measures, such as Teddy the Bear, to assess children's hunger  
385 and satiety is important for improving our understanding of the development of children's  
386 eating behaviour.

387



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**393 Author contributions**

394 All authors were involved in the conceptualisation and methodology of this study, and the  
395 writing (review and editing) of this manuscript. Additional author contributions were **KLE**,  
396 **AP**: Investigation and data curation. **KLE**: Formal analysis, Writing – Original draft. **JB**,  
397 **CF**: Funding acquisition.

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**403 Data availability**

404 Data will be available on the [Open Science Framework](#).

**405 Ethical statement**

406 Aston University Health and Life Science Research Ethics Committee provided ethical  
407 approval (HLS21132). Parents provided informed consent for their own and their child's  
408 participation. Children provided verbal assent.

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### **Ethical statement**

Aston University Health and Life Science Research Ethics Committee provided ethical approval (HLS21132). Parents provided informed consent for their own and their child's participation. Children provided verbal assent.

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**Declaration of interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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