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7 **Age, puberty and attractiveness judgments in adolescents**

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17 Previous work has suggested that judgments of the attractiveness of some facial and vocal
18 features change during adolescence. Here, over 70 Czech adolescents aged 12 – 14 made forced-
19 choice attractiveness judgments on adolescent faces manipulated in symmetry, averageness and
20 femininity, and on adolescent opposite-sex voices manipulated in fundamental frequency
21 (perceived as pitch), and completed questionnaires on pubertal development. Consistent with
22 typical adult judgments, adolescents selected the symmetric, average and feminine male and
23 female faces as more attractive significantly more often than the asymmetric, masculine and non-
24 average faces respectively. Moreover, preferences for symmetric faces were positively associated
25 with adolescents' age and stage of pubertal development. Unexpectedly, voice pitch did not
26 significantly influence adolescents' attractiveness judgments. Collectively, these findings present
27 new evidence using refined methodology that adolescent development is related to variation in
28 attractiveness judgments.

29

30 **Introduction**

31 Much research has demonstrated the importance of physical attractiveness in human behaviour
32 (review in e.g. Langlois et al., 2000). Attractiveness affects a diverse range of social interactions,
33 ranging from relationship initiation to attributions of personality traits to beliefs about
34 competence (see e.g. Eagly et al., 1991; Roberts & Little, 2008). Children are by no means exempt
35 from the influences of attractiveness: children are aware of relative attractiveness from a young
36 age, tend to agree with adults about relative attractiveness, and make use of perceptions of
37 physical attractiveness in their behaviour (e.g. Cavior & Lombardi, 1973; Cross & Cross, 1971; Dion,
38 1973; Dion & Berscheid, 1974; Kleck et al., 1974).

39 Attractiveness judgments are thought to reflect mate preferences at least in part, helping
40 individuals to identify potential partners of relatively higher biological quality and suitability (see
41 e.g. Roberts & Little, 2008). Accordingly, attractiveness judgments might be expected to differ
42 across the life span because mate choice is more relevant during some stages of life (e.g.,
43 following puberty) than it is during others (e.g., prior to puberty, Little et al., 2010). Stimuli can be
44 objectively manipulated to differ in the physical parameters that are thought to provide
45 information on the quality of a potential partner, and these manipulations have systematic
46 influences on adults' attractiveness judgments (see e.g. Rhodes, 2006; Roberts & Little, 2008).
47 Manipulations can be used to alter indicators of hormonal profile (e.g., sexually dimorphic shape
48 cues, waist-to-hip ratio and voice pitch) or developmental stability (e.g., prototypicality and
49 symmetry) (see Roberts & Little, 2008). Adults tend to give higher ratings of attractiveness to
50 women whose waist is around one third smaller than their hips, and a study of participants who
51 varied in age from six years old to adulthood found that this standard adult preference developed
52 approximately linearly during childhood and adolescence (Connolly et al., 2004). Additionally,
53 facial masculinity is preferred more by women in their reproductive years, and less by women
54 before the completion of puberty or after the menopause (Little et al., 2010; see also Vukovic et
55 al., 2009). Another study found that preferences for facial averageness, male facial symmetry,
56 feminised male faces (when judged by girls but not boys), and lower-pitched opposite-sex voices
57 each increased with age during puberty (Saxton et al., 2009). Finally, a study comparing female
58 children, adolescents and adults found that only the ratings from the latter two groups gave rise to
59 significant correlations between the rated attractiveness of a man's face compared to his voice,

60 and that only the latter two groups demonstrated a preference for lower-pitched men's voices
61 (Saxton et al., 2006).

62 Research on the development of adolescents' attractiveness judgments has also investigated the
63 relationships between individual differences in face and voice preferences and the stages of
64 normal pubertal development. This follows findings that individual differences in adult
65 attractiveness judgments can be linked to individual differences in hormonal profile (e.g. Jones et
66 al., 2008; Puts, 2006; Welling et al., 2007) and that adolescent biological development corresponds
67 to levels of sexual behaviour in adolescence (Halpern et al., 1993; McClintock & Herdt, 1996; Udry,
68 1988; Udry et al., 1985). Controlling for possible effects of age, pubertal development in
69 adolescents is correlated with boys' preferences for male facial masculinity and girls' preferences
70 for male vocal masculinity (Saxton et al., 2009). In contrast, age, rather than physical development
71 (own waist-to-hip ratio, height, weight, body mass index), is more important for variation in
72 adolescents' preferences for women's waist-to-hip ratios (Connolly et al., 2004).

73 These earlier studies on attractiveness judgments and puberty used self-report measures of
74 various facets of physical development (Saxton et al., 2009), or measurements of waist-to-hip
75 ratio, height, weight and body mass index (Connolly et al., 2004), to capture biological
76 development during adolescence. However, standardised measures of puberty exist, such as the
77 Pubertal Development Scale (Petersen et al., 1988), which uses self-report of somatic markers of
78 puberty to give an overall picture of pubertal development (Bond et al., 2006; Brooks-Gunn et al.,
79 1987). The current study set out to investigate whether standardised measures of pubertal
80 development during adolescence predicted individual differences in face and voice attractiveness
81 judgments. In addition, previous studies either asked adolescents to rate adult stimuli (Little et al.,
82 2010; Saxton et al., 2006) or contrasted older adolescents' judgments of older adolescent stimuli
83 with younger adolescents' judgments of younger adolescent stimuli (Saxton et al., 2009), but have
84 not yet contrasted judgments by adolescents of different ages on the same set of adolescent
85 stimuli, which was taken up in the present study. A final subsidiary aim of the research was to
86 explore preferences in a population that does not form the subject of much current research,
87 namely Czech adolescents (c.f. Henrich et al., in press, who demonstrate how many of our
88 expectations of psychological universals may be incorrect, and recommend cross-cultural testing).

89 **Methods**

90 *Stimuli*

91 All stimuli were taken from Saxton et al (2009), where a fuller description of the methods of
92 stimuli creation can be found. In brief, face stimuli were created on the basis of 60 photographs of
93 Caucasian adolescents aged 11 – 15 (equally divided between male and female; and equally
94 divided between an age group of 11-13 and an age group of 13-15) using the specialist computer
95 graphics software Psychomorph (Tiddeman et al., 2001). Twelve pairs of faces were created that
96 differed only in symmetry: one face was manipulated to increase the bilateral symmetry of the
97 facial features, and one to decrease it. Twelve pairs of faces were created that differed only in
98 averageness: one face was made more average (that is, more similar to the average of the faces
99 making up the group which it came from: i.e. 15 males aged 11 – 13, 15 females aged 11 – 13, 15
100 males aged 13-15, or 15 females aged 13-15), and paired with the matching unmanipulated face.
101 Finally, twelve pairs of faces were created that differed only in sexual dimorphism: one face was
102 made to look more masculine (i.e. more like the average face shape of 15 boys aged 13 – 15 and
103 less like the average face shape of 15 girls aged 13 – 15) and one was made to look more feminine
104 (the reverse manipulation). Examples of the stimuli manipulations are given in Figure 1. Vocal
105 stimuli consisted of 12 pairs of opposite-sex voices (half aged 11-13 and half aged 13-15) from
106 native English speaking individuals reciting four vowel sounds, standardised in length. Voices
107 within each pair were identical except that one was raised and one lowered by 20 Hz in
108 fundamental frequency (perceived as vocal pitch) using Praat 4.4.24 (Boersma, 2001).

109



111 Figure 1. Examples of image manipulation, applied to an adult base face (children's faces are not
112 shown for reasons of consent). Top row: face has been masculinised (left) and feminised (right);
113 middle row: face is original (left) and made more average (right); bottom row: face has been made
114 more asymmetric (left) and more symmetric (right). Image originally published in Saxton et al.,
115 2009.

116

117 Raters

118 Seventy-two raters aged 12 – 14 (12 years: $n=14$ boys/8 girls; 13 years: $n=17/31$; 14 years: $n=2/0$)
119 were recruited from two school entry years (equivalent to the sixth and seventh grades) from
120 three co-educational secondary state schools based in Prague, the Czech Republic, where state
121 schools are the most common method of schooling. The sample consisted of 33 boys (of whom
122 five did not provide voice ratings, one did not provide face ratings, and one did not provide female
123 face ratings for reasons of time) and 39 girls (six of whom did not provide voice ratings).
124 Agreement by schools and children, and written consent from parents, was supplied.

125

126 Tests

127 Tests were performed in the Czech language. Face tests were presented with a Java applet that
128 presented all 72 pairs of faces, randomising presentation side and order. Male faces were blocked
129 separately from female faces. Opposite-sex voices only were rated due to time constraints, as
130 voice rating takes longer than face rating. The software package Powerpoint 2003 (Microsoft) was
131 used to present the voices in pairs. Eight different versions of presentations (half for male voices)
132 were created to minimise order effects. Each version had identical numbers of lower-pitched
133 voices presented first or second within the pair. Children carried out the face and voice tests
134 individually on one of three laptops with headphones, with a screen size of at least 26 x 16 cm and
135 a resolution of at least 1280 x 800 pixels. All children filled out a demographic questionnaire that
136 included questions on pubertal development (axillary hair; facial hair and voice change in boys)
137 adapted from the Pubertal Development Scale (Petersen et al., 1988). The questionnaire also
138 included a self-assessment of pubertal development on the basis of sex-specific line drawings
139 (taken from Taylor et al., 2001). All children self-assessed pubic hair development, and girls self-
140 assessed breast development. Children were assured that they did not need to answer any
141 questions, but that answers would be kept confidential and anonymous. To assure privacy and

142 decrease the risk of potential embarrassment, children were seated individually in a quiet corner
143 of the room away from the other children to complete the questionnaire. No child omitted any
144 answer. The order of the tests (male face test, female face test, opposite-sex voice test,
145 questionnaire) was randomised according to when computers or test stations were available.

146

147 Participant data

148 In order to create roughly equal age and pubertal development categories for the analysis, these
149 were converted to bivariate categories. Children were divided into younger (12 years of age) and
150 older (13 or 14 years of age) groups. Pubertal data were categorised into early or late pubertal,
151 following a formula adapted from Carskadon & Acebo (1993). Girls' self-assessed breast growth
152 and body hair development were included in the formula to allocate children to the different
153 categories, but in fact were not needed in order to distinguish between the categories: in our
154 sample, the girls categorised as early pubertal were all pre-menarchal ($n=13$); all post-menarchal
155 girls ($n=26$) were categorised as late pubertal. The boys categorised as late pubertal ($n=10$)
156 reported facial hair growth, voice change, and axillary hair; the remaining boys ($n=23$) were
157 categorised as early pubertal.

158

159 We calculated six face scores and one voice score for each rater. The six face scores were the
160 proportion of times s/he chose the symmetric, average or feminine male or female face as more
161 attractive than the asymmetric, non-average and masculine face respectively. The voice score was
162 the proportion of times s/he chose the lower-pitched opposite-sex voice as more attractive.
163 Statistical analysis was carried out in SPSS 18.0. Some of the sets of attractiveness judgment data
164 were non-normally distributed (as indicated by the Shapiro-Wilk test, $p < .05$), but t-tests and GLM
165 are fairly robust to violations of the assumption of normal distribution of data (Field, 2005;
166 Stonehouse & Forrester, 1998; Subrahmaniam et al., 1975).

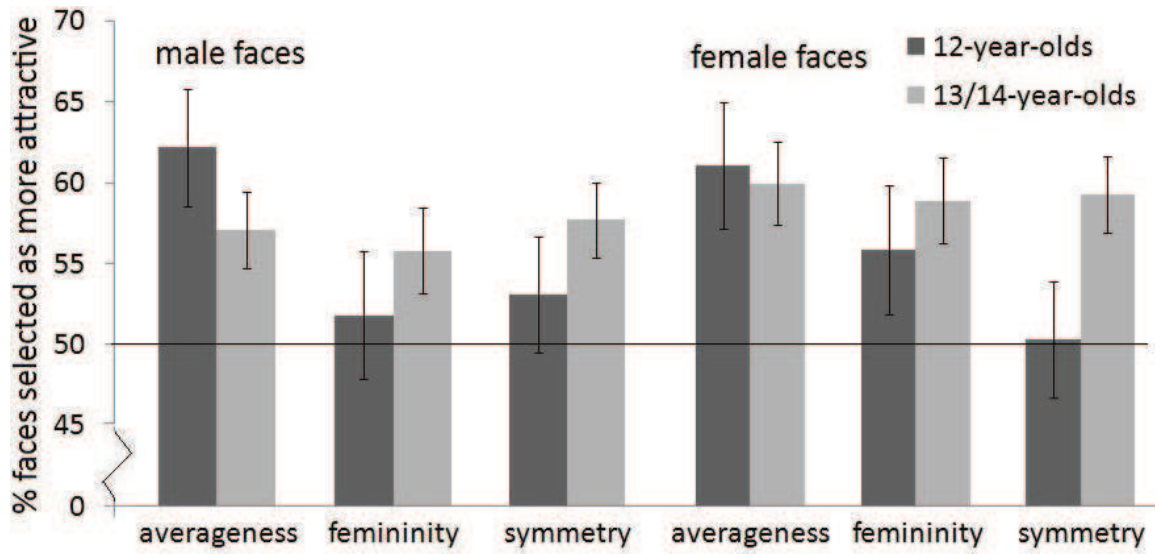
167

168 **Results**

169 First, we tested the participants' general preferences for each of the manipulations. Irrespective of
170 the sex of the rated face, the raters preferred the symmetric, average and feminine faces (over the
171 asymmetric, original and masculine faces respectively) significantly more often than predicted by

172 chance alone (all one-sample $t > 2.5$, $p < .02$). Raters only rated opposite-sex voices; their
173 preferences for high or low pitch did not differ significantly from chance (boys: $t(27) = .48$, $p = .637$;
174 girls: $t(32) = .71$, $p = .484$).

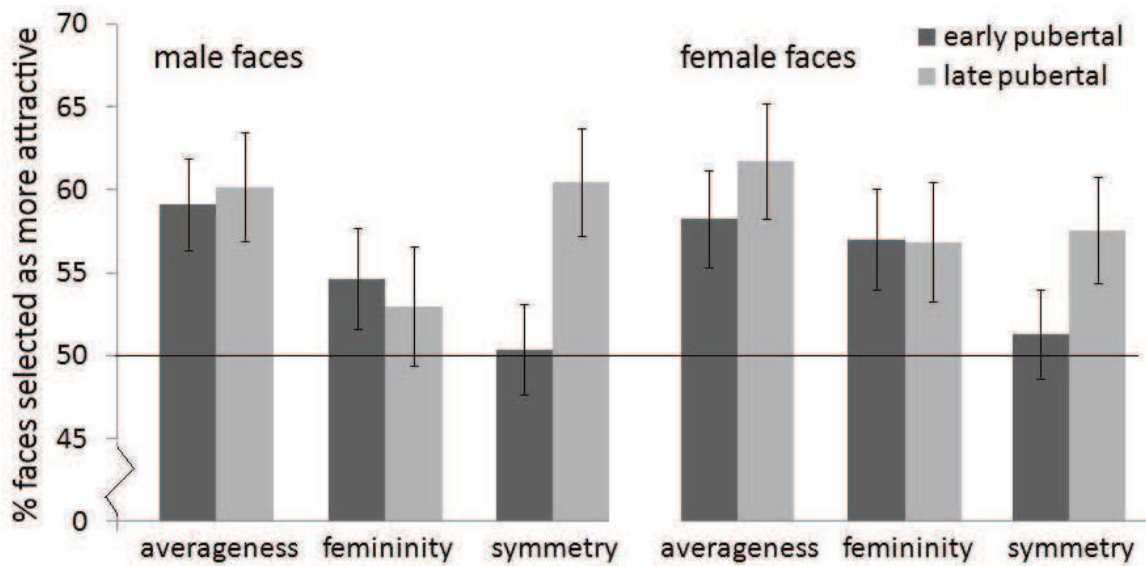
175 We tested for effects of age, sex and pubertal development with a GLM-repeated measures
176 analysis of the face scores (within-subjects factor: type of manipulation applied to the face, sex of
177 rated face; between-subjects factors: pubertal category, age category, sex). There was a significant
178 main effect of the type of manipulation ($F(2,124) = 3.21$, $p = .044$), but this was modified by
179 interactions with the sex of the rater ($F(2, 124) = 3.95$, $p = .022$), and with the pubertal category and
180 the age category ($F(2, 124) = 7.56$, $p = .001$). To understand these better, we subsequently carried
181 out three GLM-repeated measures analyses, one for each of the three types of face manipulation.
182 The sex of the rated face was a within-subjects factor, and the pubertal category, age category and
183 sex of the rater were between-subjects factors. There were no significant effects of any of these
184 variables in judgments of the faces that had been manipulated for averageness. In judgments of
185 facial femininity, there was a significant interaction between the age group and the pubertal
186 category of the raters ($F(1,62) = 9.39$, $p = .003$): in the younger age group, there was a non-significant
187 tendency for the raters in the late pubertal group to have an increased preference for facial
188 masculinity compared with the raters in the early pubertal group ($F(1,18) = 3.53$, $p = .077$), whereas
189 in the older age group, the raters in the late pubertal group had a significantly stronger preference
190 for facial femininity compared with the raters in the early pubertal group ($F(1,44) = 6.85$, $p = .012$). In
191 respect of judgments of facial symmetry, raters in the late pubertal category picked more of the
192 symmetric faces than raters in the early pubertal category ($F(1,62) = 6.79$, $p = .011$), and older raters
193 picked more of the symmetric faces than younger raters ($F(1,62) = 4.56$, $p = .037$). Data are
194 represented in Figures 2 and 3.



195

196 Figure 2. Percentage of average, feminine or symmetric faces selected as more attractive than
 197 original, masculine and asymmetric faces respectively in a forced choice judgment task, by
 198 pubertal category. Bars=mean \pm SE. Chance levels (50%) marked.

199



200

201 Figure 3. Percentage of average, feminine or symmetric faces selected as more attractive than
 202 original, masculine and asymmetric faces respectively in a forced choice judgment task, by age
 203 category. Bars=mean \pm SE. Chance levels (50%) marked.

204 Next, we tested for differences in ratings of the different aged stimulus faces, with a GLM-
205 repeated measures analysis that had the sex and age group of the rated face as the two within-
206 subject factors. There was a significant main effect of the age group of the rated face
207 ($F(1,69)=4.26, p=.043$), but this was modified by a significant interaction with the sex of the rated
208 face ($F(1,69)=6.13, p=.016$) and with the type of manipulation ($F(2,138)=4.28, p=.016$). To
209 understand the interaction with the sex of the rated face, we carried out two GLM-repeated
210 measures analyses, using identical factors but separating the male and female faces. Raters were
211 significantly more likely to select the preferred dimensions (i.e. symmetry, averageness and
212 femininity) of the older compared with the younger faces, but only when they were rating male
213 faces ($F(1,70)=8.63, p=.004$) and not when they were rating female faces ($F(1,69)=.39, p=.532$). To
214 understand the interaction with the type of manipulation, we carried out three GLM-repeated
215 measures analyses, using identical factors but separating the three types of manipulation. We
216 found a significant effect of the age of the rated faces only among the feminised faces: raters were
217 significantly more likely to select the feminised faces as more attractive when they were rating
218 older compared with younger faces ($F(1,69)=8.95, p=.004$). Results are qualitatively identical when
219 the age group of the raters is entered into the analysis, and there are no additional interactions
220 between the rater age group and the age group of the rated faces.

221 Finally, we tested for effects of age and pubertal development with two GLM analyses (one for
222 male and one for female raters) on the opposite-sex voice ratings (between-subjects factors:
223 pubertal category, age category). There was no significant effect of pubertal category, or age
224 category, on boys' judgments of pitch manipulations in girls' voices, or on girls' judgments of pitch
225 manipulations in boys' voices (all $p > .2$). With the same GLM-repeated measures analysis, but
226 separating ratings of the older and younger voices, there was no significant effect of the age of the
227 stimulus voice as an additional within-subjects factor (both $p > .2$).

228 **Discussion**

229 Overall, the Czech adolescents judged the symmetric, average and feminine male and female faces
230 to be more attractive than the asymmetric, less average and masculine male and female faces
231 respectively. This is consistent with judgments made by British adolescents of the same age
232 (Saxton et al., 2009), and broadly consistent with adults' attractiveness judgments, although adults

233 sometimes prefer masculinity in male faces (reviews in e.g. Rhodes, 2006; Roberts & Little, 2008).
234 The manipulations that we applied to the faces reflect dimensions that are thought to allow
235 individuals to judge mate quality, and our results suggest that these dimensions are salient to
236 young adolescents.

237 The adolescents' biological development (as measured by pubertal category, or by age) was linked
238 to preferences for the symmetric faces. Older children, and children in the late puberty group,
239 preferred the symmetric faces more than younger children or children in the early puberty group
240 did. Similarly, older children had stronger preferences for feminised faces if they were further
241 through puberty. Visual inspection of the data (Figures 2 and 3) suggests that more sensitive
242 measures or a greater sample size might reveal more subtle relationships of a smaller effect size
243 between development and attractiveness judgments. Although we set out to use standardised
244 measures of puberty, we divided our sample into just two developmental groups, and found that
245 in the girls menarche alone was so predictive of other developments that it distinguished between
246 the two developmental groups without the need to refer to the other measurements that we took
247 (see 'Participant data'). It remains to be tested whether late-developers eventually come to
248 resemble early-developers in their preferences for all facial traits, but this should not necessarily
249 be the default assumption; previous work has found that men who commence sexual relationships
250 at a younger age have stronger preferences for feminised female faces (Cornwell et al., 2006), and
251 that women who experience earlier menarche have stronger preferences for lower-pitched male
252 voices (Jones et al., 2010). Although many studies have shown that menstrual cycle phase affects
253 women's perceptions of men's faces, we did not consider menstrual cycle phase in the current
254 study, and note that menstrual cycles are typically anovulatory and/or irregular in the age-group
255 of circum-pubertal girls studied here (Apter & Vihko, 1985).

256 The raters showed no directional preference for high or low pitch, and there were no effects of
257 biological development on pitch preferences, in contrast with previous links found between
258 increased girls' age or pubertal development and a stronger preference for lower-pitched male
259 voices (Saxton et al., 2009). It may be that the English voice stimuli were not processed by the
260 Czech adolescents as familiar voice stimuli, although Apicella & Feinberg (2009) used English
261 phrases rated by non-English-speaking Hadza people, and found effects of pitch on ratings of
262 attractiveness.

263 A previous study on the judgments of British adolescents (Saxton et al., 2009) found that older
264 adolescents had stronger preferences than younger adolescents for male and female facial
265 averageness, male facial symmetry, and (when judged by girls but not boys) male facial femininity.
266 However, that study asked older adolescents to rate older faces and younger adolescents to rate
267 younger faces. While this controlled for the possible confounding effect of age differences
268 between rater and stimulus, it did not allow effects of rater age to be distinguished from effects of
269 the age of the stimulus face. In the present study, all of the raters rated all of the faces. In rating
270 male faces, overall the raters were significantly more likely to select the preferred manipulation
271 (symmetry, averageness and femininity) when they were rating older compared with younger
272 faces. If raters pay more attention to more sexually mature male faces, or the preferred
273 manipulation is otherwise easier to assess in the older compared with the younger male faces, this
274 could have contributed to some of the differences in judgments of male faces between older and
275 younger raters in the earlier study (Saxton et al., 2009). In rating male and female faces that varied
276 in sexual dimorphism, the raters were significantly more likely to select the feminine faces when
277 they were rating older compared with younger faces, despite the same manipulation being applied
278 to the older and younger male face stimuli. It might be that the femininity manipulation interacted
279 differently with the younger compared with the older male faces: for instance, masculinised male
280 faces tend to appear older (Boothroyd et al., 2005), so it might be that feminisation of the older
281 faces, and/or masculinisation of the younger faces, made them appear closer to the raters' ages,
282 and that this was considered more attractive. Alternatively, facial characteristics other than
283 masculinity-femininity, such as apparent health, can influence the extent to which exaggerated
284 sex-typical cues are preferred in faces (Smith et al., 2009). It is possible that stimuli from the
285 different age groups differed on such factors.

286 Despite our focus on mate choice, some of the appeal of facial symmetry, averageness and sexual
287 dimorphism may well have other roots. For instance, averageness is attractive in other animate
288 and non-animate objects, namely, dogs, birds and wristwatches (Halberstadt & Rhodes, 2000),
289 perhaps partially because average objects are easier to process (Rhodes, 2006; Winkielman et al.,
290 2006). Accordingly, we might expect averageness in particular to be attractive to younger children
291 if increased ease of processing is associated with preferences at all ages (but see e.g. Rhodes et al.,
292 2002). Further, it may be beneficial to associate oneself with attractive friends for social rather

293 than direct mate choice benefits: attractive children tend to be more popular (Dion & Berscheid,
294 1974), considered more favourably by teachers (Clifford & Walster, 1973), and have higher
295 sociometric status (Kleck et al., 1974), for instance. However, increased age of the rater, and of the
296 rated face, both affected attractiveness judgments, and we would predict that changes in
297 judgments of peers' faces may be particularly acute during adolescence. The developmental
298 profile of preferences for facial characteristics from infancy to adulthood has yet to be plotted.

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