1   Facial trustworthiness is associated with heritable aspects of face shape

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22

27   Abstract

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29   Facial trustworthiness is thought to underlie social judgements in face perception, though it

30 is unclear whether trustworthiness judgements are based on stable facial attributes. If this were the

31 case, we could expect a genetic component of facial trustworthiness. From facial photographs of a

32 large sample of identical and nonidentical twins and siblings (1320 individuals), we tested for

33 genetic variation in facial trustworthiness and genetic covariation with several stable facial

34 attributes, including facial attractiveness, two measures of masculinity, and facial width-to-height

35 ratio. We found a significant genetic component of facial trustworthiness in men (but not women),

36 and significant genetic correlations with the stable morphological facial traits of attractiveness,

37 perceived masculinity, and facial width-to-height ratio. However, there was no significant genetic

38 or shared environmental correlation between facial trustworthiness and an objective masculinity

39 score based on facial landmark coordinates, despite there being a significant phenotypic correlation.

40 Our results suggest that heritable facial traits influence trustworthiness judgements.

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43   Facial trustworthiness is associated with heritable aspects of face shape

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45   Facial trustworthiness has been proposed to be one of the key dimensions that underlie

46   social judgements in face perception (Oosterhof & Todorov, 2008). Indeed, facial trustworthiness

47   judgements has been found to predict outcomes in reality; for instance, convicted murderers with

48   trustworthy faces are less likely to receive the death sentence compared to those with untrustworthy

49   faces (J. P. Wilson & Rule, 2015). In elections, results can be predicted based on the facial

50   trustworthiness of the candidates (Little, Roberts, Jones, & DeBruine, 2012; Mattes et al., 2010).

51   Facial trustworthiness also appears to influence online purchasing decisions, with individuals more

52   likely to choose a vendor with a trustworthy face regardless of the presence of more objective

53   trustworthy indicators such as reviews (Ert, Fleischer, & Magen, 2016). In more controlled settings,

54   participants are more likely to invest in a partner high in facial trustworthiness in various economic

55   games (van 't Wout & Sanfey, 2008).

56   Trustworthiness is thought to underlie social judgements because it conveys pivotal social

57   information (Oosterhof & Todorov, 2008). Accurately assessing the trustworthiness of others is

58   important because trusting an untrustworthy individual could have severe negative consequences,

59   while not trusting a trustworthy individual results in a missed opportunity for cooperation

60   (Cosmides & Tooby, 1992). Such judgements are useful before engaging with an individual, and

61   are dynamically updated with further experience (Chang, Doll, van 't Wout, Frank, & Sanfey,

62   2010). Given the importance of trustworthiness judgements, previous research has proposed that we

63   have evolved a mechanism to evaluate trustworthiness quickly (Oosterhof & Todorov, 2008).

64   Indeed, trustworthy judgements made on faces occur with minimal exposure (less than a second;

65   Todorov, Pakrashi, & Oosterhof, 2009; Willis & Todorov, 2006), has high consensus between

66   individuals (Zebrowitz, Voinescu, & Collins, 1996) and influences behaviour from a young age

67   (Ewing, Caulfield, Read, & Rhodes, 2015).

68   To some degree, trustworthiness judgements are based on dynamic cues, such as emotional

69   expression (i.e., faces expressing happiness is positively associated with trustworthiness, while

70   those expressing anger or sadness are negatively associated; Oosterhof & Todorov, 2009;

71   Verplaetse, Vanneste, & Braeckman, 2007). Indeed, dynamic cues such as authentic smiling (and to

72   a lesser degree, fake smiling) have been associated with trustworthiness judgements (Krumhuber et

73   al., 2007; Oosterhof & Todorov, 2009). Also consistent with this notion, Dotsch and Todorov

74   (2012) identified that highly dynamic areas such as the mouth, eyes, and hair regions are

75   particularly important when making trustworthiness judgements.

76   More controversial is whether trustworthiness judgements are based on stable face traits.

77   Some researchers suggest that dynamic cues are more important for trustworthiness judgements

78   (Hehman, Flake, & Freeman, 2015), while other suggests that 'unfakeable', stable traits are more

79   important (Rezlescu, Duchaine, Olivola, & Chater, 2012). Indeed, some studies have found that

80   trustworthiness is associated with face shape from participants adopting a neutral expression

81   (Kleisner, Priplatova, Frost, & Flegr, 2013). One possibility is that judgements of trustworthiness

82   based on stable traits are over-generalisation of subtle cues to emotional states (Todorov, 2008);

83   however, trustworthiness judgements show unique brain activity independent of judgements of

84   emotional expression (Winston, Strange, O'Doherty, & Dolan, 2002).

85   Two stable traits that have received attention and are thought to be associated with facial

86   trustworthiness are facial attractiveness and facial masculinity. Attractive faces are perceived as

87   more trustworthy (R. K. Wilson & Eckel, 2006). This could be because we may have evolved to

88   find cues to trustworthiness attractive because trustworthy individuals are evolutionarily beneficial

89   as a mating partner (Gangestad & Simpson, 2000; Little, Cohen, Jones, & Belsky, 2007). However,

90   the available evidence suggests that attractive people are actually less trustworthy (Muñoz-Reyes,

91   Pita, Arjona, Sanchez-Pages, & Turiegano, 2014; Shinada & Tamagishi, 2014; Takahashi,

92   Tamagishi, Tanida, Kiyonari, & Kanazawa, 2006; Zaatari & Trivers, 2007). Alternatively, the

93   association between facial attractiveness and trustworthiness could reflect a halo effect, where

attractive individuals are judged higher on positive traits in general (Eagly, Ashmore, Makhijani, & Longo, 1991; Maestripieri, Henry, & Nickels, 2017; Surawski & Ossoff, 2006; Verhulst, Lodge, & Lavine, 2010). Research on whether attractiveness is associated with perceptions of trustworthiness finds a positive relationship for women (Langlois et al., 2000; Zaidel, Bava, & Reis, 2003), and mixed results for men, with some studies finding a positive relationship (Langlois et al., 2000), and others finding no relationship (Zaidel et al., 2003).

Facial masculinity is thought to be associated with physical dominance in men. In turn, it may be advantageous for these facially masculine men who are physically dominant to also possess untrustworthy traits (Haselhuhn & Wong, 2011), as this would give them an advantage in contexts such as resource acquisition and intrasexual competition (Little et al., 2007; Puts, 2010). Attempts to investigate this association between actual trustworthiness and facial masculinity have focused mostly on facial width-to-height ratio (fWHR), which is often considered to be a sexually dimorphic trait (Weston, Friday, & Lio, 2007), even though the best evidence suggests negligible sex differences (Kramer, 2017; Kramer, Jones, & Ward, 2012; Lefevre et al., 2012; Özener, 2012). Men with wider faces are more likely to exploit trustworthy partners in an economic game (Stirrat & Perrett, 2010), and are more willing to deceive and cheat for their own financial gain (Haselhuhn & Wong, 2011). Assuming that actual untrustworthiness is associated with masculinity more generally, this appears to follow through to trustworthiness judgements, which are negatively associated with perceived masculinity judgements (Oosterhof & Todorov, 2008), and women are less likely to find a masculine man attractive under conditions where pro-social traits are advantageous in a romantic partner (Little et al., 2007). While much research has been done with men's faces, relatively little has been done investigating the association between masculinity and trustworthiness judgements in women's faces. Also, it is unknown how trustworthiness judgements are associated with objective facial masculinity, as opposed to perceived masculinity or fWHR, the latter of which may be perceived as sexually dimorphic but objectively is not.

119   Here, we aim to further investigate the link between stable facial traits and facial

120 trustworthiness. In a sample of identical and nonidentical twins who had their photos rated and

121 analysed, we test for genetic variation in facial trustworthiness and genetic covariation with facial

122 attractiveness, fWHR, and an objective measure of facial masculinity based on facial landmark

123 coordinates.

124

125   Methods

126

127 *Participants*

128   Participants were 1320 twins and their siblings from 738 families that either took part in the

129 Brisbane Adolescent Twin Study (BATS; Wright & Martin, 2004) or the Longitudinal Twin Study

130 in Boulder Colorado (LTS; Rhea, Gross, Haberstick, & Corley, 2013). Twins from the BATS (N =

131 990) had their photographs taken as close as possible to their 16th birthday (M = 16.03 years, *SD* =

132 .43 years) while their siblings (*N* = 121) had photographs taken close to their 18th birthday (*M* =

133 17.40 years, *SD* = 1.19 years). Twins from the LTS (*N* = 209) were older than those from the BATS

134 (*M* = 21. 96 years, *SD* = .95 years).

135

136 *Photographs*

137   For twins who were part of the BATS, photographs were taken between the years 1996 and

138 2010. For the earliest waves of data collection, photographs were taken using film cameras and then

139 later scanned into a digital format. For later waves, photographs were taken using digital cameras.

140 For twins from the LTS, photographs were taken between 2001-2010. Participants from the LTS

141 were asked to adopt a neutral facial expression, while no instructions were given to participants

142 from the BATS. All photographs were taken under standard indoor lighting conditions.

143   *Facial Trait Ratings.* These photographs were rated on a number of traits, including facial

144 trustworthiness, facial attractiveness, and facial masculinity (for more detail on the rating process,

145 see Mitchem et al., 2015). Seven research assistants rated each photograph on a 7-point scale (1 =

146 low in a trait, 7 = high in a trait). Between-rater consistency statistics for each trait are reported in

147 Table 1, including Cronbach's alpha and the intra-class correlation (i.e., the proportion of total

148 variance in ratings that is between-faces compared to within).

149

150 Table 1. Between-rater consistency statistics for each rated facial attribute.

Photo Rating	Cronbach's Alpha [95% CI]	Intra-Class Correlation
Facial Trustworthiness	.56 [.53, .56]	.14
Facial Attractiveness	.87 [.86, .88]	.44
Facial Masculinity	.67 [.65, .70]	.20

151

152   *Facial Width-to-Height Ratio.* Two research assistants identified 31 facial landmarks for

153 each photograph after training. For each landmark, the mean pixel coordinates of the two research

154 assistants were used as the coordinates for that landmark. A Generalised Procrustes Analysis (GPA)

155 was conducted using these landmark coordinates, which standardises the landmark configurations

156 by removing non-shape information (i.e., translation, rotation, and scale effects). From these

157 Procrustes coordinates, facial width-to-height ratio was calculated as the width of the face (between

158 the outer edges of the most prominent part of the cheekbones) divided by the height of the face

159 (between the centre of the hairline to the centre of the chin; see Figure 1.).

160   *Objective Facial Masculinity Score.* A data-driven facial masculinity score was calculated

161 for each participant using geometric morphometrics, which is the statistical analysis of shape.

162 Similar to Lee et al. (2014), we did not include landmarks around the mouth to limit the influence

163 of facial expression on the masculinity score. The Procrustes coordinates from the GPA were

164 transformed into shape variables via principal components analysis, which are a decomposition of

165 the Procrustes coordinates that completely maintains the shape information and can be used in

166 conventional statistical techniques. To compute an objective score for facial masculinity, these

shape variables were entered into a discriminant-function-analysis (DFA) with sex as the grouping

variable (0 = Female, 1 = Male). The DFA produces a discriminant function that is the linear

combination of the shape variables that best discriminates between male and female landmark

configurations. Effectively, the discriminant function represents the sexual dimorphism dimension.

As such, where individual participants score on this function represent their objective facial

masculinity. The point-biserial correlation between the discriminant function score and participant

sex was .67, and the correct classification rate was .82, which is in line with previous research that

has used related methods to compute objective masculinity scores (Gangestad, Thornhill, & Garver-

Apgar, 2010; Scott, Pound, Stephen, Clark, & Penton-Voak, 2010). For more information on the

objective facial masculinity score, see Lee et al. (2014).
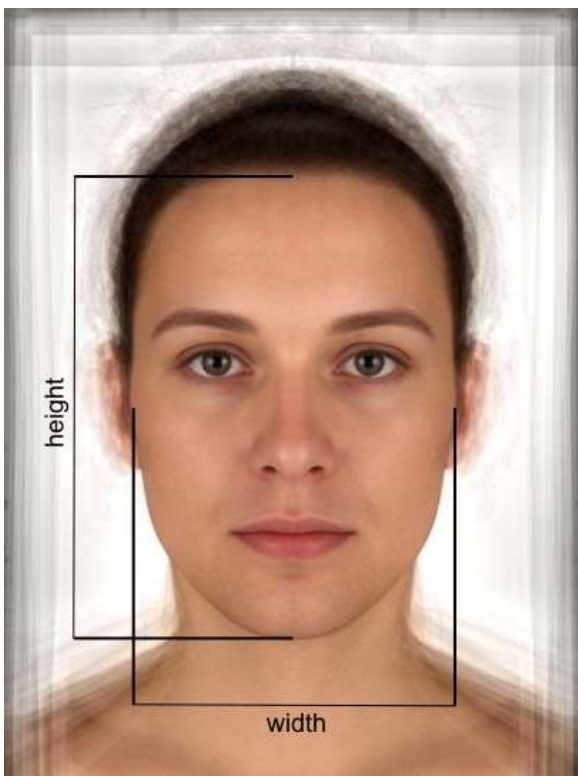
Figure 1. Dimensions used to calculate facial width-to-height ratio.

Statistical Analysis

184   Identical twins share all their genes, while nonidentical twins only share on average 50% of

185   their segregating genes, and all twins completely share family environment. Therefore, through

186   structural equation modelling we can partition the variance of any given trait into three sources:

187   additive genetic sources (A), shared environmental sources (C) such as familial upbringing, and

188   residual sources (E), which includes unique environmental factors and measurement error. As is

189   standard for twin-family designs, we conducted maximum-likelihood modelling, which determines

190   the combination of A, C, and E that best matches the observed means, variances, and twin-pair or

191   sibling correlations in the data (for more information, see Neale & Cardon, 1992; Posthuma et al.,

192   2003). Differences among the means and correlations of different zygosity groups were tested by

193   equating the relevant parameters in the model and testing the change in model fit against the change

194   in the degrees of freedom (which is distributed as χ^2). To test whether there is a genetic association

195   between facial trustworthiness and the stable facial traits, we used a common factors bivariate

196   model, which estimates the correlations between the A, C, and E components between two traits

197   (Loehlin, 1996; Neale & Cardon, 1992). Similar to the partitioning of variance in the univariate

198   model (described above), we can use the cross-twin cross-trait correlation (in this instance, the

199   perceived facial trustworthiness of one twin and the other stable facial trait of the other twin) to

200   partition the covariance between traits into genetic correlation (*rA*), common environmental

201   correlation (*r*C), and residual correlation (*r*E). For more detail on the common factors bivariate

202   model, see the supplementary materials. These analysis has previously been used to test for genetic

203   correlation between facial traits (Lee et al., 2014, 2016). All analyses were conducted in OpenMx

204   package in the R statistical software (Boker et al., 2011).

205

206

207   Results

208

209   *Facial Trustworthiness*

210   Visualisation of shape differences in trustworthiness are shown in Figure 2. A key area that

211   appears to influence trustworthiness judgements in our sample is the shape of the mouth, with

212   upturns in the corners of the mouth being associated with trustworthiness (i.e., a smile). This is in-

213   line with previous work that suggests subtle cues to emotional states of happiness are associated

214   with trustworthiness ratings.

215

216

217   Figure 2. Visualisations of low (left) and high (right) shape differences on facial trustworthiness ($\pm$

218   3 *SD* from the mean face shape).

219

220   There were significant differences between twins and siblings in means and variance for

221   rated facial trustworthiness such that the siblings were rated as more trustworthy compared to twins

222   ($\chi^2(2) = 6.44$, $p = .040$ and $\chi^2(2) = 7.54$, $p = .023$ for means and variances respectively); therefore,

223   models were run with the estimated means for twins and siblings both equated and not equated.

224   This did not influence the pattern of results, so we report models where sibling means were equated

225   to those of twins. We also found significant differences in covariance between men and women of

226   the same zygosity ($\chi^2(2) = 10.52$, $p = .005$). Indeed, as indicated by the twin-pair correlations

227   reported in Table 2, male twin pairs had smaller twin-pair correlations on facial trustworthiness

228   compared to female twin-pairs of the same zygosity. As a result, we estimated separate parameters

229   for males and females.

230   Twin-pair correlations for facial trustworthiness are reported in Table 2. The overall MZ

231   twin pair correlation was significantly larger than the DZ twin pair correlation ($\chi^2(1) = 10.65$, $p =$

232   .001), indicating a genetic influence on the trait. Variance components from the ACE model are

233   presented in Table 3. For women, shared environmental sources had a larger influence than genetic

234   sources, though variation in facial trustworthiness was not significant for either. For men, or when

235   sexes are pooled, variation in facial trustworthiness was significantly attributable to genetic sources.

236

237

238   Table 2. Twin-Pair correlations (r and 95% CI) for facial trustworthiness.

Zygosity Group	Facial Trustworthiness
All identical twins	**.42 [.29, .54]**
Identical female twins	.47 [.31, .64]
Identical male twins	.34 [.13, .55]
All non-identical twins	**.26 [.15, .38]**
Non-identical female twins	.41 [.25, .62]
Non-identical male twins	.05 [-.16, .28]
Non-identical opposite-sex twins	.22 [.03, .43]
All non-identical twins + siblings	**.19 [.09, .29]**
Non-identical female twins + female siblings	.36 [.21, .50]
Non-Identical Male Twins + male siblings	.03 [-.14, .22]
Non-identical opposite-sex twins + opposite-sex siblings	.11 [-.04, .25]

239

240   Table 3. Proportions of variance of facial trustworthiness accounted for by A (additive genetic), C

241   (shared environmental), and E (residual) influences.

	Facial Trustworthiness		
	A	C	E
Females	.18 [.00, .52]	.28 [.00, .49]	.54 [.42, .67]
Males	.27 [.05, .43]	.00 [.00, .18]	.73 [.52, .92]
Overall	.39 [.18, .49]	.00 [.00, .15]	.61 [.51, .71]

242

243   *Trustworthiness and Attractiveness*

244   Phenotypic correlations (controlling for the non-independence of twins) between facial

245   trustworthiness and other facial traits are reported in Table 4. There was a significant phenotypic

13

246 correlation between ratings of trustworthiness and attractiveness for both males and females. In

247 order to determine if facial trustworthiness and attractiveness share a genetic component, we ran a

248 common factors bivariate model. In the sex-specific model, none of the genetic, shared

249 environmental, or residual correlations were significant. However, when the sexes were analysed

250 together, we found a significant correlation between genetic components of facial trustworthiness

251 and facial attractiveness (rA = .42, 95% CI = .09, .70). There was no significant shared

252 environmental correlation in the sex-pooled model $\chi^2(1)$ = 1.46, p = .230. Full models are reported

253 in the supplementary materials.

254

255 Table 4. Phenotypic correlations (and corresponding 95% CI) between all facial traits. Correlations

256 for males (N = 718) are in the upper corner, while those for females (N = 602) are in the lower

257 corner.

258   MALES N = 718

	Trustworthiness	Attractiveness	Objective Masculinity	Perceived Masculinity	fWHR
Trustworthiness		.26 [.18, .33]	-.19 [-.25, -.14]	-.25 [-.33, -.17]	-.20 [-.28, -.12]
Attractiveness	.34 [.27, .41]		-.02 [-.11, .06]	-.17 [-.25, -.08]	-.12 [-.20, -.05]
Objective Masculinity	-.22 [-.30, -.14]	-.21 [-.28, -.13]		.21 [.13, .28]	-.11 [-.19, -.03]
Perceived Masculinity	-.30 [-.37, -.23]	-.69 [-.73, -.65]	.28 [.21, .35]		-.05 [-.13, .03]
Width-to-height ratio	-.12 [-.20, -.05]	-.06 [-.14, .01]	-.07 [-.15, .01]	-.03 [-.11, .04]	

259   FEMALES N = 602

260

261 *Trustworthiness and Masculinity*

262   Phenotypic correlations between facial trustworthiness and all three masculinity measures

263 are reported in Table 4. For both men and women, there was a significant negative correlation

264 between facial trustworthiness and both rated masculinity and objective masculinity. fWHR

265 (purportedly representing a masculine facial trait) was also, to a lesser extent, significantly

266 negatively associated with trustworthiness ratings, but there was no significant positive correlation

267 between perceived masculinity and fWHR in either men or women, or between objective

268 masculinity and fWHR for women. There was a significant negative association between objective

269 masculinity and fWHR in men, but this is the opposite direction to what would be expected if

270 fWHR reflected masculinity as per the assumption in prior research. Indeed, women in our sample

271 had significantly wider faces compared to men $t(1227) = 2.45$, $p = .014$. Together, these results

272 further discredit fWHR as an appropriate index of masculinity.

273   As with facial attractiveness, we conducted common factors bivariate models with facial

274 trustworthiness and each facial masculinity measure. Similar to the results for facial attractiveness,

275 no genetic or shared environmental correlations were significant in the sex-specific models, with

276 the exception of a significant genetic correlation between rated masculinity and facial

277 trustworthiness in men. When considering sex-pooled models, results were inconsistent across the

278 different masculinity measures. For the model with objective masculinity, there was no significant

279 genetic correlation between facial trustworthiness and the objective masculinity score ($rA = -.35$,

280 $95\% CI = -.77, .10$). However, there was a significant overall genetic correlation in the models that

281 included rated masculinity ($rA = -.50$, $95\% CI = -.75, -.30$) and fWHR ($rA = -.28$, $95\% CI = -.70, -

282 .02$). The C correlation was not significant in any of the sex-pooled masculinity models. Full

283 models are reported in the supplementary materials.

284

285   Discussion

286

287   Overall, our results suggest that stable facial traits may be important when making

288 trustworthiness judgements. We found a significant genetic component of facial trustworthiness in

289 men and in the overall sample, and significant genetic correlations with stable morphological facial

290 traits such as attractiveness, perceived masculinity, and fWHR. However, there was no significant

15

291 genetic or shared environmental correlation between facial trustworthiness and objective

292 masculinity, despite there being a significant phenotypic correlation.

293   When estimating parameters for each sex separately, neither genetic nor shared

294 environmental sources significantly explain variation in facial trustworthiness for women. This

295 likely due to a lack of power to adequately detect a significant effect, as the familial effect (i.e.

296 genetic plus shared environment) is significant in both sexes, and also the genetic component by

297 itself is significant when sexes are pooled. For nonidentical female twins, the twin-pair correlation

298 was similar to that of identical twins, while virtually no correlation in facial trustworthiness existed

299 between nonidentical male twins. This could suggest that genetic sources play a more important

300 role in determining facial trustworthiness in men, but common environmental sources are more

301 important in women. Indeed, we found that there was a significant genetic component of facial

302 trustworthiness for men. This is consistent with previous research that has implied that making

303 judgements of trustworthiness based on stable facial traits is particularly important in male targets

304 (e.g., Stirrat & Perrett, 2010). Inaccurate trustworthiness judgements of men potentially carry higher

305 costs compared to judgements of women in several contexts. For instance, when considering a

306 mate, women overall face higher potential costs with choosing an untrustworthy partner due to

307 minimal parental investment (Gangestad & Simpson, 2000). Also, trusting an untrustworthy male

308 introduces higher physical risk, as men are more likely to have higher levels of aggression and

309 strength (Zaatari & Trivers, 2007).

310   For both men and women, we found a significant positive phenotypic correlation between

311 facial attractiveness and perceived trustworthiness, consistent with previous research (Langlois et

312 al., 2000; Zaidel et al., 2003). We also contributed the novel finding that genetic sources associated

313 with facial trustworthiness are also associated with facial attractiveness. If perceived

314 trustworthiness reflected actual trustworthiness, this would support the evolutionary model where

315 genes that influence facial trustworthiness are also found attractive since it is advantageous to

316 choose a trustworthy mate for long-term relationships (Gangestad & Simpson, 2000). However,

317 given previous work has found a negative association between actual trustworthiness and

318 attractiveness (Muñoz-Reyes et al., 2014; Shinada & Tamagishi, 2014; Takahashi et al., 2006;

319 Zaatari & Trivers, 2007), the positive association between perceived trustworthiness and

320 attractiveness more likely reflects a halo effect (Maestripieri et al., 2017). One might expect that

321 any perceptible stable trait associated with untrustworthiness would be selected against, but such an

322 association could evolve if the stable trait is highly desirable or advantageous in another domain

323 (Haselhuhn & Wong, 2011). In a mating context, having a facially attractive partner is

324 advantageous in various domains, such as potential genetic benefits to offspring health (Rhodes et

325 al., 2001). As a result, there may be a positive net benefit in choosing an attractive partner despite

326 them being less trustworthy; this may motivate individuals to in fact over-estimate positive

327 attributes of facially attractive individuals (Maestripieri et al., 2017).

328   We also found a significant negative phenotypic correlation between facial trustworthiness

329 and all three masculinity measures. This is consistent with previous findings that perceived facial

330 masculinity is negatively associated with facial trustworthiness (Oosterhof & Todorov, 2008), and

331 is the first demonstration of a significant association between trustworthiness and an objective facial

332 masculinity score. Such a score entirely avoids the issue of fWHR not representing a sexually

333 dimorphic trait (Kramer, 2017; Kramer et al., 2012; Lefevre et al., 2012; Özener, 2012).

334 Interestingly, the association between perceived facial trustworthiness and fWHR in our data is in

335 line with previous found association between actual trustworthiness and fWHR (Haselhuhn &

336 Wong, 2011; Stirrat & Perrett, 2010). Given that fWHR does not reflect masculinity, it is

337 theoretically unclear why wide faces are seen as less trustworthy. We also found the association

338 between trustworthiness judgements and masculinity with both men and women. Given that

339 previous work investigating actual trustworthiness and facial attributes has focused on men (e.g.,

340 Haselhuhn & Wong, 2011; Stirrat & Perrett, 2010), our results indicate that future investigation

341 should also consider women.

342   Bivariate quantitative genetic models including facial trustworthiness and masculinity were

343   inconsistent between masculinity measures. While models that included either rated masculinity or

344   fWHR revealed that these traits had a significant shared genetic component with facial

345   trustworthiness, this genetic association was not significant for objective masculinity (though it was

346   in the same direction). Previous work has theorised that sexually dimorphic men are less likely to be

347   cooperative as they have an advantage in situations requiring physical strength and aggression

348   (Stirrat & Perrett, 2010; Zaatari & Trivers, 2007). Our data suggests that this may also be reflected

349   in trustworthiness judgements, but given the inconsistent results further investigation is needed.

350   While we focus the discussion on the influence of stable facial cues on trustworthiness

351   judgements, our data does not exclude the possibility that dynamic cues are also important. Indeed,

352   landmark configurations between trustworthy and untrustworthy faces suggest highly dynamic

353   areas, such as the mouth, are important with trustworthiness judgements. In particular, upturned

354   corners of the mouth were associated with greater trustworthiness ratings, lending support to the

355   notion that trustworthiness judgements are influenced by emotional expression (Oosterhof &

356   Todorov, 2009; Verplaetse et al., 2007), or may represent overgeneralisations of emotional state

357   (Todorov, 2008).

358   Limitations of our study include those inherent to the classical twin design. This includes the

359   inability to simultaneously estimate shared environmental (C) and non-additive genetic (D)

360   variance, which may be particularly useful given the inconsistencies in twin-pair correlations for

361   facial trustworthiness between non-identical men and women. This could be overcome by including

362   other family members (e.g., parents) in the analysis. Also, previous research has indicated that there

363   is high consensus in trustworthiness judgements (Zebrowitz et al., 1996), but there was

364   comparatively low inter-rater consistency in our sample. Previous research has found that

365   trustworthiness judgements are influenced by conditions of the perceiver, such as family

366   composition (DeBruine et al., 2011), self-resemblance with the target (DeBruine, 2005), or sex

367   (Wincenciak, Dzhelyova, Perrett, & Barraclough, 2013). Our analyses do not account for individual

368 differences in ratings of facial trustworthiness judgements, which could help explain the relatively

369 low levels of inter-rater consistency for ratings of facial trustworthiness. Heritability estimates can

370 be no more than the Cronbach's alpha because error contributes to the residual variance; therefore,

371 improving the inter-rater consistency of facial trustworthiness may lead to higher heritability

372 estimates. We could also expect that low consistency of facial trustworthiness judgements between

373 raters would introduce noise to the analysis and reduce any detectable association between facial

374 trustworthiness and other facial attribute.

375   Overall, our data suggests that both dynamic and stable cues may influence facial

376 trustworthiness judgements. We note that here we solely investigate whether perceptions of

377 trustworthiness are correlated with facial traits, and do not investigate the accuracy of those

378 perceptions. Future research could investigate the association between facial characteristics and

379 objective measures of trustworthiness, such as choices in economic games.

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