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2 **Children aged 7 – 9 prefer cuteness in baby faces, and femininity in women's**

3 **faces**

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5 Tamsin K. Saxton *[a], Thomas V. Pollet [a], Jenny Panagakis [a], Emily K. Round [a], Samantha E.

6 Brown [a], Janek S. Lobmaier [b]

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8 [a] Psychology Department, Northumbria University, Newcastle, NE8 2GR, United Kingdom.

9 [b] University of Bern, Institute of Psychology, Department of Social Neuroscience and Social

10 Psychology, Fabrikstrasse 8, 3012 Bern, Switzerland

11 * corresponding author

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18

19 **Abstract**

20

21 Infant facial features are typically perceived as 'cute', provoking caretaking behaviours. Previous

22 research has focused on adults' perceptions of baby cuteness, and examined how these

23 perceptions are inflenced by events of the adult reproductive lifespan, such as ovulation and

24 menopause. However, globally, individuals of all ages, including prepubertal children, provide

25 notable proportions of infant care. In this study, we recruited participants in and around northern

26 England, and tested 330 adults and 65 children aged 7 – 9 using a forced-choice paradigm to

27 assess preferences for infant facial cuteness in two stimulus sets, and (as a control task)

28   preferences for femininity in women's faces. We analysed the data with Hierarchical Bayesian

29   Regression Models. The adults and children successfully identified infants that had been

30   manipulated to appear cuter, although children's performance was poorer than adults, and

31   children reliably identified infant cuteness in only one of the two infant stimuli sets. Children

32   chose the feminised over masculinised women's faces as more attractive, although again their

33   performance was poorer than adults'. There was evidence for a female advantage in the tasks:

34   girls performed better than boys when assessing the woman stimuli and one of the infant

35   stimulus sets, and women performed better than men when assessing one of the infant stimulus

36   sets. There was no evidence that cuteness judgements differed depending upon exposure to

37   infants (children with siblings aged 0 - 2; adults with a baby caregiving role), or depending upon

38   being just younger or older than the average age of menopause. Children and grandparents

39   provide notable portions of infant caretaking globally, and cuteness perceptions could direct

40   appropriate caregiving behaviour in these age groups, as well as in adults of reproductive age.
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46   **1 Introduction**

47

48   The appeal of babies has been the subject of extensive research, predominantly focused

49   around infants' visual appearance (Kringelbach, Stark, Alexander, Bornstein, & Stein, 2016).

50   Infant facial features such as protruding cheeks, a large forehead, and large eyes make up the

51   infant 'Kindchenschema' (Lorenz, 1943), which precipitates assessments of 'cuteness' (Alley,

52   1981; Glocker et al., 2009; Hildebrandt & Fitzgerald, 1979b; Hückstedt, 1965; Little, 2012).

53   These infantile facial features are powerful and salient. They activate reward systems in the

54   brain (review in Hahn & Perrett, 2014), provoke behavioural care (review in Kringelbach et al.,

55   2016), and automatically capture attention and induce physiological responses in both familiar

56   and less familiar faces (Brosch, Sander, & Scherer, 2007; Esposito et al., 2014; Proverbio, Riva,

57   Zani, & Martin, 2011). Reactions to infant features carry over into other domains, shaping our

58   reactions to other species (e.g. Golle, Probst, Mast, & Lobmaier, 2015; Little, 2012), to

59   'babyfaced' adults (see e.g. Zebrowitz & Montepare, 1992), and to inanimate objects (e.g. Hinde

60   & Barden, 1985), with far-reaching implications for many aspects of contemporary culture,

61   including marketing and social media (Dale, Goggin, Leyda, McIntyre, & Negra, 2016).

62

At what point in development do children become attuned to the facial cues to baby cuteness that adults attend to so reliably? Children aged 2 – 6 years demonstrated some preferences for kittens and puppies compared to adult cats and dogs, as well as for infantile facial features in kittens and teddy bears (Borgi & Cirulli, 2013). Six and 8-year-olds, but not 4-year-olds, preferred baby-faced over adult-faced teddy bears (Morris, Reddy, & Bunting, 1995). These two studies indicate that children are alert to differences in infantile features, although the small numbers of stimuli that were employed ($n = 18$ photographs in the former study, and $n = 8$ teddy bears in the latter) differed in ways other than just infantile features (e.g. the former study compared preferences for photographs of 2 teddy bears with infant features against photographs of 2 teddy bears without infant features, but the teddy bears also differed in colour etc). Another study (Borgi, Cogliati-Dezza, Brelsford, Meints, & Cirulli, 2014) presented children (aged 3 – 6) and adults with images of adult and infant dogs, cats, and humans, all of which had been manipulated to be higher or lower in infantile features. In a forced-choice test, overall, the children spent more time looking at the stimuli with the infantile features, but this seemed to be mainly driven by their attention to infantile features in adult faces. When the adults and children were asked to rate the images for cuteness, they gave higher ratings to infantile faces than non-infantile faces, but adults rated faces of infants as cuter than faces of the adults across all three species, whereas children did not differentiate those categories. A final study (Sanefuji, Ohgami, & Hashiya, 2007) asked children of around 5 years of age and adults to rank order the cuteness of pictures of infants of different ages from 5 different species. Children and adults created ranking orders that demonstrated some similarities (e.g. both groups considered the 3-month-old human babies to be cuter than the 18-month-old human babies). These studies therefore provide converging evidence that infantile features influence judgements in early childhood, even if the patterns of children's judgements do not exactly mirror those of adults.

However, pre-pubertal children are less attuned to some facial features that affect adults' evaluative judgements (Boothroyd, Meins, Vukovic, & Burt, 2014; Saxton, Caryl, & Roberts, 2006; Saxton, DeBruine, Jones, Little, & Roberts, 2009), and we could infer that they might also be relatively insensitive to subtle facial cues of infant cuteness. Some literature has focussed on how baby cuteness perceptions are shaped by the impact of sex hormones and events such as ovulation and menopause (Luo, Ma, et al., 2015), working on the basis that cuteness perception is most relevant to individuals during their reproductive lifespan. Thus, we find one study reporting that girls aged 12 – 13 had stronger preferences for pictures of infants over pictures of

96 adults if the girls were postmenarchal rather than premenarchal (Goldberg, Blumberg, & Kriger,

97 1982), although another study of girls aged 10 – 15 reported that their interest in interacting with

98 infants declined with age and menarchal status (Frodi, Murray, Lamb, & Steinberg, 1984). In

99 terms of reacting to cues of infant cuteness specifically, women who were younger than the

100 average age of menopause, or pre-menopausal, were better at detecting infant cuteness than

101 women over the average age of menopause, or post-menopausal (Sprengelmeyer et al., 2009).

102 There is some evidence that people with raised levels of artificial reproductive hormones (i.e.

103 users of hormonal contraceptives) are more sensitive to infant facial cuteness ((Sprengelmeyer

104 et al., 2009); but see (Sprengelmeyer, Lewis, Hahn, & Perrett, 2013)). Other researchers have

105 indicated that testosterone levels rather than estradiol or progesterone levels are better at

106 explaining differential sensitivity to infant facial cuteness (Hahn, DeBruine, Fisher, & Jones,

107 2015). Women were found to be better able to discriminate between high- and low-cuteness

108 versions of infant faces around ovulation (Lobmaier, Probst, Perrett, & Heinrichs, 2015),

109 although, perhaps unsurprisingly, such ovulatory-linked shifts were not apparent in a smaller

110 sample (Sprengelmeyer et al., 2013). Irrespective, face processing behaviour is shaped by

111 hormones (review in Scherf, 2012), indicating one plausible mechanism for differences between

112 adults and children in sensitivity to cuteness cues.

113

114 On the other hand, caregiving behaviour that is motivated by baby cuteness seems functionally

115 significant even in childhood. In many societies and cultures, and across history, from early

116 childhood onwards, siblings and other children (particularly females) are often involved in infant

117 caretaking (Weisner, 1987; Weisner et al., 1977). A survey (Weisner et al., 1977) of 186

118 societies, which were selected to have fairly rich ethnographic data available and to be

119 representative of the different cultures worldwide, reported that, in the 162 samples that could

120 be coded, the mother acted as infant caretaker either almost exclusively or principally in 86

121 societies, but people other than the mother had at least an important role (or, in a small number

122 of cases, rivalled the mother's care) in 76 societies. These caretakers were most likely to be

123 specified as adults or others including employees in 92 societies, and as children in the

124 remaining 46 societies that could be coded. That is, childhood caretaking of infants is not the

125 dominant mode, but it is far from insignificant. Children may well be acting as infant caretakers

126 from the age of 7, if not even younger (Weisner, 1987; Weisner et al., 1977), something that has

127 also been noted in hunter-gatherer societies (Hewlett & Lamb, 2017), which are often seen as

128 an approximate model for standard patterns of human existence in former eras. The functional

129 significance of adults' cuteness perceptions, which could provoke appropriate caregiving (Hahn

130 & Perrett, 2014), also then seems relevant to children's cuteness perceptions. Thus, it is
131 relevant to ask whether or to what extent pre-pubertal children detect and respond to infant
132 cuteness. The developmental trajectory of cuteness perception has been identified as one of the
133 key outstanding questions within this area (Kringelbach et al., 2016). Further, studying the
134 developmental trajectory of face perceptions helps us understand the development of cognitive
135 abilities and the origins of facial evaluations, and allows us to better map psychological
136 adaptations (Archer, 2019).
137
138 Accordingly, we set out to determine whether children aged 7 – 9 can distinguish subtle facial
139 cues of infant cuteness, and how their judgements compared with those of adults. Children
140 aged 7 – 9 were chosen because they have been shown to differ from adults in terms of their
141 judgements of several facial cues (Boothroyd et al., 2014), which might imply they would also be
142 poor at detecting infant facial cuteness. On the other hand, children are frequently acting as
143 caretakers of infant by age 7 – 9 (Weisner, 1987; Weisner et al., 1977), such that a functional
144 explanation would predict that they would respond to infant facial cuteness. As a control task,
145 we asked the participants to evaluate the attractiveness of female faces that differed in
146 femininity, given that previous research has demonstrated extensively that adults find femininity
147 attractive in female faces (Rhodes, 2006; Thornhill & Gangestad, 1999), whereas female facial
148 femininity does not appear to be reliably perceived as attractive by children in the 7 – 9 age
149 group (Boothroyd et al., 2014).
150
151 Alongside the general age-linked development of facial evaluations, there may also be
152 important individual differences in face judgements, contingent upon individual variables.
153 Consistent with the greater infant caretaking role of females than males on average, women
154 have been reported as more sensitive than men to subtle differences in infant facial cuteness,
155 whereas women and men were equally competent at judging infant age and happiness
156 (Lobmaier, Sprengelmeyer, Wiffen, & Perrett, 2010; Sprengelmeyer et al., 2009), and
157 accordingly, we compared male and female judgements in our study. Sibling status alters
158 evaluative judgements of others in adaptive ways (Lieberman, Tooby, & Cosmides, 2007), while
159 visual experience with siblings may also alter facial judgements (Luo, Kendrick, Li, & Lee, 2015;
160 Saxton, Little, DeBruine, Jones, & Roberts, 2009), and exposure to faces of a particular age
161 group enhances judgements made about faces in that age group (de Heering & Rossion, 2008).
162 Therefore, we also investigated the impact of visual exposure to babies on cuteness
163 judgements. Finally, given that a relationship between menopause and infant cuteness

164   judgements has been reported (Sprengelmeyer et al., 2009), we investigated whether that effect

165   held in our dataset. We had access to two different infant facial image stimuli sets which were

166   created from differently aged infants (newborn, and young babies aged around six months), and

167   we elected to use both stimuli sets in the study, allowing us to carry out a simultaneous

168   conceptual replication.

169

170

171   **2 Methods**

172

173   2.1 Participants

174

175   Participants consisted of 65 children (7 aged 7, 34 aged 8, 24 aged 9; 34 boys, 31 girls), and

176   330 adults (aged 18 – 66, mean 31.6, SD 13.9; 290 women, 41 men). 56 additional adults

177   accessed the online survey but did not complete it, and one adult participant did not give their

178   gender as male or female, and so their data were discarded. Children were recruited from two

179   schools in northern England, while adults were recruited online, via networks based

180   predominantly in the north-east of England. Of our child participants, 14 had a sibling aged 0 –

181   2; of our adult participants, 80 reported a substantial caregiving role with respect to a baby or

182   babies. Following the categorisation in (Sprengelmeyer et al., 2009), we additionally coded a

183   group of women aged 45 – 51 (n = 30; at or below the average age of menopause in Britain as

184   reported in Sprengelmeyer et al., 2009), and a group of women aged 53 – 60 (n = 25; above the

185   average age of menopause).

186

187   2.2 Materials

188

189   *"Newborn" and "Young Baby" image stimulus sets*

190

191   The infant stimulus sets (see Figure 1) consisted of 5 male and 5 female pairs of newborn

192   faces, and 5 male and 5 female pairs of young baby faces. Within each pair, the images were

193   identical, except that one had been manipulated to be more cute, and one had been

194   manipulated to be less cute (see details below). The images were created using the computer

195   graphics program PsychoMorph (Tiddeman, Burt, & Perrett, 2001). All of the infants in the

196   photographs had their eyes open.

197

198   To create the "Newborn" image stimulus set, first, pictures of 71 female and 71 male newborn
199   infants (aged 3 – 5 days) were taken from websites of different maternity wards, and placed in
200   an online survey. 50 adults (mean age = 27.2 years) rated them for cuteness (minimum of 42
201   ratings per image). 20 male and 20 female images rated of intermediate cuteness were placed
202   into sex-matched groups of 4 images, and each group of 4 images was combined to make a
203   composite image, giving rise to 5 male and 5 female composite images. Then, each composite
204   image was manipulated +/- 25% of the difference between a high-cute or low-cute sex-matched
205   prototype. These high-cute and low-cute prototypes were created separately for female and
206   male faces, and each consisted of the 10 faces rated cutest and 10 faces rated least cute from
207   the original set of 71 male and 71 female newborn images.

208

209   The "Young Baby" image stimulus set was that used in Lobmaier et al. (2015; 2010). To create
210   these faces, first, photographs of 25 male and 25 female infants aged 6 – 8 months were
211   separated into sex-matched groups of 5 images, and each group of 5 images was combined to
212   make a composite image, giving rise to 5 male and 5 female composite images. Then, each
213   composite was manipulated +/- 25% of the difference between a high-cute or low-cute sex-
214   matched prototype. These high-cute and low-cute prototypes were composites of the 10 male /
215   female faces rated most and least cute by the 10 young adult women and 10 young adult men
216   who rated a batch of 58 photographs of infants aged 5 – 8 months.

217

218   *Female facial image stimulus set*

219

220   Female facial images (see Figure 1) were taken from an online database (DeBruine & Jones,
221   2017) that provided images of white female students (aged 17 – 19; mean age 18.4 years) from
222   a university in Ontario, Canada. From this dataset, we took pairs of images that were
223   manipulated +/-50% along a dimension that had been created in Webmorph
224   (https://webmorph.org) with reference to the differences between the typical facial features /
225   shape of men compared to women. Accordingly, each pair consisted of two images that were
226   identical except that one was more feminised and the other was more masculinised. The
227   images were 'unmasked': i.e. the hairstyles and upper part of the shoulders were visible. This
228   protocol has been used previously in numerous studies that examine people's facial
229   preferences (Rhodes, 2006).

230

Click on the face which you think is cuter...

Click on the face which you think is cuter...

Click on the face which you think is more attractive...

232

Figure 1: Examples of image stimuli, as presented to participants, from the three stimuli sets: newborn (top row; 'cuter' on right), young baby (middle row; 'cuter' on left) and woman (bottom row; 'more feminine' on right). The women image stimuli are taken from an online database (DeBruine & Jones, 2017) under a Creative Commons licence.

2.3 Procedure

Ethical approval for the study was granted by the institutional ethics committee. The study ran online (qualtrics.com), and requested participant consent followed by some demographic details (age, gender; child participants were asked for the number and age of brothers and sisters, while adult participants were asked whether they had a substantial caregiving role with respect to a baby or babies). Next, participants were presented with the 40 pairs of faces, as a two-alternative forced choice preference test (see Figure 1). Within each pair, the faces were identical, except for being high- vs low-cute versions of the same infant face, or feminised vs masculinised versions of the same woman's face. For each pair, the presentation side (right or left) was randomised. The 20 infant face pairs were presented in a separate block from the 20 female face pairs, and the blocks were presented in counterbalanced order between participants. Copies of the adult and child surveys are available on the OSF (https://osf.io/6aqru/).

Child participants

Children were recruited from two schools in northern England. In the first school, children took study information sheets home to parents / caregivers, who provided written consent if they wished their child to take part. In the second school, consent was obtained from the school acting in loco parentis, with opt-out letters distributed to parents of children in Years 3 and 4. In the first school, children went through the survey supported one-to-one by the researcher, who sat behind them so as not to influence their answers. The researcher checked that the children understood the words 'cute' and 'attractive'. The former word was readily understood, and the second was glossed as 'prettier' where appropriate. In the second school, children participated in groups of up to five children, working silently each at a separate computer, and supervised to eliminate collusion or distraction. The researcher asked the children whether they understood

266   the words 'cute' and 'attractive'. No child reported difficulty, and the classroom teacher
267   confirmed that the children involved should have understood these words. The children were
268   instructed to fold their arms to signal completion of the study, so that no other participants were
269   disrupted or felt the need to rush their responses, and were asked not to discuss the study with
270   their peers once back in the classroom until all children had completed the task.
271
272   *Adult participants*
273
274   Adult participants were recruited through channels including social networks and social media
275   advertisements circulated around networks predominantly based in the north-east of England,
276   and a research participation portal for psychology students at a university in the north-east of
277   England. All participated online. Online studies are widely used, provide comparable results in
278   many settings to offline data collection methodologies, and typically benefit from larger sample
279   sizes, thereby offsetting any increased noise in the data (Birnbaum, 2004; Epstein, Klinkenberg,
280   Wiley, & McKinley, 2001; Krantz & Dalal, 2000).
281
282   2.4 Analysis
283
284   Analyses were performed in R 3.6.3 (R Core Development, 2019). After presenting descriptive
285   statistics and binomial tests for the face pairs, our core analyses consisted of Hierarchical
286   Bayesian Regression Models where the stimulus chosen was modeled as a Bernoulli trial
287   (attractive or cute stimulus chosen or not), using the "BRMS" package in R (Bürkner, 2017). The
288   estimation of each model was based on four chains, each containing 4,000 iterations (2,000 for
289   a warm-up), using the defaults from BRMS. The models showed very good convergence based
290   on R̂. The random effects structure had a random intercept associated with the participant. We
291   tested if a model with the variables of interest (gender of the participant; stimulus type; age
292   group [adults vs children]) performed better than the null model, based on WAIC (Vehtari,
293   Gelman, & Gabry, 2017). We also tested the effects of the variable relating to exposure to
294   young children (whether children had siblings aged 0 – 2; whether adults replied 'yes' to the
295   question asking if they had a substantial caregiving role with respect to a baby or babies), and
296   of the factor that distinguished women below and above the average age of menopause,
297   following the grouping of Sprengelmeyer et al. (2009). Differences of over 10 units in the
298   information criterion can be interpreted as conclusive support for one model over another
299   (Burnham & Anderson, 2002, 2004). We also performed some additional analyses and

300   robustness checks (e.g., including a random intercept for stimulus pair). These analyses are

301   reported in full on the OSF (https://osf.io/6aqru/).

302

303   **3 Results**

304

305   3.1 Entire sample

306

307   Binomial tests showed that participants' choices differed significantly from chance in 39 out of

308   40 stimulus pairs ($p < .05$ after correction with the Benjamini-Hochberg procedure; Benjamini &

309   Hochberg, 1995; Figure 2). Thus, with the exception of one stimulus in the adult woman

310   category (where participants were non-significantly more likely to select the masculinised face

311   as more attractive), participants were significantly more likely than chance to select the

312   feminised woman's face and the cuter newborn or young baby face. Performance was poorer

313   for the young baby stimuli than for the newborn or woman stimuli.

314

315   We calculated a null model (intercept only, WAIC = 15300.0) and a model of the form Gender +

316   Stimulus * Age group (main effect + two-way interaction, WAIC = 15285.3). These were both

317   out-performed by the best fitting model, which contained a three-way interaction, Stimulus *

318   Gender * Age group (WAIC = 15275.3). This three-way interaction suggests that gender

319   interacts with stimulus type differently in children compared to adults (Figure 3). Although adults

320   selected the expected stimulus as cuter / more attractive more often than children did overall,

321   this difference was not apparent in the males' judgements of the young baby stimuli. In contrast,

322   when it came to judgements of the newborn and women stimuli, there was a bigger difference

323   between male adult and child judgments than between female adult and child judgments. In

324   order to explore the three-way interaction further, we next examined the age groups (children vs

325   adults) separately.

326

327

328

329
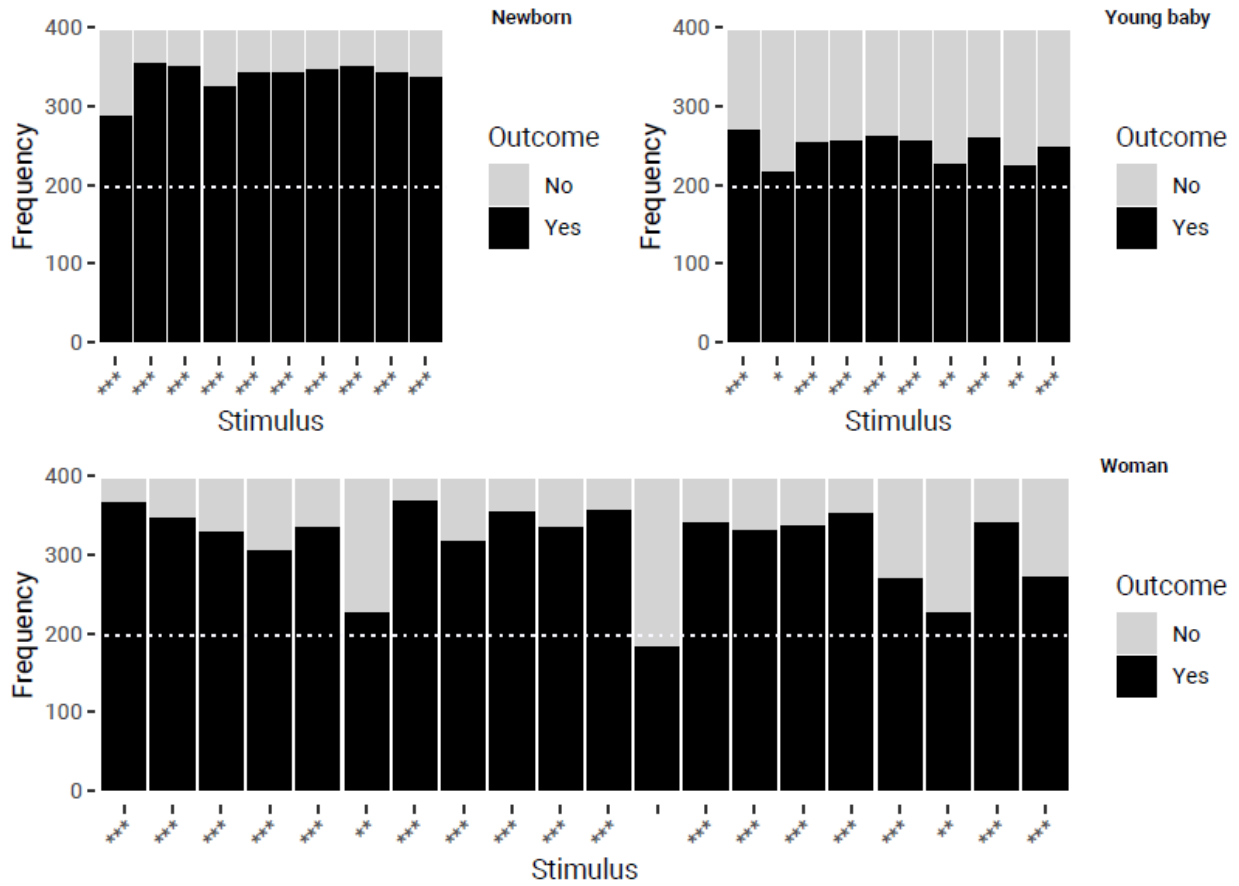
Figure 2: Frequency with which the feminised woman or cuter newborn / young baby was chosen (Outcome = 'Yes') by the 395 participants (dashed line represents 197.5 participants), * $p < .05$, ** $p < .01$, *** $p < .001$ (Benjamini-Hochberg corrected).

333

334

Figure 3: Interaction between participant gender, age group (child vs adult), and stimulus type, in relation to the proportion of stimuli selected as cuter (newborn or young baby stimuli) or more attractive (woman stimuli). 0.5 = chance levels; error bars are 95% CIs.

3.2 Children

In 26 of the 40 forced choice pairs, children chose in the expected direction (more feminine woman, cuter newborn) at rates significantly exceeding chance (at $p < .05$ after correction with the Benjamini-Hochberg procedure; Benjamini & Hochberg, 1995). However, children did not discriminate the set of young baby stimuli based on cuteness (Figure 3).
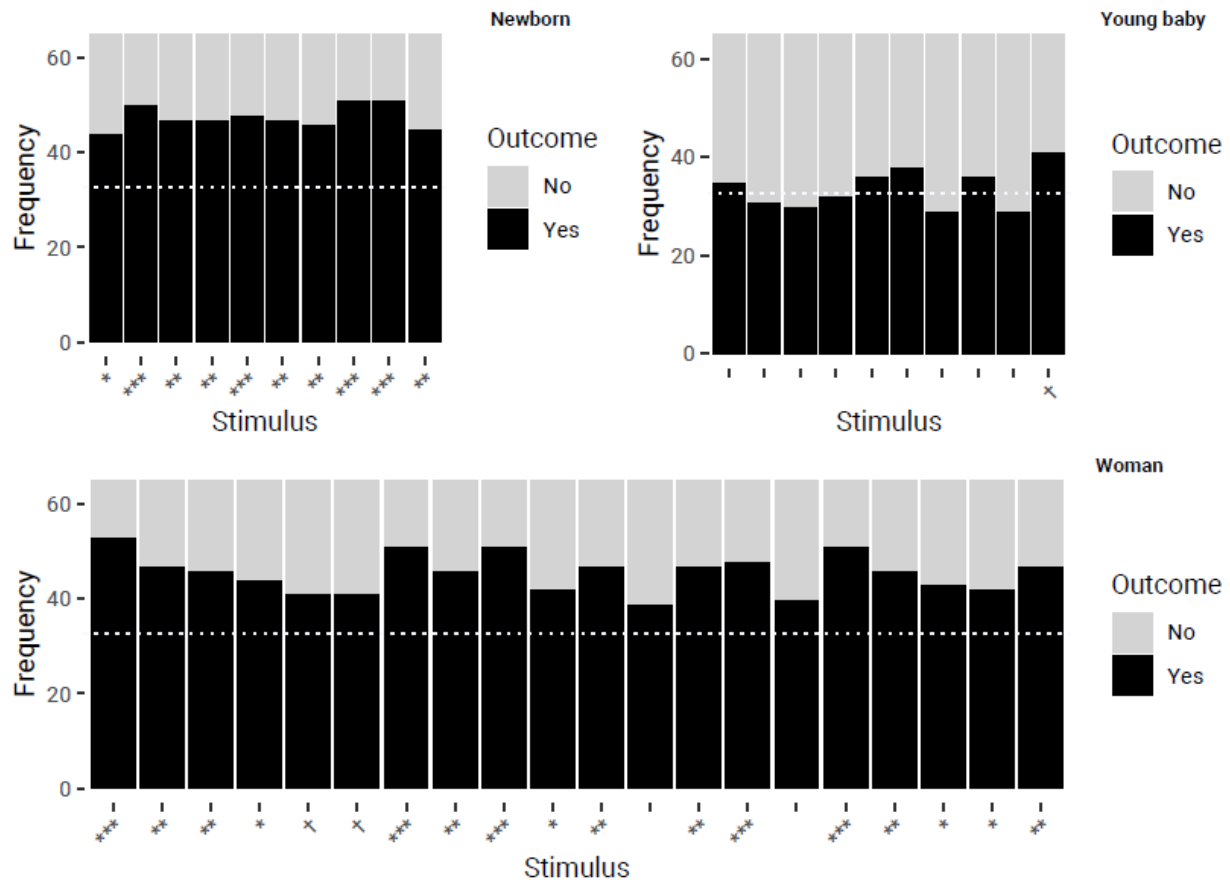
Figure 4: Frequency with which the feminised woman or cuter newborn / young baby was chosen (Outcome = 'Yes') by the 65 child participants (dashed line represents 32.5 participants), † .0 5< p < .10, * p < .05, ** p < .01, *** p <.001 (Benjamini-Hochberg corrected)

The best fitting model of the children's data contained an interaction between participant gender and stimulus (WAIC = 3185.2; Figure 3). Girls performed better than boys when assessing the newborn and woman stimuli. However, there was no gender difference in performance when judging the cuteness of the young baby stimuli, where performance was lower. This interaction model performed substantially better than a null model (WAIC = 3272.9), but only marginally better than a model with two main effects, one for gender and one for stimulus (WAIC = 3186.5).

There was no suggestion of a difference in performance based on exposure to young children, namely, whether children had siblings aged 0 – 2 or not (WAIC = 3188.1 for a model of Stimulus

367 * Exposure + Gender). If anything, exposure was associated with poorer performance (see

368 OSF, https://osf.io/6aqru/), although only 14 of the 65 children fell into this group of children with

369 much younger siblings.

370

371 3.3 Adults

372

373 In 39 of 40 forced choice pairs, adults chose in the expected direction (more feminine woman,

374 cuter newborn or young baby) at rates significantly exceeding chance (at $p < .05$ after correction

375 with the Benjamini-Hochberg procedure; Benjamini & Hochberg, 1995). Unexpectedly, adults

376 selected the masculinised version significantly more over than the feminised version in respect

377 of one pair of women's faces. Overall, the adults' performance was substantially lower in

378 relation to young baby stimuli than newborn or woman stimuli (Figures 3 and 5).

379

380
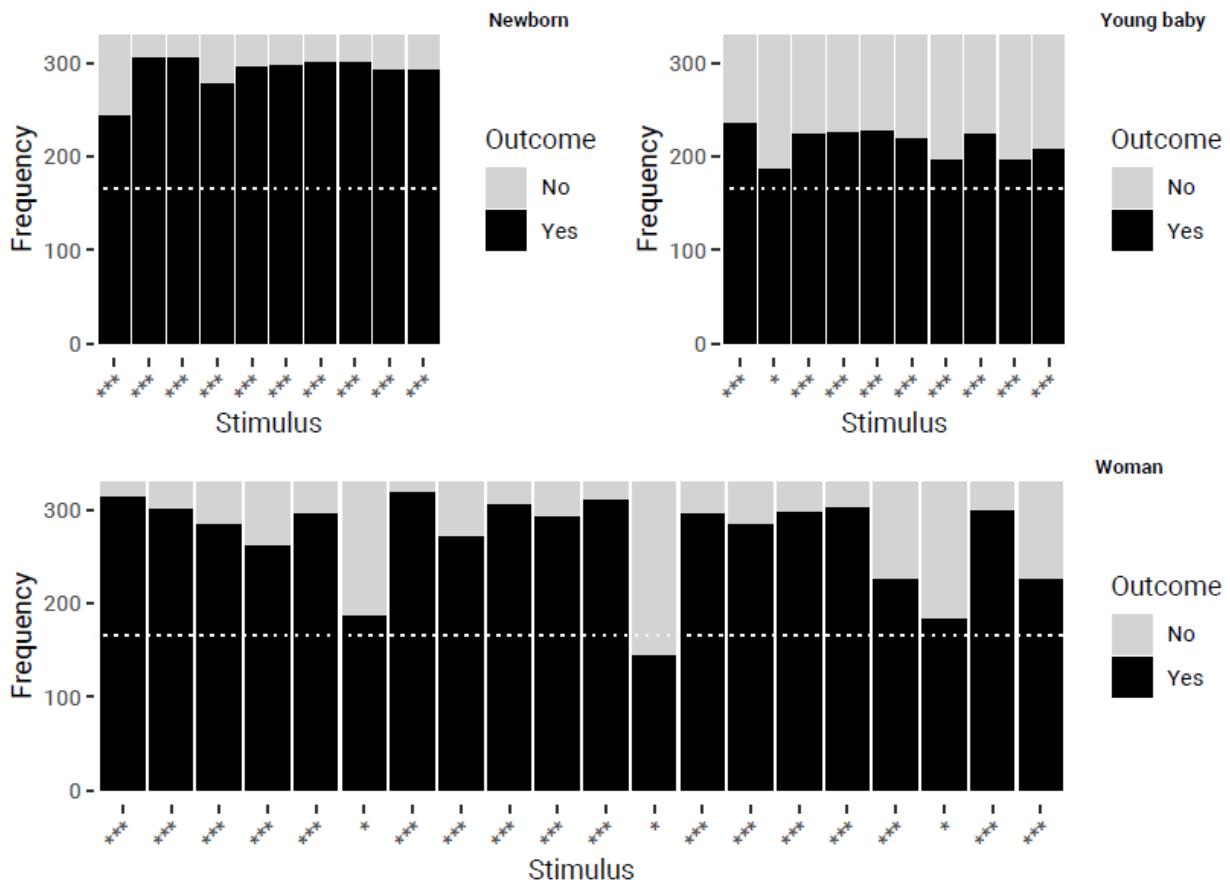
381

382

383   Figure 5: Frequency with which the feminised woman or cuter newborn / young baby was

384   chosen (Outcome = 'Yes') by the 330 adult participants (dashed line represents 165

385   participants), * $p < .05$, *** $p < .001$ (Benjamini-Hochberg corrected).

386

387

388   In relation to the adult dataset, a model with a Gender * Stimulus interaction (WAIC = 12081.0)

389   proved a better fit than a null model (WAIC = 12731.1) or a model with just a Gender and

390   Stimulus main effect (WAIC = 12091.5). While there was not much difference between men and

391   women in their judgments of newborn and women stimuli, men performed more poorly than

392   women when judging the young baby stimuli (Figure 3).

393

394   There was little support for a model that additionally accounted for participants' answers to the

395   question of whether they had a substantial caregiving role with respect to a baby or babies

396   (Stimulus * Child care + Gender: WAIC = 12088.8).

397

398   Among women, there was no support for the hypothesised difference between the purported

399   pre- and post-menopausal groups (women aged 45 – 51 vs women aged 53 – 60). The

400   interaction model with an Age category * Stimulus interaction (WAIC = 1875.3; Figure 6)

401   performed more poorly than a null model (WAIC = 1872.5).

402

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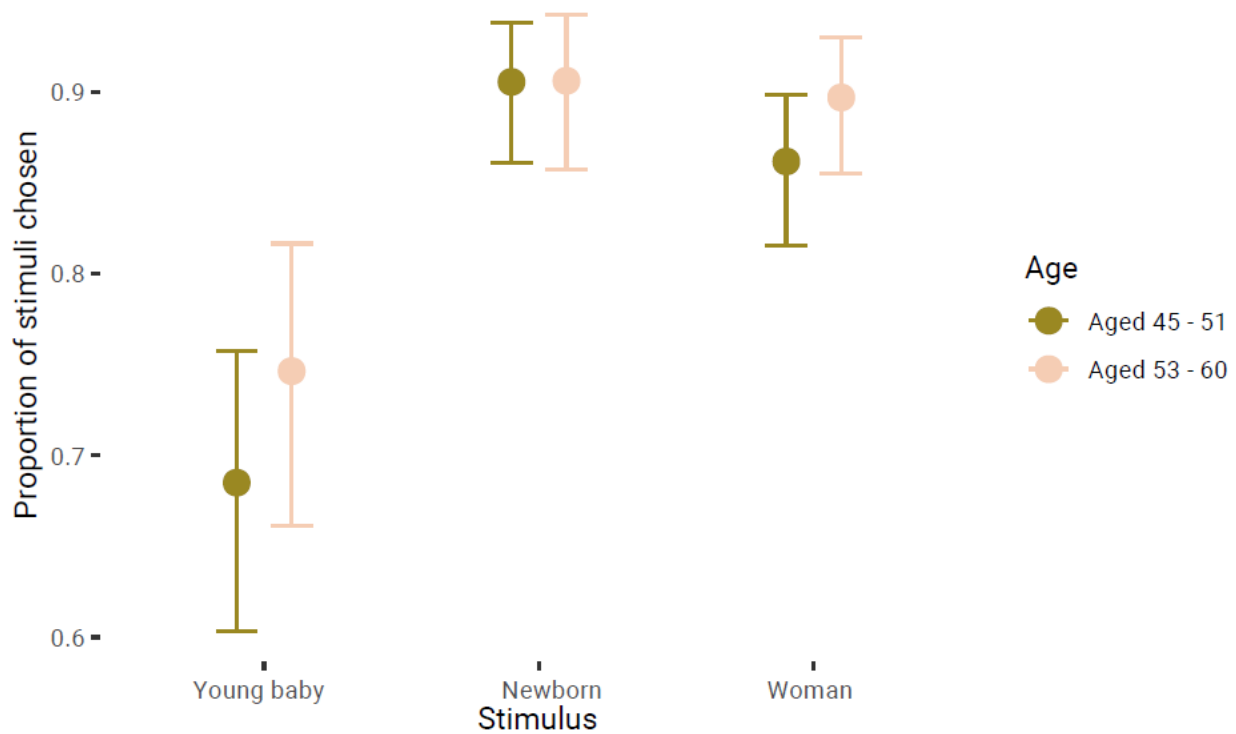
404
405
406   Figure 6: Interaction between stimulus type and purported pre- and post-menopausal age group
407   (women aged 45 - 51 vs aged 53 - 60), in relation to the proportion of stimuli selected as cuter
408   (newborn or young baby stimuli) or more attractive (woman stimuli). 0.5 = chance levels; error
409   bars are 95% CIs.
410
411

412   **4 Discussion**

413

414   We set out to uncover whether children aged 7 – 9 were responsive to subtle facial cues of baby
415   cuteness, and how their judgements compared to adults' judgements. Further, we examined the
416   impact of participant gender and exposure to infants, and carried out an analysis of purported
417   pre- vs post-menopausal status in older women following a previous study (Sprengelmeyer et
418   al., 2009). We used judgements of the attractiveness of feminised female faces as a control
419   task, given that adult preferences for feminised female faces have been robustly demonstrated
420   (Rhodes, 2006; Thornhill & Gangestad, 1999), whereas the extant research indicated that
421   children in this age group do not draw substantially from cues of femininity / masculinity in rating
422   facial attractiveness (Boothroyd et al., 2014).

423

424 Both boys and girls selected the cuter of the newborn images at rates exceeding chance. By

425 demonstrating children's awareness of even subtle cues, we have provided further evidence of

426 the impact of infant facial cuteness features. Baby cuteness has been framed as a trigger for

427 parental care, but this care may be supplied by people other than the parents (Kringelbach et

428 al., 2016; Schaller, 2018), including indeed other children. Children's reactions to baby cuteness

429 may support them in this endeavour. Having said this, children's performance on the baby

430 cuteness task was lower than adults'. We would expect lower task performance by prepubertal

431 children than adults on any cognitive task such as this, although this does also imply that adults

432 perform better than children do in discriminating infant cuteness. The difference between adults

433 and children was not apparent in relation to males' judgements of the young baby stimuli,

434 although this comparison relied on a smaller sample because of the smaller number of men who

435 took part.

436

437 We found that children discriminated cuteness reliably in our set of 'newborn' stimuli, but not in

438 our set of 'young baby' stimuli. This difference between the stimuli sets mirrored adult

439 judgements: adults more readily selected the cuter image from among the newborn than the

440 young baby stimulus sets. The newborn and young baby stimuli sets were created in similar

441 ways, but drew from different image pools, and evidently varied in the ease with which

442 participants could distinguish the relevant cues, indicating that the stimulus properties were not

443 equal between the stimulus groups. This could have arisen if there were a greater difference in

444 perceived cuteness between the cutest and least cute newborns than between the cutest and

445 least cute young babies in our dataset. Newborns are more dependent upon their mother than

446 weanlings (i.e. the 'young babies'), and so newborns may gain less than older infants do from

447 appealing to a wider range of potential caregivers. Studies have reported that infants are rated

448 cuter at the age of three or six months, compared to both newborn (Franklin, Volk, & Wong,

449 2018) and to older babies (Sanefuji et al., 2007), although other work found that 9 – 11-month-

450 olds were rated cuter than infants at younger or slightly older ages (excluding neonates)

451 (Hildebrandt & Fitzgerald, 1979a). Our study was not designed to compare the cuteness of

452 differently aged infants, and our results are perhaps a reminder of the importance of using a

453 range of stimuli in research studies given that different stimuli can give rise to differing results

454 (e.g. Hurlbert, 1984; Kroodsma, Byers, Goodale, Johnson, & Liu, 2001; Wells & Windschitl,

455 1999); indeed, in our stimulus set consisting of women's faces, one stimulus pair was

456 unexpectedly judged more attractive in masculinised rather than feminised format.

457

458   It has been suggested that being able to distinguish cuter and less cute babies may provide the

459   adaptive benefit of allowing people to direct their caretaking resources towards those infants

460   who require lower levels of investment while having better chances of providing higher levels of

461   returns, perhaps particularly when resources are scarce (DeBruine, Hahn, & Jones, 2016;

462   Franklin et al., 2018; Hahn & Perrett, 2014). Consistent with this position, healthier-looking

463   infants are rated as cuter (Volk, Lukjanczuk, & Quinsey, 2005; Volk & Quinsey, 2002; Waller,

464   Volk, & Quinsey, 2004), and cuter babies receive greater visual attention (Hildebrandt &

465   Fitzgerald, 1978, 1981), and give rise to greater reports of caretaking motivation (Glocker et al.,

466   2009). Similarly, more attractive babies receive more affectionate and playful maternal

467   interactions (Hildebrandt & Fitzgerald, 1983; Langlois, Ritter, Casey, & Sawin, 1995). If the

468   ability to distinguish more or less cute babies is adaptive, our findings raise the possibility that

469   children too could personalise their caretaking investment in babies. On the other hand, perhaps

470   human abilities to distinguish subtle differences in infant cuteness are the application of an

471   ability whose function is to direct caretaking to infants, or perhaps to distinguish only the very

472   unhealthiest infants; it has been pointed out that the evaluation of fine-grained differences in

473   facial qualities may be evolutionarily novel (Penton-Voak, 2011). Contemporary culture provides

474   an intense training ground for distinguishing slight differences between faces, and this gives rise

475   to evaluative distinctions that might not have been part of our evolutionary history (Scott et al.,

476   2014). Further, it is not always the case that investing in the most healthy infants will provide the

477   most payback, given the law of diminishing returns, and dependent upon the resources

478   available to the investors. Investing additional care in healthy babies may make limited

479   differences to their outcomes, whereas greater returns may arise from investing in less healthy

480   babies. Finally, subtle differences in facial cues are probably less important than many other

481   variables such as kinship and infant temperament (DeBruine et al., 2016; Parsons et al., 2014),

482   or – especially when it comes to sibling caretaking – explicit adult instruction, all of which might

483   influence people to invest more or less in an infant. Given all of the above, we think that the

484   case for an adaptive ability to distinguish between marginally more or less cute infants is far

485   from closed; our findings indicate that children are alert to cues to infant cuteness, but do not

486   necessarily imply that distinguishing between subtly higher and lower levels of cuteness is itself

487   an adaptation.

488

489   We anticipate that our findings that 7 – 9 year-olds are alert to facial cues to cuteness in some

490   contexts would be applicable at least to all children who have some visual experience with baby

491   facial features (through exposure to babies or 'cute' toys etc). However, the frequency of

492   exposure to such a wide range of different faces that is characteristic of many media-immersed,

493   city-focused cultures (such as that where the study took place) has been argued to train

494   humans in face perception, leading them to respond to minute facial differences in evolutionarily

495   novel ways (Scott et al., 2014), and this makes it particularly important to determine whether our

496   findings are generalisable to other cultures. Having said that, the prevalence of sibling

497   caretaking across societies, and also in related species (e.g. Fairbanks, 1990), implies that

498   children's positive reactions to infantile features might be universal.

499

500   We did not find that children's exposure to younger siblings, or adults' exposure to infants, was

501   associated with enhanced judgements of baby cuteness, although only small numbers of

502   children fell into this group of participants with such exposure. However, even outside of sibling-

503   caretaking societies, the tending of dolls (or other representations of animate beings such as

504   bears) is a typical activity from early childhood, especially among girls (e.g. Cherney &

505   Dempsey, 2010; Lowe, 1975), and all of our participants would have had frequent exposure to

506   objects designed (increasingly over time) to be cute (Gould, 1992; Hinde & Barden, 1985),

507   including through films, toys, books, etc. Such saturation can create ceiling effects, perhaps

508   overwhelming any individual differences in cuteness perception contingent upon exposure.

509

510   Female participants had some performance advantages over male participants. Specifically,

511   women outperformed men in assessing the young baby (but not newborn or women) stimuli,

512   and girls outperformed boys when assessing the newborn and women (but not young baby)

513   stimuli. This is consistent with much previous research. For example, a cross-sectional study of

514   children in different classes (from 2nd grade, around 7 – 8 years of age, to 12th grade, around

515   17 – 18 years of age), and adults, found that girls shifted from preferring adult faces to

516   preferring infant faces by about 8th grade (around 13 – 14 years of age), whereas boys'

517   preferences for infants over adults only exceeded chance from around 12th grade (Fullard &

518   Reiling, 1976). Overall, women appear to be more sensitive than men to subtle differences in

519   infant facial cuteness (Lobmaier et al., 2010; Sprengelmeyer et al., 2009). There are many

520   similar documented gender differences in reactions to infants (Berman, 1980; Hahn & Perrett,

521   2014; Scherf, 2012), although differences in women's and men's reactions to infants overlap to

522   greater or lesser extents depending on setting, and sit alongside extensive individual

523   differences. This pattern of differences between men and women no doubt represents a whole

524 range of different mechanisms, including neural, hormonal, and social (Berman, 1980; Hahn &
525 Perrett, 2014; Scherf, 2012).

526

527 We did not anticipate that our child participants would select the feminised female faces as
528 more attractive, because previous research (albeit with a smaller number of feminised face
529 stimuli) had indicated that explicit preferences for facial femininity are not apparent at age 9
530 (Boothroyd et al., 2014), but then have emerged by age 11 (Saxton, DeBruine, et al., 2009); see
531 also (Saxton et al., 2010). However, we found that both boys and girls aged 7 – 9 selected the
532 feminised women's faces as more attractive than the masculinised women's faces, in line with
533 adult judgements (although not as reliably as the adults). Indeed, it has been shown previously
534 that even children younger than our participants distinguish feminised and masculinised faces.
535 By 4 years of age, children were robustly selecting dominant men's faces as being stronger or in
536 charge (Terrizzi, Brey, Shutts, & Beier, 2019), and infants aged 12 – 24 months looked longer at
537 (i.e. demonstrated a visual preference for) feminised over masculinised male and female faces.
538 Future research would be needed to continue to tease out the origins of explicit preferences for
539 facial femininity, as well as variables such as visual experience (Boothroyd et al., 2016; Saxton,
540 Little, et al., 2009) that might predict the early emergence of these preferences.

541

542 We failed to replicate previous findings (Sprengelmeyer et al., 2009) that women aged 45 – 51
543 (i.e. at or younger than the average age of menopause in Britain cited by Sprengelmeyer et al.,
544 2009) outperformed women aged 53 – 60 (above the average age of menopause) in judging
545 infant cuteness. Our sample size ($n = 55$) was more than double than that of the original study
546 ($n = 24$), although unlike the original study, we did not confirm that no participant was taking
547 hormone-replacement therapy or had undergone hysterectomy. Future work could scrutinise
548 this question further, by using larger samples again, and confirming menopausal status (as in
549 the second study of Sprengelmeyer et al., 2009). However, in the same way that we would
550 argue that children's discrimination of infant cuteness could have functional significance given
551 that children provide a reasonable proportion of childcare the world over (Weisner, 1987;
552 Weisner et al., 1977), we also know that post-menopausal women provide significant
553 proportions of childcare globally (Coall & Hertwig, 2010; Fergusson, Maughan, & Golding, 2008;
554 Jappens & Van Bavel, 2012), and thus might also benefit from distinguishing infant cuteness.

555

556 Despite our novel findings, the study has some limitations. Baby cuteness was manipulated
557 merely with reference to rated cuteness, rather than being pinned to any behavioural or

558 biological corollary (such as the likelihood of eliciting care, or infant health), and as such, we
559 cannot conclude that adults demonstrated objectively superior performance. Our methodological
560 choice here followed other work in relation to perceptions of infant facial cuteness (Lobmaier et
561 al., 2015; Sprengelmeyer et al., 2013; Sprengelmeyer et al., 2009), and was well-suited to allow
562 us to compare adult and child perceptions. The stimuli were clearly computer generated rather
563 than actual photographs, which could have impeded performance, perhaps particularly in the
564 child rather than the adult group, although it did not impede performance sufficiently to obscure
565 the children's preferences; the advantage of computer generated images is that they allow us to
566 manipulate just the variable of interest. Future work might explore cuteness perceptions in other
567 domains, including using implicit measures (Hahn, Xiao, Sprengelmeyer, & Perrett, 2013;
568 Parsons, Young, Kumari, Stein, & Kringelbach, 2011).
569
570 In conclusion, we found that both boys and girls aged 7 – 9 could distinguish subtle cues to
571 infant cuteness, and this ability to detect facial cues to cuteness was not diminished in a group
572 of purportedly post-menopausal women. This is consistent with reports that children aged 7 or
573 younger, as well as grandparents, provide notable portions of infant caretaking globally
574 (Weisner, 1987; Weisner et al., 1977); the functional explanations given of adults' reactions to
575 cuteness, that it directs appropriate caregiving behaviour, could also apply to this extended age
576 group of potential caregivers.
577
578

579 **5 References**
580

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