

Little A, Burriss R, Petrie M, Jones BC & Roberts SC (2013) Oral contraceptive use in women changes preferences for male facial masculinity and is associated with partner facial masculinity, *Psychoneuroendocrinology*, 38 (9), pp. 1777-1785.

**This is the peer reviewed version of this article**

*NOTICE: this is the author's version of a work that was accepted for publication in Psychoneuroendocrinology. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Changes may have been made to this work since it was submitted for publication. A definitive version was subsequently published in Psychoneuroendocrinology, [VOL 38, ISS 9 (2013)] DOI: <http://dx.doi.org/10.1016/j.psyneuen.2013.02.014>*

1 **Oral Contraceptive Use in Women Changes Preferences for Male Facial Masculinity and is**  
2 **Associated with Partner Facial Masculinity**

3

4 **Running head:**

5 Hormones affect preference and choice

6

7 **Authors:**

8 Anthony C. Little<sup>1\*†</sup>, Robert P. Burriss<sup>1</sup>, Marion Petrie<sup>2</sup>, Benedict C. Jones<sup>3</sup>, & S. Craig

9 Roberts<sup>1\*†</sup>

10

11 <sup>1</sup> School of Natural Sciences, University of Stirling, FK9 4PA, Scotland, UK

12 <sup>2</sup> Institute for Ageing and Health, Newcastle University, Newcastle upon Tyne, NE4 5PL, UK

13 <sup>3</sup>Institute of Neuroscience & Psychology, University of Glasgow, Glasgow, G12 8QB, Scotland,

14 UK

15

16

17 \*Correspondence to: [anthony.little@stir.ac.uk](mailto:anthony.little@stir.ac.uk) or [craig.roberts@stir.ac.uk](mailto:craig.roberts@stir.ac.uk)

18 †These authors contributed equally to this work

19

20 **Abstract**

21 Millions of women use hormonal contraception and it has been suggested that such use may alter  
22 mate preferences. To examine the impact of oral contraceptive (pill) use on preferences, we  
23 tested for within-subject changes in preferences for masculine faces in women initiating pill use.  
24 Between two sessions, initiation of pill use significantly decreased women's preferences for male  
25 facial masculinity but did not influence preferences for same-sex faces. To test whether altered  
26 preference during pill use influences actual partner choice, we examined facial characteristics in  
27 170 age-matched male partners of women who reported having either been using or not using the  
28 pill when the partnership was formed. Both facial measurements and perceptual judgements  
29 demonstrated that partners of women who used the pill during mate choice have less masculine  
30 faces than partners of women who did not use hormonal contraception at this time. Our data (A)  
31 provide the first experimental evidence that initiation of pill use in women causes changes in  
32 facial preferences and (B) documents downstream effects of these changes on real-life partner  
33 selection. Given that hormonal contraceptive use is widespread, effects of pill use on the  
34 processes of partner formation have important implications for relationship stability and may  
35 have other biologically relevant consequences.

36 **Key words: Oral contraception; pill; attractiveness; mate-choice; disruption; menstrual**  
37 **cycle**

38 **Introduction**

39 Biological approaches to human attractiveness have documented several traits linked to mate  
40 preferences (Roberts and Little, 2008). These include preferences for visible facial and body  
41 traits, such as symmetry and sexually dimorphic cues (Thornhill and Gangestad, 1999; Little et  
42 al., 2011), vocal cues, such as pitch (Feinberg et al., 2006; Feinberg et al., 2008), and odour cues,  
43 such as those associated with genetic profiles (Wedekind, 1995; Roberts et al., 2008). Sexually  
44 dimorphic traits, relative masculinity/femininity, in faces have received much attention from  
45 those interested in evolutionary approaches to human preferences and perception (see e.g.,  
46 Thornhill and Gangestad, 1999). This is because masculinity in male faces has been proposed to  
47 relate to both inter-sexual selection (Thornhill and Gangestad, 1999; Little et al., 2011),  
48 influencing attraction to the opposite-sex, and intra-sexual selection (Swaddle and Reiersen,  
49 2003), relating to competition between members of the same sex. In terms of attractiveness to the  
50 opposite-sex, there are benefits that could be associated with sexual dimorphism: 1. indirect  
51 benefits, genetic benefits that are passed to offspring such as genes associated with strong  
52 immune systems, and 2. direct benefits, benefits that are directly passed to mates or offspring,  
53 such as resources or avoidance of disease. In line with links to both types of benefit, masculine-  
54 faced men are perceived as dominant (Perrett et al., 1998), report better health (Thornhill and  
55 Gangestad, 2006) and are physically stronger (Fink et al., 2007). However, masculine faced men  
56 also receive negative attributions, such as being seen as poor parents (Perrett et al., 1998), and  
57 have more short-term partners (Boothroyd et al., 2008) which suggests low investment in  
58 relationships. Facial masculinity in men then appears to be associated with a trade-off between  
59 investment and quality (Perrett et al., 1998). For example, masculinity may be negatively linked  
60 to levels of investment (direct benefit) but also positively to quality in terms of genes for

61 health/dominance (indirect benefits) as well as current health/resources (direct benefits). Such a  
62 trade-off is consistent with variation in masculinity preferences, such as increased preferences  
63 for masculinity in short-term contexts (Little et al., 2002).

64 Multiple studies have demonstrated that women's preferences for various traits in various  
65 domains shift across the menstrual cycle (Rikowski and Grammer, 1999; Puts, 2005; Feinberg et  
66 al., 2006; Little et al., 2011). One of the most well-documented phenomena in studies examining  
67 cyclical preference shifts is a greater attraction to masculine faces at peak fertility in the  
68 menstrual cycle (Penton-Voak et al., 1999; Johnston et al., 2001; Little et al., 2007; Jones et al.,  
69 2008; Little and Jones, 2012), a within-individual shift driven by variation in hormone levels  
70 across the cycle. This shift has been proposed to be adaptive in changing the preferences of  
71 women when they are most likely to become pregnant towards high quality males or in leading  
72 to attraction to more cooperative men when not likely to become pregnant (Penton-Voak et al.,  
73 1999; Johnston et al., 2001; Little et al., 2007; Jones et al., 2008; Little and Jones, 2012).

74 In view of hormonal differences between users and non-users of hormonal contraception,  
75 we might expect hormonal contraceptive use to influence these cyclical shifts in preferences.  
76 Indeed, studies of cycle effects have demonstrated a lack of (or weaker) shifts in preference  
77 among women using hormonal contraceptives (Penton-Voak et al., 1999; Alvergne and Lummaa,  
78 2010). Hormonal contraception also has the potential to change preferences across several  
79 different domains (Wedekind, 1995; Alvergne and Lummaa, 2010). For example, in the auditory  
80 domain preferences for masculinity in male vocal traits also appear to be weaker in pill users  
81 than non-users (Feinberg et al., 2008). Other research has examined preferences for the odour of  
82 genetically similar and dissimilar men. Some studies have found that preferences for men who  
83 are dissimilar at the major histocompatibility complex (MHC, a suite of genes coding for

84 immune response), move towards preferences for genetically similar men in pill users  
85 (Wedekind, 1995; Roberts et al., 2008), indicating that pill use may change preferences in the  
86 smell domain.

87         Given that the pill and other hormonal contraceptives are used by 12.5% of partnered  
88 women of reproductive age worldwide (United Nations, 2011), and that the proportion of US  
89 women, for example, who have ever used the contraceptive pill stands at 82% (Mosher and  
90 Jones, 2010), any alteration of preferences caused by hormonal contraceptive use is likely to be  
91 widespread. It is therefore important to examine how preferences and partner choice are affected  
92 by contraceptive pill use. Past research on the effects of the pill on preferences has generally  
93 examined only between-group comparisons, comparing different groups of pill users and non-  
94 users. This means that there may exist other differences between users and non-users that  
95 account for variation in preference beyond hormonal changes associated with the pill (Roberts et  
96 al., 2008), such as differences in sexual behaviour (Little et al., 2002). Whether potential shifts in  
97 preference due to pill use lead to measurable differences in partner choices also remains to be  
98 addressed, and this is important because such differences could impact on the benefits and costs  
99 associated with preferring and partnering with masculine-faced men. We therefore examined the  
100 effect of pill use on preferences experimentally in Study 1 and measured the potential  
101 downstream influence of any altered preferences on partner choice in Study 2.

### 102 **Study 1: experimental test of preference change after initiation of pill use**

103 Previous studies of visual preferences for masculine traits documenting differences between  
104 women using and not using hormonal contraceptives have not been experimental in design, and  
105 have therefore been unable to demonstrate causative links between hormonal contraception and  
106 altered mate preferences. In our first study we experimentally examined change in preferences

107 following initiation of pill use. We recruited an experimental group and a control group of  
108 women who completed two facial masculinity preference tests with an interval of approximately  
109 three months. Tests incorporated opposite- and same-sex faces manipulated using computer  
110 graphics techniques to appear more or less masculine (see Figure 1). Opposite-sex faces were  
111 judged for attractiveness as both a long-term and short-term partner, since relationship term is  
112 known to influence preferences (Penton-Voak et al., 1999; Little et al., 2002). The experimental  
113 group commenced pill use after the first test while the control group did not. If pill use affects  
114 preferences we expected that our experimental group would demonstrate a change in preference  
115 while our control group would not. We additionally predicted that if changes in preferences for  
116 sex-typicality reflect adaptation for mate choice then any change in preference for facial  
117 masculinity in the experimental group would be restricted to opposite-sex faces.

118 **Figure 1 about here**

## 119 **Methods**

### 120 **Participants**

121 Participants were 18 women in the experimental group who initiated use of the pill during the  
122 experiment (aged between 18 and 24, mean = 19.7, SD = 1.5) and 37 women in the control group  
123 (aged between 18 and 25, mean = 20.7, SD = 1.9). Three women (two in the experimental group  
124 and one in the control group) chose not to complete same-sex ratings. Participants were students  
125 or staff at Newcastle University, recruited by advertisement or word of mouth. They were  
126 offered £25 in compensation for time, travel and inconvenience. Participation requirements  
127 included not using any form of hormonal contraception either currently or within the preceding  
128 three months, not being pregnant, experiencing regular cycles, and being heterosexual. Women  
129 included in the pill group were either planning or considering to use the pill, and were willing to

130 schedule initiation around the experiment. For ethical reasons, allocation to the pill/control group  
131 was entirely the decision of the volunteers, not the experimenters. The study was approved by  
132 the Ethics Committee of the Newcastle and North Tyneside NHS Trust.

### 133 **Stimuli**

134 To measure preferences for masculine features, we used five interactive face continuum trials of  
135 each sex which were constructed using composite faces made from 5 groups of male and female  
136 faces. The composite images were made by creating an average image from individual facial  
137 photographs (Benson and Perrett, 1993; Tiddeman et al., 2001). Each group of composite faces  
138 contributed to a single continuum trial and consisted of approximately 20 male and 20 female  
139 facial images of young adults in a neutral pose. 174 feature points were delineated on each face  
140 image. Using the linear difference between feature points in the average male and female shape,  
141 a continuum of 11 face shapes ranging from +50% masculinized to +50% feminized was  
142 constructed (Perrett et al., 1998). The images were made perfectly symmetrical by combining  
143 them with their mirror image prior to masculinity manipulation. For more details on the  
144 techniques see (Tiddeman et al., 2001). Figure 1 shows an example of the end-points for  
145 masculinized and feminized male and female faces. The final stimuli were 10 interactive tests  
146 which allowed for the on-screen transformation of a composite male or female face between a  
147 masculinized and feminized version of itself. These interactive tests were used in previous  
148 studies (Perrett et al., 1998; Penton-Voak et al., 1999).

### 149 **Procedure**

150 Following previous methods (Roberts et al., 2008), the preferences of all participants were tested  
151 twice, with a between-test interval of approximately 3 months to allow for hormonal changes to  
152 become stable and representative of continuous pill use (women were scheduled for their second



153 test session during the third cycle, or pill packet, after the first test). To control for any influence  
154 of cycle, participants in the control group were tested in the follicular phase (between day 10-14  
155 of their cycle), when most likely to conceive, during both test sessions. In the experimental  
156 group, women were tested in the follicular phase (between day 10-14 of their cycle) in the first  
157 test session, began taking the pill at the beginning of their next menstrual cycle (approximately 2  
158 weeks later), and were tested for the second time on days 5-9 of their third pill packet  
159 (corresponding to days 10-14 following the first day of bleeding when not using the combined  
160 pill).

161 Participants were informed at the outset that they would complete tests twice over  
162 approximately 3 months, but any change or consistency across tests due to this knowledge would  
163 apply to both the treatment and experimental groups and so could not be responsible for any  
164 between-group differences. In each test session, participants completed a short questionnaire  
165 assessing age, sex, and sexual orientation followed by the main test which consisted of selecting  
166 the most attractive image out of the continua. In each test session, we assessed participants'  
167 preferences for masculinity in male and female faces using the 10 (5 male, 5 female) interactive  
168 continua. Participants judged the male sequences twice resulting in five trials in each of three  
169 blocks (short-term, long-term, and same-sex). Participants were cued to make their judgements  
170 of male faces based on either short- or long-term relationships by the message "alter the face  
171 until you think it is closest to the appearance you would find attractive for a short- [or long-]  
172 term relationship and then left click the mouse button". Definitions of term were presented as in  
173 previous studies (Little et al., 2002):

174 SHORT-TERM: You are looking for the type of person who would be attractive in a  
175 short-term relationship. This implies that the relationship may not last a long time. Examples of

176 this type of relationship would include a single date accepted on the spur of the moment, an  
177 affair within a long-term relationship, and possibility of a one-night stand.

178 LONG-TERM: You are looking for the type of person who would be attractive in a long-  
179 term relationship. Examples of this type of relationship would include someone you may want to  
180 move in with, someone you may consider leaving a current partner to be with, and someone you  
181 may, at some point, wish to marry (or enter into a relationship on similar grounds as marriage).

182 Female faces were judged using the question: “alter the face until you think it is most  
183 attractive and then left click the mouse button”.

184 Participants judged male faces for both types of relationship context and female faces for  
185 attractiveness. The blocks and trials within each block were presented in a random order. During  
186 each trial, left or right (randomized between trials) mouse-movement altered the shape of the  
187 face in the on-screen image, making it more or less masculine. The starting point of the  
188 continuum was randomized in each trial. There was no time limit for decisions and a mouse click  
189 selected the most attractive image and also moved the participant on to the next trial.

#### 190 **Calculating preferences for masculine faces**

191 For each trial a percentage preference was recorded. We calculated three scores for each test  
192 session: preference for masculinity in male faces for long-term relationships, preference for  
193 masculinity in male faces for short-term relationships, and preference for masculinity in female  
194 faces. To produce the scores, for each woman, we calculated the mean percentage of masculinity  
195 chosen in the five relevant trials (Perrett et al., 1998; Penton-Voak et al., 1999; Little et al.,  
196 2002), with high scores indicating more masculine faces were preferred. The correlations  
197 between preferences in Session 1 and Session 2 for each of the three preference tests were all

198 positive and significant (short-term:  $r = .415, p = .002$ , long-term:  $r = .289, p = .032$ , same-sex:  $r$   
199  $= .472, p = .001$ ).

200 We calculated the change in preference between the first and second test session for each  
201 of the three scores by subtracting scores in the first test session (Session 1) from scores in the  
202 second test session (Session 2). Positive scores indicated an increase in preferences for  
203 masculinity and negative scores indicated a decrease in preferences for masculinity across  
204 sessions. These difference scores are used as variables in the analysis below.

## 205 **Results**

206 A mixed-model 2x2 ANOVA was carried out with change in preference for masculinity in male  
207 faces as the dependent variable, *term* (long-term/short-term) as a within-participant factor and  
208 *condition* (experimental/control) as a between-participant factor. This analysis revealed a  
209 significant main effect of *condition* ( $F_{1,53} = 6.91, p = .011, \eta_p^2 = .115$ ). There was no significant  
210 main effect of *term* ( $F_{1,53} = 2.72, p = .105, \eta_p^2 = .049$ ) and no significant interaction between  
211 *condition* and *term* ( $F_{1,53} < 0.01, p = .976, \eta_p^2 < .001$ ). Means (collapsing across term) can be  
212 seen in Figure 1. The main effect of *condition* indicated that preferences for male facial  
213 masculinity were generally lower in the experimental, pill-using group at Session 2 compared  
214 with Session 1, a decrease not evident in the control group (Figure 1). Adding age as a covariate  
215 did not significantly affect the results of this analysis (see supplementary analysis).

216 Given that there was no interaction between term and condition, we computed average  
217 change across short-term and long-term judgements. Restricting analysis to those women with  
218 both same-sex and opposite-sex scores (see experimental procedures), to compare opposite-sex  
219 to same-sex judgements, a mixed-model ANOVA was carried out with change in preference as  
220 the dependent variable, *sex of face* (male/female) as a within-participant factor and *condition*

221 (experimental/control) as a between-participant factor. This analysis revealed a significant  
222 interaction between *sex of face* and *condition* ( $F_{1,50} = 4.48, p = .039, \eta_p^2 = .082$ ). There was also  
223 a significant main effect of *sex of face* ( $F_{1,50} = 8.69, p = .005, \eta_p^2 = .148$ ). There was no  
224 significant main effect of *condition* ( $F_{1,50} = 2.26, p = .142, \eta_p^2 = .043$ ). Independent samples t-  
225 tests revealed that change in masculinity preferences was significantly different according to  
226 *condition* for judgements of opposite-sex faces ( $t_{50} = 2.81, p = .007, d = 0.795$ ) but not same-sex  
227 faces ( $t_{50} = 0.31, p = .761, d = 0.088$ ). Confirmatory one sample t-tests against no change (0),  
228 revealed that, for those in the experimental group, there was a significant decrease in preference  
229 for masculinity in male faces ( $t_{17} = 3.59, p = .002, d = 1.741$ ) but not female faces ( $t_{15} = 1.05, p =$   
230  $.309, d = 0.542$ ) and that for the control group there was no significant change for either male ( $t_{36}$   
231  $= 0.33, p = .747, d = 0.110$ ) or female faces ( $t_{35} = 0.95, p = .403, d = 0.321$ ).

232 **Study 2: measurement of women's partner's facial masculinity according to pill use at the**  
233 **time of partner selection**

234 Changes in preference induced by pill use could lead to different partner choices in real life.  
235 Based on results of our experimental manipulation, we predicted that there would be differences  
236 in masculinity between the partners of those who met their partner while using or not using  
237 hormonal contraception. To test this, we conducted a second study on an age-matched sample of  
238 85 couples who reported using, and 85 couples who reported not using, the pill at the time of  
239 partnership formation. Standardized front-on neutral photographs were taken of the men. We  
240 determined men's masculinity in three ways: 1. forced-choice judgements of the original images,  
241 2. forced-choice judgements of computer manipulated images capturing the shape differences  
242 between the partners of pill-users and non-users (see Figure 2), and 3. measurement of known  
243 sexually dimorphic face traits (see Figure 3).

244 **Figure 2 about here**

245 **Figure 3 about here**

## 246 **Methods**

### 247 **Participants**

248 Target participants were 170 male-female couples (aged between 18 and 73, mean = 35.8, SD =  
249 11.3). All couples reported to be heterosexual. We collected data and images from 333 couples  
250 who were visitors to a science exhibition centre and who responded positively to a face-to-face  
251 invitation to participate. The only inclusion criteria were that both members of the couple were  
252 present. From this larger set, we created an age-matched final set: using reported male age, for  
253 each male who met their partner while using the pill we searched for a same aged male who met  
254 their partner while not using the pill (nor any other form of hormonal contraception). Men for  
255 which there were no remaining age matches were excluded. Where multiple matches were  
256 available, men were selected randomly.

257 An additional 30 participants (20 women, 10 men, aged between 17 and 41, mean = 26.0,  
258 SD = 5.5) judged pairs of the original face images for relative masculinity. A different set of 80  
259 participants (56 women, 24 men, aged between 17 and 57, mean = 26.1, SD = 8.5) judged pairs  
260 of the manipulated face images for relative masculinity. Both sets of raters were recruited online  
261 and completed the test over the Internet.

262 The study was approved by the Ethics Committee of the Department of Psychology,  
263 University of Stirling.

### 264 **Photography**

265 Photographs of the men were taken under standardized lighting conditions and participants posed  
266 with a neutral expression. To equate size, all images were aligned to standardize the position of  
267 the pupils in the image.

### 268 **Stimuli for ratings**

269 For judgements of the original images, the images were resized to 280 x 325 pixels. To create  
270 computer manipulated images capturing the shape differences between the partners of pill-users  
271 and non-users, we first created one composite face for each group of men, using the method  
272 described for Study 1. To make the transformed faces, we manipulated 10 male base faces +50%  
273 towards the pill user's partner or +50% towards the non-user's partner using the shape difference  
274 between the two composites, creating 10 pairs of images that capture the differences between the  
275 composites (partners of pill users and non-users). These transformed faces were made using the  
276 same way methods used to manipulate masculinity in Study 1.

### 277 **Procedure for ratings**

278 In both rating studies, participants were presented on a computer with a brief questionnaire  
279 followed by pairs of images and were asked to "Choose the most masculine image out of the  
280 pair". Selecting an image moved on to the next trial. The order of the trials and the side of  
281 presentation was randomized. There was no time limit for judgements. For the original images  
282 test there were 85 trials and for the manipulated images test there were 10 trials.

### 283 **Measurements**

284 Sexual dimorphism measures were taken from points marked on facial features used in previous  
285 studies (Penton-Voak et al., 2001; Little et al., 2008b) and can be seen in Figure 3. Three  
286 measurements were taken: Cheekbone Prominence, Jaw Height/Lower Face Height, and Face  
287 Width/Lower Face Height. These measurements have been found to be sexually dimorphic in

288 previous studies (Penton-Voak et al., 2001; Little et al., 2008b). To compute an overall measure  
289 of masculinity, these variables were normalised and summed:  $JH/LFH - ((CP + FW/LFH)/2)$ .  
290 High scores on this measure indicated masculine face shape. Two markers independently placed  
291 points, and the average score for each face was then calculated (correlation between score for the  
292 two markers was:  $r = .935$ ).

## 293 **Results**

294 A one sample t-test comparing choice between pairs of original faces of the two groups of men  
295 (partners of pill users and non-users at relationship formation) revealed that the partners of non-  
296 users were seen as significantly more masculine, both using average scores for each rater ( $t_{29} =$   
297  $7.13, p < .001, d = 2.648$ ) and average scores for each face ( $t_{84} = 2.14, p = .035, d = 0.467$ ). A  
298 one sample t-test for the manipulated face images, in which shape cues were isolated, using  
299 average scores for each rater again revealed that the partners of non-users were seen as  
300 significantly more masculine ( $t_{79} = 3.38, p = .001, d = 0.761$ ). Finally, a paired sample t-test on  
301 the metric masculinity for each face also revealed that men whose relationships began while their  
302 partner used the pill had significantly less morphologically masculine faces than those whose  
303 partners did not use the pill at relationship formation ( $t_{84} = 2.00, p = .048, d = 0.436$ ).

## 304 **Discussion**

305 Our first study represents the first experimental demonstration that pill initiation changes visual  
306 preferences for a trait associated with mate-quality, complementing within-subject  
307 demonstrations that pill use can change odour preferences for genetic similarity (Roberts et al.,  
308 2008). Effects were only seen for preferences for opposite-sex faces, suggestive that the effects  
309 of pill use influence mate preferences but not general preferences for faces. Experimental studies  
310 are critical because behavioural variables, such as sexual behaviour (Little et al., 2002), that

311 could impact on preference and mate choice differ between pill-users and non-users (Roberts et  
312 al., 2008). The second study builds on our experimental demonstration of changed preferences,  
313 documenting a downstream consequence of pill use during formation of actual partnerships,  
314 suggesting that altered preferences lead to altered mate choice. Original face images and  
315 computer generated images of women's partners, whom they met while using the pill, were  
316 judged as less masculine than those of women who met their partner when not using the pill.  
317 Facial measurements of the masculinity of the women's partners were in line with this effect.  
318 The effect size for the measurements by face was smaller than the effect size for the perceptual  
319 ratings by rater, potentially reflecting that the facial measurements used do not capture all of the  
320 variation in masculinity between the faces (e.g., color cues are absent), although we note that this  
321 appears also due to variation in the type of analysis, as more similar effect sizes are seen when  
322 comparing the effect size for the measurements by face and the perceptual ratings by face.

323         We focused on facial masculinity because researchers have proposed that sexually  
324 dimorphic facial traits (masculine appearance in men and feminine appearance in women) may  
325 be cues to indirect (genetic benefits to offspring) and direct fitness benefits (Thornhill and  
326 Gangestad, 1999). Masculinity, though, is not universally preferred by women and many  
327 previous studies demonstrate individual differences in preference for masculine and feminine  
328 traits in faces ( Little et al., 2011). While masculine-faced men are healthier (Rhodes et al., 2003;  
329 Thornhill and Gangestad, 2006), physically stronger (Fink et al., 2007), and more facially  
330 symmetric (Little et al., 2008a) than their feminine faced counterparts, choosing a masculine  
331 partner also carries a cost. Masculine-faced men are seen to possess less pleasant personality  
332 traits (Perrett et al., 1998) and are more likely to pursue short-term relationships than feminine-  
333 faced men (Boothroyd et al., 2008). As might be expected, masculine faces are seen as more



334 dominant but not as possessing traits that would be desirable in a long-term partner (Perrett et al.,  
335 1998). Initiation of pill use impacts preferences for these traits, suggesting that associated  
336 hormonal changes alter the balance in favour of cooperative feminine partners over  
337 dominant/healthy masculine partners. Hormonal contraceptives work by altering hormonal  
338 fluctuations that occur during the natural menstrual cycle, through negative feedback effects on  
339 the hypothalamus and anterior pituitary gland, which suppress gonadotropin release and inhibit  
340 follicular development and ovulation (Rivera et al., 1999). They consist of synthetic formulations  
341 of either a progestogen (e.g., the “minipill”, or progestin-only pill) or a dose of both an estrogen  
342 and a progestogen (e.g., the “combined pill”). The oral contraceptive pill, and other hormone-  
343 based contraceptives (e.g., patch or implant) work by suppressing ovarian hormones, which  
344 alters the hormonal profile of the woman, and results in a levelling effect in concentrations of  
345 estrogen and progesterone (Rivera et al., 1999; Benagiano et al., 2006). This in turn works to  
346 prevent follicular development and subsequent hormonal shifts associated with ovulation (Frye,  
347 2006). Women’s levels of circulating testosterone are also suppressed during hormonal  
348 contraceptive use (e.g., Alexander et al., 1990), which may contribute to change in women’s  
349 sexuality, at least in some individuals (e.g., Graham et al., 2007). These changes in hormonal  
350 profile likely underpin the changes in preference and choice seen in our studies. For example,  
351 because the hormonal profile of pill users reflects low likelihood of conception and is thus in this  
352 specific respect closer to that seen during pregnancy, a time when cooperation and investment is  
353 valued more than other measures of quality, women using hormonal contraceptives may prefer  
354 partners displaying visual cues to cooperation and not genetic quality (Alvergne and Lummaa,  
355 2010). Alternatively, pill users may not necessarily be more or less attracted to different faces,  
356 but rather they may be less attentive to facial masculinity because they do not experience a

357 periovulatory increase in visual attention towards mate-salient cues that is normally experienced  
358 by non-users (Anderson et al., 2010). Through any of these hormonally mediated mechanisms,  
359 changes in partner choice that are associated with pill use could then affect subsequent  
360 relationship quality and stability (Roberts et al., 2012) as well as potentially influencing the  
361 health of future offspring (Havlicek and Roberts, 2009; Alvergne and Lummaa, 2010).

362         Although we think our results bring important evidence for an influence of pill use in  
363 shaping women's partner choice, they raise some additional questions which warrant further  
364 examination. First, our design in Study 1 tested women's preference change following initiation  
365 of pill use, but not following discontinuation. A further study might therefore compare  
366 preferences of pill users before and after discontinuation, with the prediction that their  
367 masculinity preference would increase as they resume cycling. Second, future studies could  
368 explore dose-dependent effects of oral contraceptives on preference. Women using pill brands  
369 with higher doses of synthetic estrogen experience higher levels of sexual jealousy (Cobey et al.,  
370 2011) and related behaviour (Welling et al., 2012) than those using lower-dose brands, and it is  
371 possible that dosage also influences other psychological variables including partner preferences.  
372 Unfortunately, we were unable to investigate this in our study as many of the women in Study 2  
373 could not recall which pill brand they had been using when they met their partner. Third, future  
374 work could investigate an alternative interpretation of the results of Study 2, which is that men  
375 are more active in choosing long-term partners than women and that masculine-faced men prefer  
376 non-users over users. This could be a plausible explanation because more masculine men might  
377 compete more effectively for attractive women, and women appear most attractive at peak  
378 fertility (e.g., Roberts et al., 2004; Havlicek et al., 2006). However, at this point, we think that  
379 this is a less likely explanation for the observed effect because, as in non-human animals,

380 selection on female choice is thought to be stronger than on male choice. It also appears more  
381 parsimonious that effects of pill use are directly exerted on the female user than indirectly on  
382 potential male partners, and, furthermore, Study 1 shows a consistent effect on women's  
383 preference for the relevant facial trait. Finally, the results of Study 2 could be explained by pill  
384 users having stronger preference for another male trait which is itself correlated with lower facial  
385 masculinity. This could be an interesting possibility but, again, the results presented in Study 1  
386 provide support for a preference change based directly on sexually dimorphic facial cues.

387         We also note that in Study 1 we tested women in the follicular phase, when preference  
388 for masculinity is usually elevated (Penton-Voak et al., 1999), and that, in real life, long-term  
389 partner selection is likely an extended process, occurring across multiple cycles in which women  
390 can vary in their attraction to masculinity and femininity. It is therefore possible that pill use may  
391 have a smaller effect on women's preferences than indicated by our effect size, if preferences  
392 were to be averaged across measures at multiple points across the cycle. Even if this is the case,  
393 however, the results of Study 2 indicate that effects of pill use on preference remain sufficiently  
394 substantial to exert an effect on actual partner selection.

395         Despite their influence on partner preferences, it is important to also note that modern  
396 contraceptive methods have improved quality of life around the world by reducing the frequency  
397 of unintended pregnancies and maternal deaths (Alvergne and Lummaa, 2010). They have also  
398 given women much more control over their reproductive lives, enabling them to postpone  
399 childbearing, increase their educational level, and pursue more varied career paths (Shah et al.,  
400 2001; Goldin and Katz, 2002). The pill is also associated with several demonstrated health  
401 benefits through stabilization of hormonal fluctuations, such as helping to control premenstrual  
402 syndrome and reduce acne (Sherif, 1999). Nevertheless, the impact of the pill on partner choice

403 and the implications of this impact may have been generally underappreciated. Given that the pill  
404 and other hormonal contraceptives are used by millions of women of reproductive age  
405 worldwide, our data could allow women to weigh the costs and benefits of pill use versus other  
406 contraceptive methods.

407

## 408 **References**

409 Alexander, G.M., Sherwin, B.B., Bancroft, J., Davidson, D.W., 1990. Testosterone and sexual-  
410 behavior in oral-contraceptive users and nonusers - a prospective-study. *Horm Behav* 24, 388-  
411 402.

412 Alvergne, A., Lummaa, V., 2010. Does the contraceptive pill alter mate choice in humans?  
413 *Trends Ecol Evol* 25, 171-179.

414 Anderson, U.S., Perea, E.F., Becker, D.V., Ackerman, J.M., Shapiro, J.R., Neuberg, S.L.,  
415 Kenrick, D.T., 2010. I only have eyes for you: Ovulation redirects attention (but not memory) to  
416 attractive men. *J Exp Soc Psychol* 46, 804-808.

417 Benagiano, G., Bastianelli, C., Farris, M., 2006. Contraception today. In: Creatsas, G.,  
418 Mastorakos, G., Chrousos, G.P. (Eds.), *Women's Health and Disease: Gynecologic, Endocrine,*  
419 *and Reproductive Issues, Annals of the New York Academy of Sciences*, vol . 1092, pp. 1-32.

420 Benson, P.J., Perrett, D.I., 1993. Extracting prototypical facial images from exemplars.  
421 *Perception* 22, 257-262.

422 Boothroyd, L.G., Jones, B.C., Burt, D.M., DeBruine, L.M., Perrett, D.I., 2008. Facial correlates  
423 of sociosexuality. *Evo Hum Behav* 29, 211-218.

424 Cobey, K.D., Pollet, T.V., Roberts, S.C., Buunk, A.P., 2011. Hormonal birth control use and  
425 relationship jealousy: Evidence for estrogen dosage effects. *Pers Individ Differ* 50, 315-317.

426 Feinberg, D.R., DeBruine, L.M., Jones, B.C., Little, A.C., 2008. Correlated preferences for men's  
427 facial and vocal masculinity. *Evo Hum Behav* 29, 233-241.

428 Feinberg, D.R., Jones, B.C., Law-Smith, M.J., Moore, F.R., DeBruine, L.M., Cornwell, R.E.,  
429 Hillier, S.G., Perrett, D.I., 2006. Menstrual cycle, trait estrogen level, and masculinity  
430 preferences in the human voice. *Horm Behav* 49, 215-222.

431 Fink, B., Neave, N., Seydel, H., 2007. Male facial appearance signals physical strength to  
432 women. *Am J Hum Biol* 19, 82-87.

433 Frye, C.A., 2006. An overview of oral contraceptives - Mechanism of action and clinical use.  
434 *Neurology* 66, S29-S36.

435 Goldin, C., Katz, L.F., 2002. The power of the pill: Oral contraceptives and women's career and  
436 marriage decisions. *J Polit Econ* 110, 730-770.

437 Graham, C.A., Bancroft, J., Doll, H.A., Greco, T., Tanner, A., 2007. Does oral contraceptive-  
438 induced reduction in free testosterone adversely affect the sexuality or mood of women?  
439 *Psychoneuroendocrinology* 32, 246-255.

440 Havlicek, J., Dvorakova, R., Bartos, L., Flegr, J., 2006. Non-advertized does not mean  
441 concealed: Body odour changes across the human menstrual cycle. *Ethology* 112, 81-90.

442 Havlicek, J., Roberts, S.C., 2009. MHC-correlated mate choice in humans: A review.  
443 *Psychoneuroendocrinology* 34, 497-512.

444 Johnston, V.S., Hagel, R., Franklin, M., Fink, B., Grammer, K., 2001. Male facial attractiveness:  
445 evidence for a hormone-mediated adaptive design. *Evo Hum Behav* 22, 251 - 267.

446 Jones, B.C., DeBruine, L.M., Perrett, D.I., Little, A.C., Feinberg, D.R., Smith, M.J.L., 2008.  
447 Effects of menstrual cycle phase on face preferences. *Arch Sex Behav* 37, 78-84.

448 Little, A.C., Jones, B.C., 2012. Variation in facial masculinity and symmetry preferences across  
449 the menstrual cycle is moderated by relationship context. *Psychoneuroendocrinology* 37, 999-  
450 1008.

451 Little, A.C., Jones, B.C., Burt, D.M., Perrett, D.I., 2007. Preferences for symmetry in faces  
452 change across the menstrual cycle. *Biol Psychol* 76, 209-216.

453 Little, A.C., Jones, B.C., DeBruine, L.M., 2011. Facial attractiveness: Evolutionary based  
454 research. *Philos T Roy Soc B* 366, 1638-1659.

455 Little, A.C., Jones, B.C., DeBruine, L.M., Feinberg, D.R., 2008a. Symmetry and sexual  
456 dimorphism in human faces: Interrelated preferences suggest both signal quality. *Behav. Ecol.*  
457 19, 902-908.

458 Little, A.C., Jones, B.C., Penton-Voak, I.S., Burt, D.M., Perrett, D.I., 2002. Partnership status  
459 and the temporal context of relationships influence human female preferences for sexual  
460 dimorphism in male face shape. *Proc R Soc Lond B Biol Sci* 269, 1095-1100.

461 Little, A.C., Jones, B.C., Waite, C., Tiddeman, B.P., Feinberg, D.R., Perrett, D.I., Apicella, C.L.,  
462 Marlowe, F.W., 2008b. Symmetry is related to sexual dimorphism in faces: data across culture  
463 and species. *PLoS One* 3, e2106.

464 Mosher, W.D., Jones, J., 2010. Use of contraception in the United States: 1982-2008. *Vital and*  
465 *health statistics. Series 23, Data from the National Survey of Family Growth*, 1-44.

466 Penton-Voak, I.S., Jones, B.C., Little, A.C., Baker, S., Tiddeman, B., Burt, D.M., Perrett, D.I.,  
467 2001. Symmetry, sexual dimorphism in facial proportions, and male facial attractiveness. *Proc R*  
468 *Soc Lond B Biol Sci* 268, 1617-1623.

469 Penton-Voak, I.S., Perrett, D.I., Castles, D.L., Kobayashi, T., Burt, D.M., Murray, L.K.,  
470 Minamisawa, R., 1999. Menstrual cycle alters face preference. *Nature* 399, 741-742.

471 Perrett, D.I., Lee, K.J., Penton-Voak, I.S., Rowland, D.R., Yoshikawa, S., Burt, D.M., Henzi,  
472 S.P., Castles, D.L., Akamatsu, S., 1998. Effects of sexual dimorphism on facial attractiveness.  
473 Nature 394, 884-887.

474 Puts, D.A., 2005. Mating context and menstrual phase affect women's preferences for male voice  
475 pitch. *Evo Hum Behav* 26, 388-397.

476 Rhodes, G., Chan, J., Zebrowitz, L.A., Simmons, L.W., 2003. Does sexual dimorphism in human  
477 faces signal health? *Proc R Soc Lond B Biol Sci* 270, S93-S95.

478 Rikowski, A., Grammer, K., 1999. Human body odour, symmetry and attractiveness. *Proc R Soc*  
479 *Lond B Biol Sci* 266, 869-874.

480 Rivera, R., Yacobson, I., Grimes, D., 1999. The mechanism of action of hormonal contraceptives  
481 and intrauterine contraceptive devices. *Am J Obstet Gynecol* 181, 1263-1269.

482 Roberts, S.C., Gosling, L.M., Carter, V., Petrie, M., 2008. MHC-correlated odour preferences in  
483 humans and the use of oral contraceptives. *Proc R Soc Lond B Biol Sci* 275, 2715-2722.

484 Roberts, S.C., Havlicek, J., Flegr, J., Hruskova, M., Little, A.C., Jones, B.C., Perrett, D.I., Petrie,  
485 M., 2004. Female facial attractiveness increases during the fertile phase of the menstrual cycle.  
486 *Proc R Soc Lond B Biol Sci* 271, S270-S272.

487 Roberts, S.C., Klapilova, K., Little, A.C., Burriss, R.P., Jones, B.C., DeBruine, L.M., Petrie, M.,  
488 Havlicek, J., 2012. Relationship satisfaction and outcome in women who meet their partner  
489 while using oral contraception. *Proc R Soc Lond B Biol Sci* 279, 1430-1436.

490 Roberts, S.C., Little, A.C., 2008. Good genes, complementary genes and human mate  
491 preferences. *Genetica* 132, 309-321.

492 Shah, N.M., Shah, M.A., Al-Rahmani, E., Behbehani, J., Radovanovic, Z., Menon, I., 2001.  
493 Trends, patterns and correlates of contraceptive use among Kuwaitis, 1984-1999. *Med Prin Pract*  
494 10, 34-40.

495 Sherif, K., 1999. Benefits and risks of oral contraceptives. *Am J Obstet Gynecol* 180, S343-  
496 S348.

497 Swaddle, J.P., Reiersen, G.W., 2003. Testosterone increases perceived dominance but not  
498 attractiveness in human males. *Proc R Soc Lond B Biol Sci* 269, 2285-2289.

499 Thornhill, R., Gangestad, S.W., 1999. Facial attractiveness. *Trends Cog Sci* 3, 452-460.

500 Thornhill, R., Gangestad, S.W., 2006. Facial sexual dimorphism, developmental stability, and  
501 susceptibility to disease in men and women. *Evo Hum Behav* 27, 131-144.

502 Tiddeman, B.P., Burt, D.M., Perrett, D.I., 2001. Prototyping and transforming facial texture for  
503 perception research. *IEEE Computer Graphics and Applications* 21, 42-50.

504 United Nations, Department of Economic and Social Affairs, Population Division 2011. *World*  
505 *Contraceptive Use 2010*. POP/DB/CP/Rev2010.

506 Wedekind, C., Seebeck, T., Bettens, F. & Paepke, A.J., 1995. MHC-dependent mate preferences  
507 in humans. *Proc R Soc Lond B Biol Sci* 260, 245-249.

508 Welling, L.L.M., Puts, D.A., Roberts, S.C., Little, A.C., Burriss, R.P., 2012. Hormonal  
509 contraceptive use and mate retention behavior in women and their male partners. *Horm Behav*  
510 61, 114-120.

511

512

513



514 **Figure Legends**

515 **Figure 1: Example stimuli and results for Experiment 1. Left: Feminized (left) and**  
516 **masculinized (right) male and female faces. Participants saw an interactive continuum.**  
517 **Right: Change in women's percentage preference for facial masculinity (+/- 1 SEM) in**  
518 **opposite-sex (experimental group N =18, control group N = 37) and same-sex (experimental**  
519 **group N = 16, control group N = 36) faces according to condition (experimental versus**  
520 **control).**

521

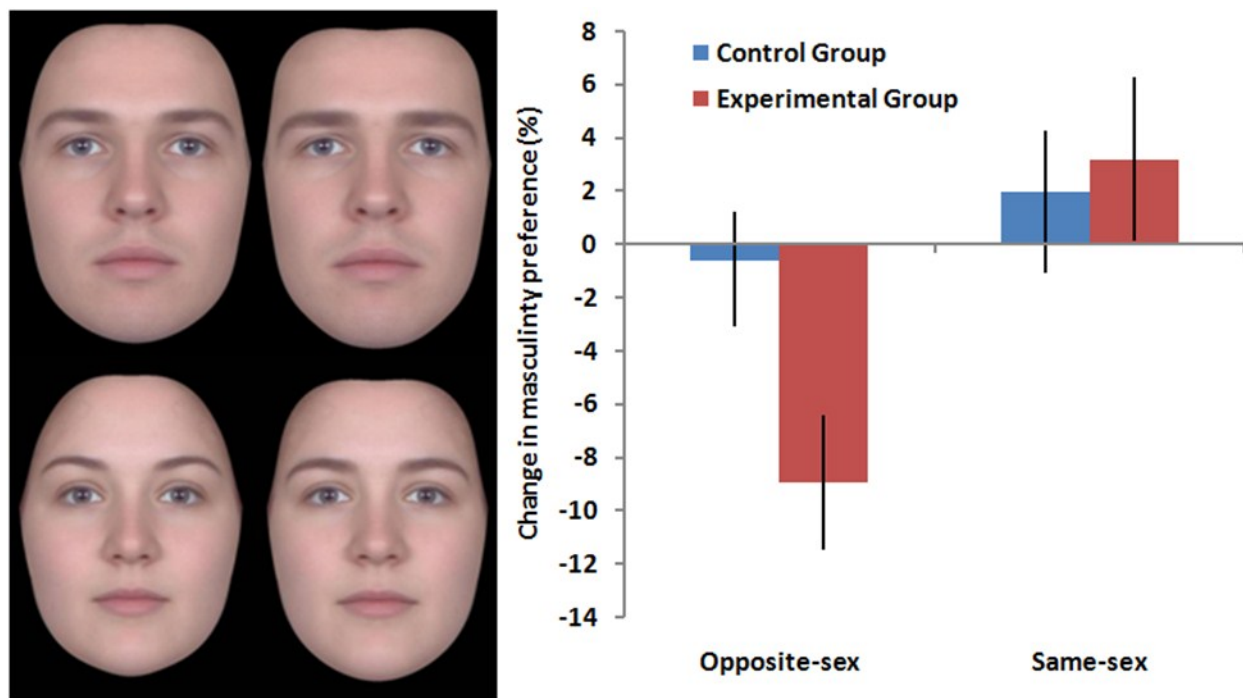
522 **Figure 2: Composite images of male partners according to pill use and results for Study 2.**  
523 **Left: Transformed faces based on pill use. Partner of pill user (+50% top left), partner of**  
524 **non-user (+50%, right). For illustration here, we extrapolated the differences: partner of**  
525 **pill user (+200% bottom left), partner of non-user (+200%, bottom right). Right: Top:**  
526 **Percent choice of non-users partner's face as more masculine (+/- 1 SEM) for original**  
527 **(rater N = 30) and transformed rater (N = 80) faces in Study 2. Bottom: Z-score measured**  
528 **masculinity for the partners (N = 85 in each group) of pill users and non-users (+/- 1 SEM).**

529

530 **Figure 3: Sexual dimorphism was calculated by measuring distance between facial features**  
531 **and calculating three ratios: Cheekbone Prominence (D3/D6), Jaw Height/Lower Face**  
532 **Height (D9/D8), and Face Width/Lower Face Height (D3/D8). Where two features were**  
533 **available for a height distance measure (e.g., D8 uses the average of both eye points), the**  
534 **average height was used. The numbers assigned are to keep features labelled consistently**  
535 **with previous studies (Penton-Voak et al., 2001; Little et al., 2008b).**

536

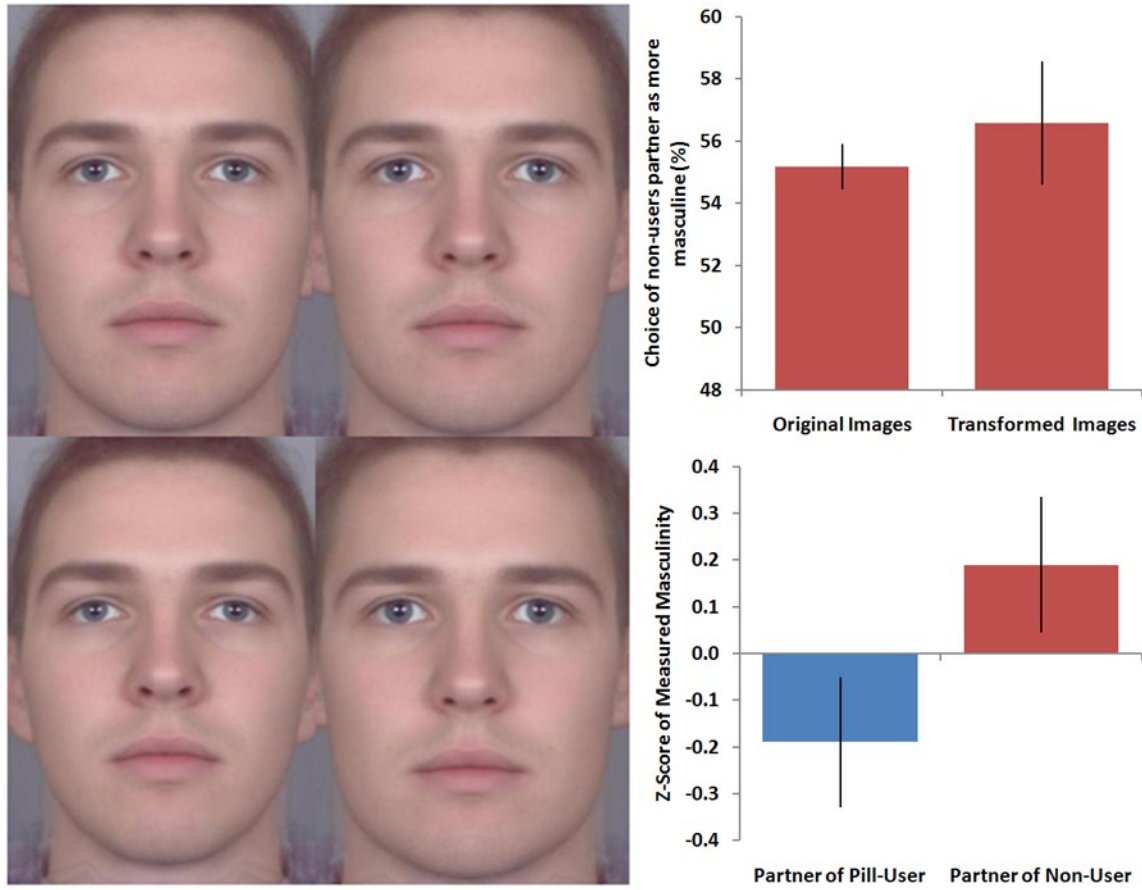
537 Figure 1.



538

539

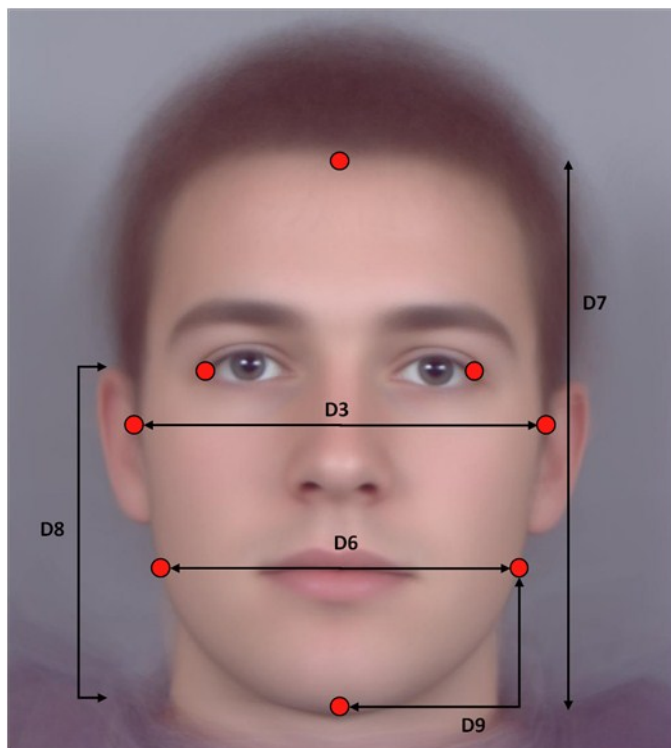
540 Figure 2.



541

542

543 Figure 3.



544

545

## 546 **Supplementary Material**

### 547 **Supplementary analysis for Study 1:**

#### 548 **Baseline preferences for masculinity**

549 One-sample t-tests against chance (0% masculinity preference) revealed that, in the first test  
550 session, women demonstrated a significant preference for male facial masculinity for short-term  
551 relationships ( $t_{54} = 3.43, p = .001, d = 0.933$ ) and significant preferences for femininity in female  
552 faces ( $t_{52} = 10.77, p < .001, d = 2.99$ ). In the first test session, women judging male faces for  
553 long-term relationships expressed no significant masculinity preference ( $t_{54} = 1.33, p = .189, d =$   
554  $0.362$ ). A paired sample t-test revealed a non-significant difference between long- and short-term  
555 male facial masculinity preferences ( $t_{54} = 1.65, p = .104, d = 0.449$ ). Women preferred more  
556 masculine faces for short-term than long-term relationship judgments and this difference would  
557 approach significance in a 1-tailed test (one-tailed  $p = .052$ ). Independent samples t-tests  
558 revealed no significant differences in masculinity preferences at the first test session for short-  
559 term ( $t_{53} = 0.29, p = .777, d = 0.080$ ), long-term ( $t_{53} = 0.03, p = .975, d = 0.008$ ), or same-sex ( $t_{51}$   
560  $= 0.96, p = .340, d = 0.269$ ) judgments.

561

#### 562 **Controlling for participant age**

563 Participants were older in the experimental condition than in the control condition, although this  
564 was on the border of significance using an independent samples t-test ( $t_{53} = 2.00, p = .051, d =$   
565  $0.549$ ). In order to rule out the possibility that age was confounding the effects of pill use on  
566 preferences, we reran both of the relevant ANOVAs with age as a covariate. Controlling for age  
567 did not change the pattern of results. Additionally, age was not significantly correlated with

568 either change in average preference for masculinity in opposite-sex ( $r = -.055, p = .692$ ) or same-  
569 sex faces ( $r = -.146, p = .303$ ).

570

### 571 **Preference change using mean scores separately for Session 1 and Session 2**

572 We present an analysis using difference scores between Session 1 and Session 2 in the main  
573 article text. Here we present an alternative analysis using the mean rating scores separately from  
574 Session 1 and Session 2.

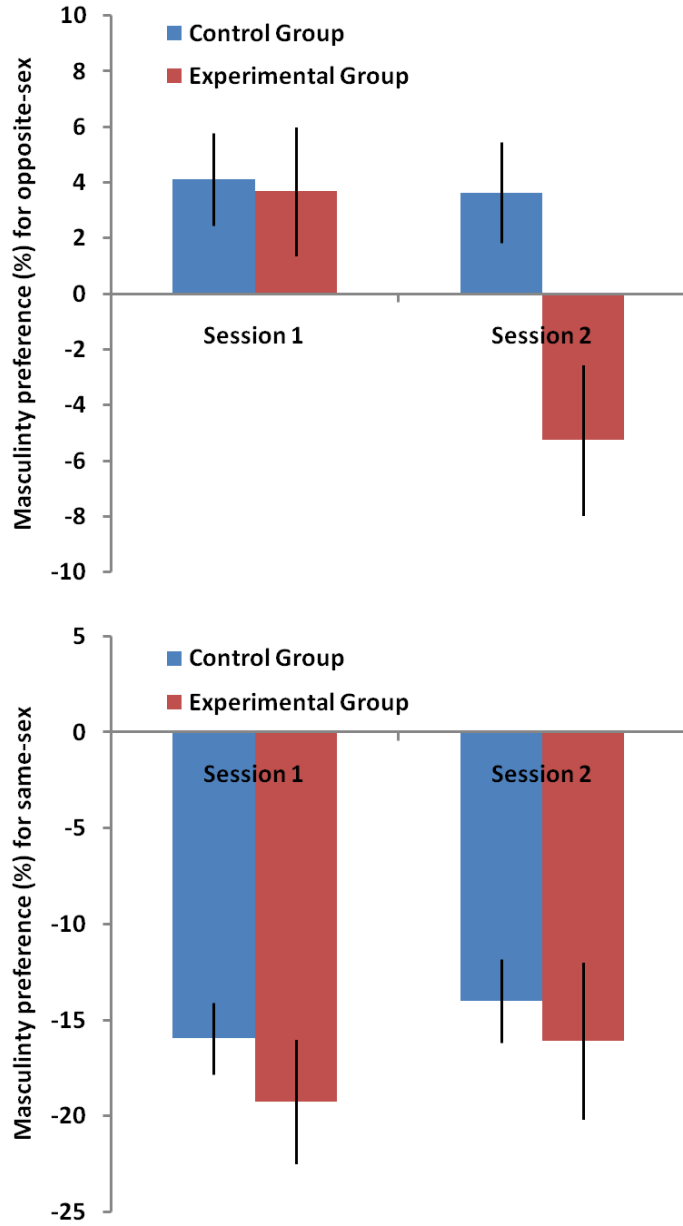
575 To address changes in preferences for men's faces, a mixed-model ANOVA was carried  
576 out with preference for masculinity as the dependent variable, *session* (Session 1/Session 2) and  
577 *term* (short-term/long-term) as within-participant factors and *condition* (experimental/control) as  
578 a between-participant factor. This analysis revealed a significant interaction between *session* and  
579 *condition* ( $F_{1,53} = 7.05, p = .010, \eta_p^2 = .117$ ). There was also a significant main effect of *session*  
580 ( $F_{1,53} = 8.79, p = .005, \eta_p^2 = .142$ ) and a close to significant main effect of *condition* ( $F_{1,53} = 3.28,$   
581  $p = .142, \eta_p^2 = .058$ ), although both were qualified by the above interaction. No other effects or  
582 interactions were significant (all  $F_{1,53} < 2.66$ , all  $p > .109$ , all  $\eta_p^2 < .048$ ). Mean preferences can  
583 be seen in Figure S1. Splitting by condition, follow-up paired sample t-tests confirmed that  
584 preferences for masculinity were significantly lower in Session 2 than Session 1 for those in the  
585 experimental group (short-term,  $t_{17} = 2.91, p = .010, d = 1.411$ , long-term,  $t_{17} = 2.45, p = .025, d$   
586  $= 1.188$ ) but not those in the control group (short-term,  $t_{36} = 1.28, p = .209, d = 0.427$ , long-term,  
587  $t_{36} = 0.71, p = .481, d = 0.237$ ).

588 For women's faces, a mixed-model ANOVA was carried out with preference for  
589 masculinity as the dependent variable, *session* (Session 1/Session 2) as a within-participant  
590 factor and *condition* (experimental/control) as a between-participant factor. This analysis

591 revealed no significant interaction between *session* and *condition* ( $F_{1,50} = 0.09, p = .761, \eta_p^2 =$   
592  $.002$ ). There was no significant main effect of *session* ( $F_{1,50} = 1.64, p = .206, \eta_p^2 = .032$ ) and no  
593 significant main effect of *condition* ( $F_{1,50} = 0.66, p = .421, \eta_p^2 = .013$ ). Mean preferences can be  
594 seen in Figure S1. Splitting by condition, follow-up paired sample t-tests confirmed that  
595 preferences for masculinity were not significantly different in Session 2 than Session 1 for those  
596 in the experimental group ( $t_{15} = 1.05, p = .309, d = 0.542$ ) or those in the control group ( $t_{35} =$   
597  $0.85, p = .403, d = 0.287$ ).

598

600 **Figure S1: Women’s percentage preference for facial masculinity for Session 1 and Session**  
601 **2 (+/- 1 SEM) in opposite-sex (top, experimental group N = 18, control group N = 37) and**  
602 **same-sex (bottom, experimental group N = 16, control group N = 36) faces according to**  
603 **condition (experimental versus control).**





605

606 **Supplementary analysis for Study 2:**

607 **Influence of couple age**

608 In order to address if couple age was related to the relationship between pill use and partner  
609 choice in the matched faces of Study 2 we used two scores: the mean choice of non-pill using  
610 women's male partners as more masculine and the difference in measured masculinity between  
611 the partners of pill users and non-users- at the time of relationship formation (calculated as non-  
612 users partner minus pill users partner so that positive scores indicate that that the partners of non-  
613 users were more masculine). These scores represented an effect of pill use on masculine partner  
614 choice, with higher scores indicating greater effects of the pill on the selection of masculine  
615 partners.

616 We correlated the two measures, the perceptual score and metric score, with male age.  
617 For the perceptual measure, this revealed a non-significant relationship between age and the  
618 relationship between pill use and partner choice ( $r = -.078, p = .476$ ). For the metric score, this  
619 revealed a close to significant relationship between age and the relationship between pill use and  
620 partner choice ( $r = .191, p = .080$ ). The latter effect is suggestive that the effect of pill use on  
621 partner choice may be most apparent in older couples, although the fact that it is not significant  
622 and the absence of this effect (which even suggests the opposite direction of relationship) for the  
623 perceptual measures means it should be treated with caution.

624