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

Running head:

Hormones affect preference and choice

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Abstract

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

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

Introduction

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

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

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

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

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

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

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

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

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

Figure 1 about here

Methods

Participants

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

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

Stimuli

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

Procedure

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

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

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

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

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

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

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

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

Calculating preferences for masculine faces

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

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

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

Results

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

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

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

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

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

Figure 2 about here

Figure 3 about here

Methods

Participants

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

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

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

Photography

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

Stimuli for ratings

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

Procedure for ratings

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

Measurements

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

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

Results

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

Discussion

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

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

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

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

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

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

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

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

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

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

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Figure Legends

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

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

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

537 Figure 1.

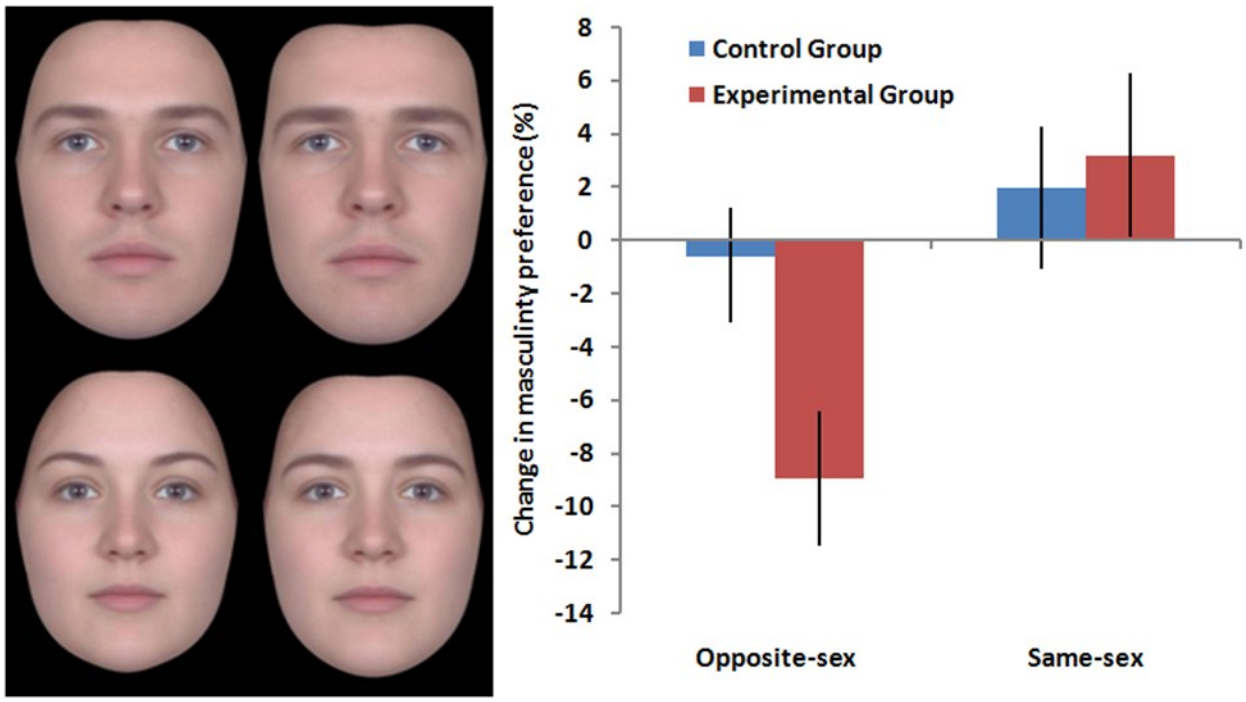

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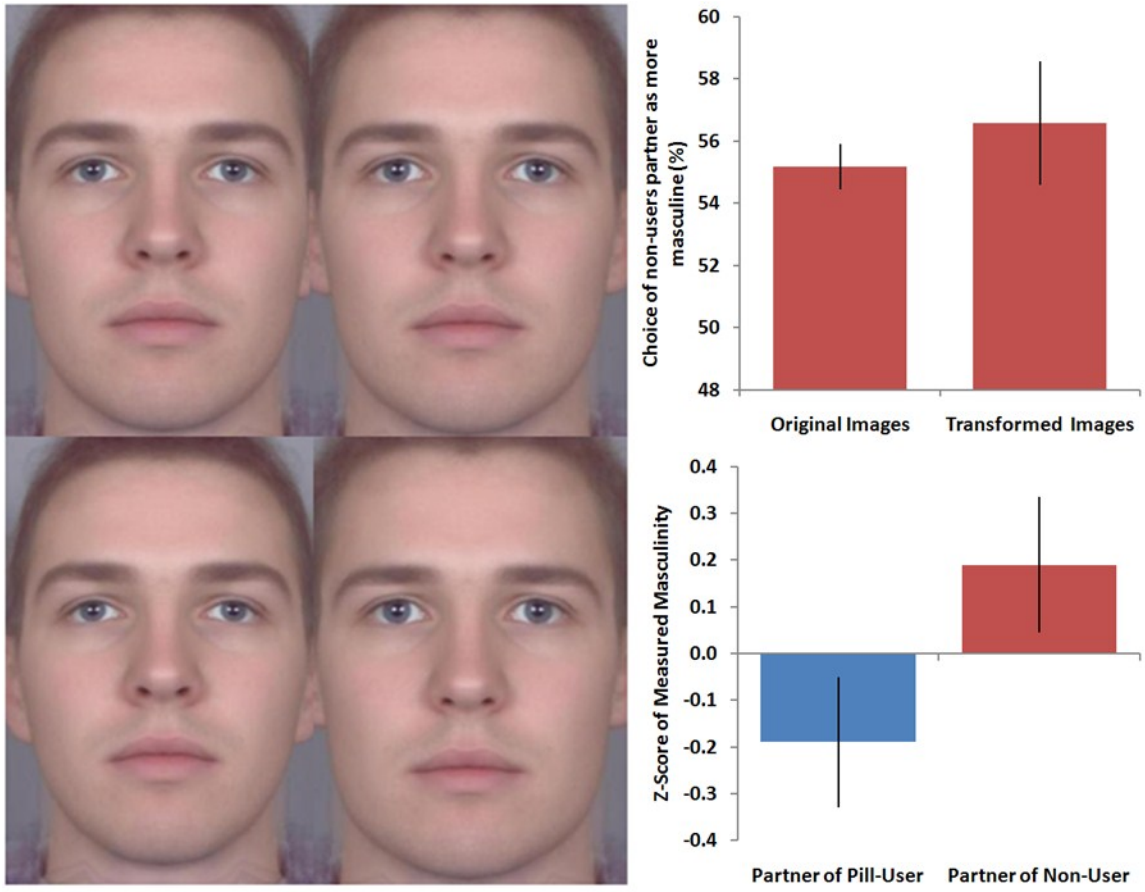
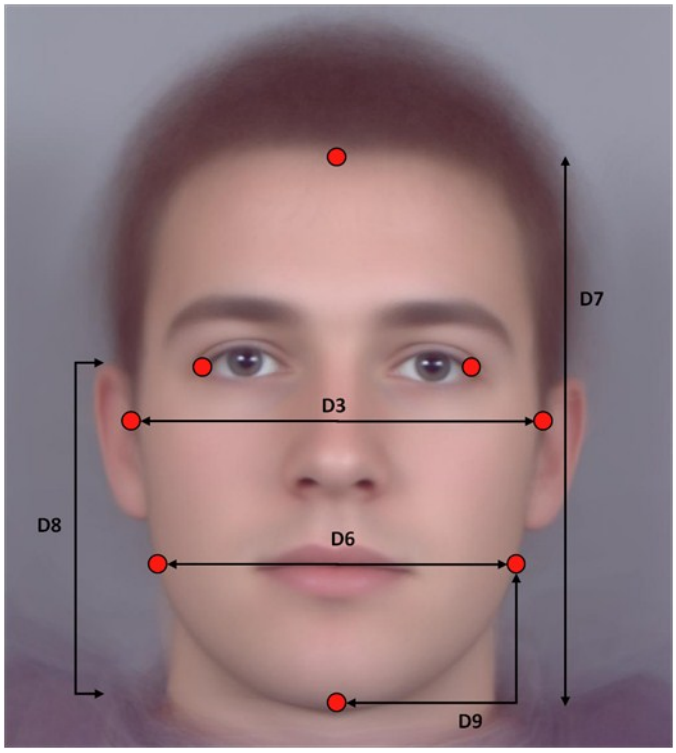
Figure 2.


Choice of non-users partner as more masculine (%)
60
58
56
54
52
50
48
Original Images
Transformed Images
Z-Score of Measured Masculinity
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
Partner of Pill-User
Partner of Non-User

543 Figure 3.



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Supplementary Material

Supplementary analysis for Study 1:

Baseline preferences for masculinity

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

Controlling for participant age

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

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

Preference change using mean scores separately for Session 1 and Session 2

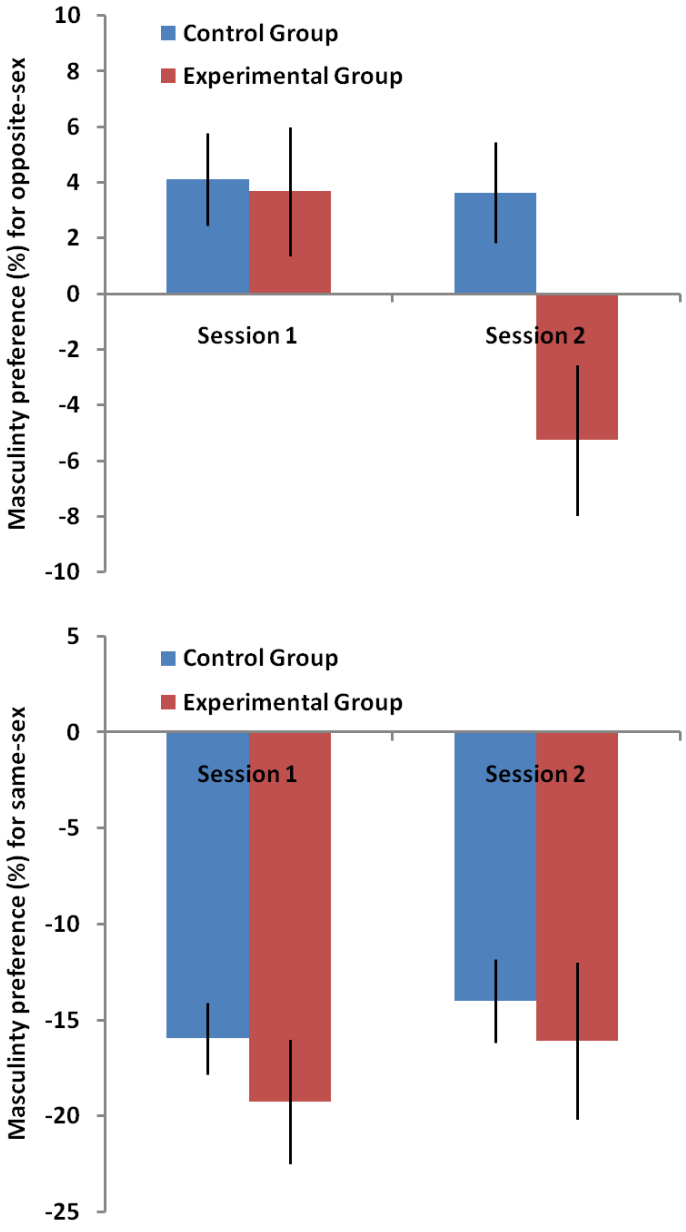
We present an analysis using difference scores between Session 1 and Session 2 in the main article text. Here we present an alternative analysis using the mean rating scores separately from Session 1 and Session 2.

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

For women's faces, a mixed-model ANOVA was carried out with preference for masculinity as the dependent variable, *session* (Session 1/Session 2) as a within-participant 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

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



Supplementary analysis for Study 2:

Influence of couple age

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

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