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Women's preferences for masculinity in male faces are highest during reproductive age range and lower around puberty and post-menopause

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Summary Masculinity in male faces is thought to be a sign of mate quality and is associated with measures of long-term health. Previous studies have demonstrated that women's masculinity preferences change across the menstrual cycle with women preferring more masculine men during phases of the menstrual cycle where fertility is highest (i.e. the late follicular phase). Given the hormonal correlates of such preferences and that these hormones change across the life span, we tested for differences in female masculinity preferences at different ages. We compared the masculinity preferences of peri-pubescent girls and young adult women (Study 1), circummenopausal women reporting to either be pre- or post-menopause (Study 2), and a large sample of women across a wide range of ages (Study 3). In all three studies, preferences for masculinity in male faces were highest in women who were at a reproductively active age. Preferences for masculinity were lower when females were peri-pubescent, post-menopausal, or at ages corresponding to these groups. These data support the notion that masculinity in male faces is an important trait for reproductively relevant mate choice decisions. These data also highlight a shift in female visual preferences for men that is associated with important stages of the lifespan. Visual preferences appear to track important hormonal changes associated with age; as women pass puberty their preferences shift towards facial traits associated with mate quality and as women undergo menopause their preferences for such facial traits decrease. Overall, these

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results demonstrate the important role of reproductive status and support the notion that preferences for male faces are tied to reproductively relevant hormones.

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1. Preferences for masculinity in male faces are highest during reproductive age range in women

Masculine facial characteristics in men are positively associated with measures of long-term health (Rhodes et al., 2003; Thornhill and Gangestad, 2006), but are also associated with an increased interest in pursuing short-term relationships (Rhodes et al., 2005; Boothroyd et al., 2008). This means masculinity in male faces is associated with a trade-off between health and investment and one aspect of this trade-off means benefits of mating with masculine- or feminine-faced men will change according to women's fertility (see Gangestad and Thornhill, 2008; Jones et al., 2008 for recent reviews).

Many studies have demonstrated that women's preferences for male traits change across the menstrual cycle. For example, studies have reported increased preferences for facial masculinity (Frost, 1994; Penton-Voak et al., 1999; Penton-Voak and Perrett, 2000; Johnston et al., 2001; Jones et al., 2005; Little et al., 2008), vocal masculinity (Puts, 2005; Feinberg et al., 2006), video clips of dominant behaviour (Gangestad et al., 2004), taller men (Pawłowski and Jasienska, 2005) and masculine body shapes (Little et al., 2007) during the late follicular menstrual cycle phase when women are most fertile. Moreover, these changes in preferences for masculine men are potentially adaptive as they may function to increase offspring health by promoting mating with masculine men around ovulation (Penton-Voak et al., 1999; Penton-Voak and Perrett, 2000; Johnston et al., 2001; Jones et al., 2005; Little et al., 2008).

Preferences for masculinity in faces are also affected by other factors relating to potentially adaptive strategic mate choices. For example, because an increased preference for potential good-gene health benefits to offspring over signs of parental investment would be expected in extra-pair copulations when a woman has already acquired a long-term partner, women's partnership status should affect their face preferences. Indeed, Little et al. (2002) have shown that women who have partners prefer masculine male faces more than those without a partner. In a similar manner, women also report having stronger preferences for masculine-faced men when judging for short-term relationships than when judging for long-term relationships (Little et al., 2002) and women who report more interest in short-term mating also prefer more masculine faces (Waynforth et al., 2005; Smith et al., 2009).

The strategic preferences and cyclic shifts evident in women's preferences for masculinity in male faces are evident in adult women who were generally selected for having natural cycles (i.e. not pregnant or using hormonal contraceptives). Since cyclic shifts and strategic preferences for masculine men do not appear to occur in women who do not have natural menstrual cycles (Penton-Voak et al., 1999; Little et al., 2002), women who are pre-pubescent and post-menopausal are also typically excluded from studies

of masculinity preferences. There are good reasons, however, to predict that women's preferences for facial masculinity may change during the transitions between different phases of a woman's reproductive lifespan. Because women are not able to reproduce either pre-puberty or post-menopause, we might see a shift away from mating psychology at these times. Similarly, attention to cues important in choosing partners that may benefit offspring via genetic inheritance may be diminished relative to women within their reproductive years (Hawkes et al., 1998; Vukovic et al., 2009). Both puberty and menopause are associated with shifts in hormonal profile in women and it is these hormones that may help determine preferences for traits such as masculinity in men.

The transition through puberty represents the move from a juvenile to an adult state and involves significant changes in behaviour as well as hormonal profile (such as gonadotropins and sex steroids). Puberty is known to affect many types of psychological processes (Buchanan et al., 1992), although broad similarities between judgments of facial attractiveness by children and by adults are generally found (Cross and Cross, 1971; Cavior and Lombardi, 1973; Dion, 1973; for review see Langlois et al., 2000). Indeed, even infants appear to prefer looking at faces that adults deem as attractive compared to those deemed unattractive (Langlois et al., 1991; Slater et al., 1998) although certain face traits preferred by adults, such as symmetry and averageness, do not appear to be preferred by infants (Rhodes et al., 2002).

As social interaction is relevant across the entire lifetime it might be expected that individuals attend to attractiveness broadly in choosing social partners. Studies demonstrating agreement between children and adults have generally not focussed on specific traits that may be more relevant for mate choice—traits that are more likely to show differences pre- and post-puberty. Several studies have demonstrated interesting differences in ratings that might reflect pubertal development. For example, young children do not show preferences for the waist-to-hip ratio that is found most attractive by adults, but teenagers do (Connolly et al., 2004). Another study has shown that while children's judgments are in agreement with adults' judgments in their perceptions of facial attractiveness there is less agreement about vocal attractiveness (Saxton et al., 2006). Also in the vocal domain, older girls have been found to select lower-pitched boys' voices as more attractive than younger girls do and this appears related to pubertal development (Saxton et al., 2009). Most closely related to the current studies, Saxton et al. (2009) have also demonstrated that pubertal development is related to preferences for several important face traits. They found that in a cross-sectional sample of children aged 11–15, while both the younger and older groups of children preferred more average, symmetric and feminine faces, older children were significantly more likely than younger children to select the average, symmetric and, when judged by girls but not boys, feminine male faces as more attractive (Saxton et al., 2009).

Another point in women's lives where face preferences may change is during menopause. Again, as in puberty, changes in hormonal profile that occur at menopause influence many aspects of behaviour. Menopause in humans has been held up as an evolutionary puzzle but many modern theories suggest that the end of one's own reproduction can be adaptive if it provides post-reproductive grandmothers who enhance their inclusive fitness by helping to care and provide for their daughters' children (Hawkes et al., 1998; Shanley et al., 2007). Indeed, having maternal grandmothers improves the nutritional status and enhances the survival chances of children in rural Gambia (Sear et al., 2000). After menopause, we might then expect that women's psychological mechanisms would no longer be geared towards mating themselves and instead would be geared towards promoting investment in family and cooperation in their community (e.g., Hawkes et al., 1998). Related to the current study, one study has investigated circum-menopausal women's preferences for masculinity and femininity in the faces of young adult men and women. It was found that post-menopausal women demonstrated stronger preferences for femininity in other women's faces than pre-menopausal women did (Vukovic et al., 2009). While no significant difference between pre- and post-menopausal women was seen for judgments of men's faces, the data were in the predicted direction; pre-menopausal women reported marginally higher preferences for masculinity than post-menopausal women did. The authors suggest that dislike of feminine (i.e. attractive) same-sex competitors may decrease as fertility decreases in line with the idea that post-menopausal women are no longer as concerned by attractive potential mating rivals as are women within their reproductive range (Vukovic et al., 2009). Similar effects are seen across the cycle where more fertile women also demonstrate a decrease in preferences for femininity in female faces (Jones et al., 2005; Welling et al., 2007).

Given that masculinity preferences are expected to be positively related to measures of reproductive interest, as they are in terms of cyclic shifts, the current study examined preferences for sexual dimorphism in face shape, comparing peri-pubescent girls, post-menopausal women, and women within their reproductive age range. We predicted that masculinity preferences would be higher in women within their reproductive age range when the potential benefits associated with becoming pregnant by masculine-faced men could be realised than in women who were either peri-pubescent or post-menopausal. All studies were conducted in line with the Declaration of Helsinki and the British Psychological Association's ethical guidelines.

2. Study 1

In Study 1 we compared peri-pubescent girls with post-pubescent women and predicted that because peri-pubescent girls are not reproductively active they would have weaker preferences for male facial masculinity than post-pubescent women.

2.1. Participants

92 female children (aged either 11 or 12) and 99 female adults (aged between 19 and 28, mean = 20.9, SD = 2.7) took

part in the study. Children were recruited at a series of open days held at the University of Liverpool. The girls in the sample were aged either 11 or 12; prior research has placed the average age of menarche at 12 years 11 months with a small standard deviation (Whincup et al., 2001). Thus, the majority of the girls in our study were likely to be peri-pubescent. Adults were recruited during lectures given at the University of Liverpool. Adults were selected if they reported themselves as heterosexual.

2.2. Consent

Parental consent was given for the children to attend the open day and take part in related events under accompanying adult supervision. The nominated supervisors administered the test and explained participation was voluntary. For the adult group, participants were given the form in a lecture and told that by filling in the form and submitting it to the experimenter they were consenting to take part in the study.

2.3. Stimuli

To measure preferences for sexually dimorphic features we used a pair of composite male face images. The pair comprised one masculinised and one feminised version of the same face (see Fig. 1). Original images were photographs of 50 young adult Caucasian men and 50 young adult Caucasian women taken under standard lighting conditions and with a neutral expression. The composite image was made by creating an average image made up of five randomly assigned individual facial photographs (this technique has been used to create composite images in previous studies, see e.g., Benson and Perrett, 1993; Tiddeman et al., 2001; Little and Hancock, 2002). Faces were transformed on a sexual dimorphism dimension using the linear difference between a composite of all 50 young adult males and a composite of all 50 young adult females (following the technique reported in Perrett et al., 1998). Transforms represented $\pm 50\%$ of the shape difference between these two composites (100% would represent the complete transform and so starting from a female face +100% towards male would make the face into a perceptually male shape). This meant that the face was transformed along the sexual dimorphism shape axis, either increasing masculinity or increasing femininity, and that the faces retained their identity and perceived sex (the faces remained male in appearance). All composite images were made perfectly symmetric prior to transform so that transforms did not manipulate symmetry.

2.4. Procedure

Groups of participants were given a sheet of printed paper with a pair of faces (1 pair of male images, one masculine and one feminine). Under each face in the pair were check boxes. The sheet also contained check boxes for sex to record that all participants were female (boy/male, girl/female) and a box to write in age for the adults' test. For the adults, this was handed out at the beginning of a lecture and the experimenter explained the procedure. For the children, as they were attending lectures also in small groups (approximately 20 per group) and in the care of supervising adults (3–5), the



Figure 1 Feminised (left) and masculinised (right) male faces used in Study 1. Similarly transformed faces were used in Studies 2 and 3.

adults had the brief procedure explained to them and it was the supervising adults who then administered the test to the children they were supervising. Participants were asked to tick whether they were a female/girl or male/boy and then tick which face they preferred. On each sheet were written instructions: "Tick which face of each pair you prefer". Faces were presented counterbalanced by side (i.e. half of the sheets had the masculine face on the right and half had the masculine face on left).

2.5. Results

As only one pair of faces was used, the data were categorical in nature. In terms of masculinity preferences, female adults chose the masculine male face 58% (58/99) of the time, while female children chose the masculine male face 42% (39/92) of the time. A Pearson Chi-square test revealed the proportions for adults and children were significantly different (Chi-square = 5.00, DF = 1, $p = 0.025$), with female adults preferring the masculine male face more often than female children did. Separate chi-square tests revealed non-significant differences from chance (50%) for adults (Chi-square = 2.92, DF = 1, $p = 0.088$) and children (Chi-square = 2.13, DF = 1, $p = 0.144$) although we note that the pattern of results suggests that neither group chose randomly.

3. Study 2

Study 1 compared peri-pubescent girls with post-pubescent women and found that the post-pubescent women had stronger preferences for male facial masculinity than the younger group. In Study 2 we examined an older sample of women who were either pre-menopause or post-menopause. We predicted that, as women are no longer reproductively active after menopause, preferences for masculinity would be lower in the post-menopausal women.

3.1. Participants

163 female adults (aged between 45 and 60, mean = 20.9, SD = 2.7) took part in the study. Women were selected for being older than 44 and younger than 61 years of age and reporting that they were heterosexual and not currently

pregnant. Participants were recruited for the study online via a research-based website (www.alittlelab.com) and the study was conducted online. Participants formed two groups, those who reported that their menstrual cycles had stopped ($N = 100$, mean age = 52.4, SD = 3.8) and those who reported that they still experienced regular menstrual cycles ($N = 63$, mean age = 47.9, SD = 2.5). Nine participants reported using some form of hormonal contraception but their exclusion did not alter the results below.

3.2. Consent

Participants were given a description of the study prior to filling in the questionnaire and instructed that by continuing to the next page they were consenting to take part in the study and that they were free to drop out at any point.

3.3. Stimuli

Stimuli were 10 pairs of masculinised and feminised male faces made in the same way as in Study 1. Here 10 different composite images were used as base faces for transformation to make 10 pairs of images.

3.4. Procedure

Participants were administered a short questionnaire assessing age, sex, sexual orientation, hormonal contraception use, and cycle status ("Have you stopped cycling due to menopause?"), followed by the face tests. The 10 pairs of masculine and feminine faces were shown with both order and side of presentation randomised. Participants were asked to choose the face from the pair that they found most attractive. Clicking a button moved participants on to the next face trial.

3.5. Results

The percentage of masculine faces chosen out of the 10 pairs was calculated for each participant.

One sample t -tests against chance (50%) revealed significant preferences for masculine faces for both pre- ($t_{62} = 6.41$, $p < .001$) and post-menopausal ($t_{99} = 3.93$, $p < .001$) women. An independent samples t -test revealed

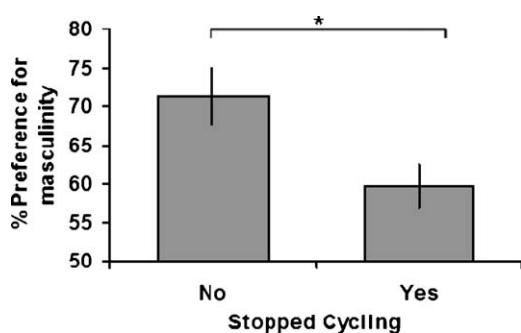


Figure 2 % preference for masculinity (± 1 SE of mean) for women reporting their cycle had stopped or reporting that they were still cycling (means corrected for age of participant) in Study 2. $*p < .05$.

that pre-menopausal women had stronger preferences for masculinity than post-menopausal women ($t_{161} = 2.48$, $p = .014$).

Using an independent samples t -test, the two groups were found to be significantly different in age (see participants section for mean ages, $t_{161} = 8.51$, $p < .001$). Pre-menopausal women ($M = 47.9$) were younger than post-menopausal women ($M = 52.4$). To examine the effect of menopause on preference independently of age, a univariate ANCOVA was carried out with masculinity preference as the dependent variable, pre-/post-menopause as a between-participant factor, and age as a covariate. This revealed a significant effect of menopause status ($F_{1,160} = 5.49$, $p = .020$, $\eta_p^2 = .644$) and no significant effect of age ($F_{1,160} = 0.27$, $p = .266$, $\eta_p^2 = .081$). Mean scores corrected for age can be seen in Fig. 2.

4. Study 3

Studies 1 and 2 measured facial masculinity preferences and compared peri-pubescent with post-pubescent females and pre-menopausal with post-menopausal women. Across both studies we found that females who were below or above reproductive age had relatively lower preferences for male facial masculinity than those women who were currently at an age where they could reproduce. In Study 3 we examined preferences for male facial masculinity in a large cross-section of females spanning from pre-puberty to post-menopause to explore how preferences change across a wider range of ages.

4.1. Participants

A total of 8635 women (after selection criteria were applied, see below) took part in Study 3. Participants were recruited from the BBC science and nature website (<http://www.bbc.co.uk/sn>) and the study was conducted online. Participants were broken down into five age blocks of 10-year lengths spanning from less than 15 to greater than 46. The blocks were age 11–14: $N = 469$, mean = 13.5, $SD = 0.7$; 15–25: $N = 4207$, mean = 19.0, $SD = 3.1$; 26–35: $N = 2256$, mean = 30.2, $SD = 2.9$; 36–45: $N = 1255$, mean = 40.0, $SD = 2.8$; 46+: $N = 448$, mean = 49.6, $SD = 3.7$. Of these, 6485 (~75%) women reported being resident in the UK. Participants were selected for reporting being over 10 years old, heterosexual, and not using hormonal contraception.

4.2. Consent

Consent was addressed in the same manner as in Study 2.

4.3. Stimuli

Stimuli were three pairs of masculinised and feminised male faces made in the same way as in Studies 1 and 2. Different composite base faces were used here.

4.4. Procedure

Participants were administered a short questionnaire assessing age, sex, sexual orientation, and oral contraceptive use followed by the face tests. The three pairs of masculine and feminine faces were shown in the same order and side of presentation was not randomised here (masculine was on the right in 1 case, feminine on the right in 2 cases). Participants were asked to choose the face from the pair that they found most attractive. Four options were given under each face to assess relative preferences (guess, slightly more, more, strongly more), giving a score from 1 to 8 (1 = strongly prefer feminine, 8 = strongly prefer masculine). Clicking on one of these eight buttons moved participants on to the next face trial.

5. Results

The average score for the faces chosen out of the three pairs was calculated for each participant. Low scores indicate preferences for femininity and high scores indicate preferences for masculinity.

One sample t -tests against chance (4.5) revealed significant preferences for masculine faces in all age groups (all $t > 3.70$, all $p < .001$).

A univariate analysis of variance with masculinity preference as the dependent factor and age block as a between-participant factor revealed a significant effect of age block on masculinity preference ($F_{4,8630} = 8.45$, $p < .001$, $\eta_p^2 = .004$). Pairwise comparisons revealed the 11–14 group to have significantly lower preferences for masculinity than the 15–25 ($p < .001$), 26–35 ($p < .001$), and 36–45 ($p < .001$) groups but not the 46+ group ($p = .181$). The 46+ group also had significantly lower preferences for masculinity than the 15–25 ($p = .038$), 25–35 ($p < .001$), and 35–45 ($p = .004$) groups. The 15–25 group had lower preferences for masculinity than the 25–35 ($p = .017$) and 35–45 ($p = .091$) groups, though the latter was not significant. The 25–35 and 36–45 groups did not significantly differ in preference ($p = .823$). Mean scores can be seen in Fig. 3.

Coding age block from 1 to 5 in order and running regression with age block against mean masculinity preference score for each age block revealed a strong quadratic relationship between chronological age and mean preference ($F_{2,2} = 144.7$, $p = .007$, adjusted $r^2 = .986$).

Finally, examining actual age, rather than splitting into age block, a regression analysis also revealed the quadratic relationship between age and masculinity preference seen in the above analyses ($F_{2,8632} = 12.63$, $p < .001$, adjusted $r^2 = .003$).

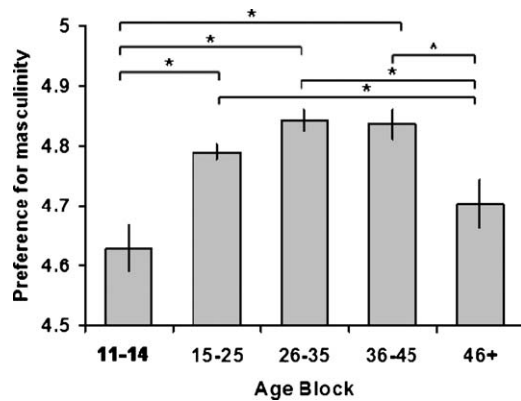


Figure 3 Preference for masculinity (4.5 = chance, ± 1 SE of mean) for women of different ages for Study 3. * $p < .05$ (for clarity, only differences between the youngest and oldest groups versus the reproductive age range samples are noted).

6. Discussion

Across three different studies we have demonstrated a role of female reproductive status, related to maturity, on preferences for masculinity in male faces. In Study 1 we examined preferences for male facial masculinity in a group of children aged 11 and 12 and compared their scores to the preferences of young adult women. This study revealed a significant difference in preferences for masculinity in the two age groups with the women preferring masculinity more than the young girls. While age was the main difference between the groups, the groups also differed in that the younger group was peri-pubescent and the older group was post-pubescent. In Study 2 we focused on an older cohort to examine preferences for masculinity in pre- and post-menopausal women. We found that women who were still normally cycling had stronger preferences for male facial masculinity than those who had stopped cycling due to menopause. Importantly, this effect of circum-menopausal status remained significant when controlling for possible effects of women's chronological age. In Study 3 we examined facial masculinity preferences in a large sample with a wide range of ages. Supporting the findings of Studies 1 and 2, we found that masculinity preferences were highest in women most likely to be normally cycling and lower in females who were more likely to be peri-pubescent or post-menopausal. Together, all three studies support the idea that preferences for masculinity are highest among women at ages when they are reproductively active.

Our findings are consistent with studies demonstrating that women's preferences for masculine male face traits change across the menstrual cycle (Frost, 1994; Penton-Voak et al., 1999; Penton-Voak and Perrett, 2000; Johnston et al., 2001; Jones et al., 2005; Little et al., 2008). Masculine-faced men are healthier than their feminine-faced counterparts (Rhodes et al., 2003; Thornhill and Gangestad, 2006) and so attraction to masculinity when women are able to reproduce, post-puberty and pre-menopause, could potentially lead to genes for health-related factors being passed on to offspring. Because women are not able to reproduce either pre-puberty or post-menopause, it appears likely that advertisements of quality that are relevant for offspring will be of diminished

importance. Given both puberty and menopause are related to major shifts in hormonal profiles in women, these hormones seem a likely candidate for mediating preferences. Potentially, similarities in the hormonal profiles may help explain both cyclic shifts and changes in preferences across the lifespan, and this remains a fruitful area for future research.

While our data may appear to conflict with the broad similarities between judgments of facial attractiveness by children and by adults that are generally found (Cross and Cross, 1971; Dion, 1973; Langlois et al., 2000), such studies are not focussed on specific traits that may be more relevant for mate choice. We note, however, that some studies have found differences between children and adults when looking broadly at facial attractiveness (Cavior and Lombardi, 1973; Kissler and Bauml, 2000). As social interaction is relevant across the entire lifetime, it might be expected that individuals attend to attractiveness broadly in choosing social partners, which may explain the mixed results on age-related differences. Studies that have looked at more mate-choice relevant traits have shown differences between adults and children that are consistent with findings presented here such as in judgments of waist-to-hip ratio (Connolly et al., 2004) and vocal attractiveness (Saxton et al., 2006). We note that our young samples were generally not exclusively pre-pubertal and that some authors have suggested sexual desire occurs after adrenal puberty from around the age of 10 (McClintock and Herdt, 1996). A stronger test would then examine preferences prior to age 10 and a more marked difference in preferences might be observed. Significant differences in both Studies 1 and 3 suggest that during the peri-puberty period preferences for masculinity are lower than in adulthood.

For the older women, around menopause, our data are consistent with theories suggesting that after menopause women shift away from mating psychology (e.g., Hawkes et al., 1998). Potentially, as suggested by others, post-menopausal women may instead focus on investment in family, perhaps particularly grandchildren, and cooperation in their community (Hawkes et al., 1998; Shanley et al., 2007). Our data also complement recent work demonstrating that post-menopausal women demonstrated stronger preferences for femininity in other women's faces than pre-menopausal women did (Vukovic et al., 2009). While Vukovic et al. (2009) found no significant difference between pre- and post-menopausal women's judgments of men's faces the data were in the same direction as seen in the studies reported here. Aging has other social consequences potentially related to preference, such as a decrease in the availability of partners. In Study 2 there was a significant but overall small age difference (4.3 years) between groups which suggests that age related variables are unlikely to be the main cause of difference given that two groups were likely to have similar social experiences based on their age (for example, have similar experiences of partnered and unpartnered males).

Our findings do conflict somewhat with a recent study that has shown that increased age is associated with an increased preference for feminised male faces in a sample of girls aged 11–15 (Saxton et al., 2009). One potential resolution is simply that we compared adult preference to child preferences rather than a more narrow age range among children.

Indeed, our children in Study 1 had slight preferences for femininity in a similar way to Saxton et al. while adults preferred masculinity. Alternatively, cohort effects, or differences in the stimuli used for the older compared with the younger raters in the earlier study, could have led to these differences. Stimuli were different and also constructed differently in that here we use adult faces and transformed sexual dimorphism in adult face shape as opposed to using age specific faces with transformed sexual dimorphism based on adolescent's face shape which may also in some part account for the discrepancy. Another study has demonstrated among young adults that those reporting reaching puberty sooner than their peers report stronger preferences for sexual dimorphism again suggesting a link between puberty and preferences (Cornwell et al., 2006).

There are alternative accounts for differences in masculinity preferences seen here that are not dependent on reproductive status. The first important issue is that of the age of the faces. All faces shown were composite images of individuals aged 18–21 and so faces may not be seen as appropriate partners for those who are younger or older than this range of ages. This might then mean weaker preferences for masculinity in younger and older women is due to decreased relevance of the stimuli. Of course, for the young children, no age of face is appropriate in mate-choice terms and hence we asked about 'preference' and so comparing child and adult preferences seems appropriate no matter what the age of the stimuli. Likewise, for the older women, while the images may not make appropriate partners, there is no strong reason to believe that older individuals would always dismiss young people as possible partners. As speculation, it is also possible that preferences could reflect other types of social preference. In the younger and older groups this could mean less masculine men were preferred as potential friends or even, for the older groups, preferences for potential partners for their own children. Another factor suggesting effects are not entirely dependent on stimuli age concerns the preferences of the groups in Study 3 where women older than the age of the stimuli in the 26–35 and 36–45 groups had the strongest preferences for masculine faces. Stimuli age, while important to address in future work, then appears unlikely to explain all of the variation in the data. Related to the age of the stimuli, masculinity makes faces appear older (Perrett et al., 1998), which is also consistent with the fact that masculinity preferences increase with age but not consistent with the decrease in preference in post-reproductive women. Future research using a range of differently aged faces can usefully parse the impact of this variable.

Another issue, related to some of the above points, is whether our effects reflect reproductive status or age related changes. In Studies 1 and 3 we did not have an indication of pubertal status for the children. While in Study 1 we examined 11- and 12-year olds, in Study 3 we grouped children as 14 and under, and so not all individuals were likely to be pre-pubescent. We did this to increase sample size in the younger age group and, because the effect appears similar between Studies 1 and 2, potentially age and not puberty is the driving factor here. The same problem arises for the older sample in Study 3, as we did not ask participants specifically about menopause or menopausal status, and relied instead on reported age. The age cut-off, however, seems likely to mainly catch post-menopausal women and the

results are in line with Study 2, which demonstrated an effect of menopausal status controlling for chronological age. Overall then, the effects in children may represent puberty or age related changes while the effects in older women appear more likely to be tied to menopause. Future studies employing more exact measures of reproductive status can better establish a direct link between preference and pubertal or menopausal state. Hormone replacement therapy (HRT) may also have impacted on preferences in the post-menopausal groups. In our samples the presence of women using HRT could reduce the difference between our groups and this variable will also be interesting to address in future studies.

Another limitation here is that between-participant data are not ideal to study a within-participant effect. Comparison was always between-participant and ideally a longitudinal study would chart changes in preferences within-individuals across the lifespan. Between-participant data are also a noisy measure of preferences, given evidence for individual differences in preference (Little and Perrett, 2002; Feinberg, 2008; Roberts and Little, 2008). We note that variation between individuals or any errors in the allocation to group, such as inaccurate reporting of age from the participants, would be most likely to decrease the chance of finding a significant effect. Neither limitation would bias the results, adding only noise to the data and only reducing the chance of finding a significant effect of age.

In summary, the current studies suggest that age, and associated reproductive status, has an impact on face preferences, with women preferring more masculine faces within their reproductively active years. We suggest that ideas of evolved mechanisms promoting attention to biologically relevant traits at times when the benefits of reproduction with high quality men are relevant may provide a parsimonious explanation for the observed results. Hormonal changes associated with puberty and menopause are a likely mechanism for explaining differences in preferences across the lifespan.

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Conflict of interest

None.

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