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Sex drive is positively associated with women's preferences for sexual dimorphism in men's and women's faces

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Abstract

Reported sex drive was recently found to be positively associated with heterosexual women's attraction to both men and women (Lippa, 2006). This finding was interpreted as evidence that sex drive is a generalized energizer of women's sexual behaviors and responses, rather than energizing behavior and responses towards potential mates only. Here we show that reported sex drive is positively associated with heterosexual women's preferences for sexual dimorphism in both men's and women's faces (Studies 1 and 2). These findings complement those reported by Lippa (2006), since our own studies and Lippa's show that sex drive is positively associated with heterosexual women's judgments of both men and women. Our findings for associations between reported sex drive and women's preferences for sexual dimorphism implicate sex drive as a possible source of individual differences in women's face preferences and present novel converging evidence that sex drive is a generalized energizer of women's sexual behaviors and responses.

Keywords: Attraction; Sex drive; Mate preferences; Sexual dimorphism

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1. Introduction

In men, masculine facial characteristics (e.g. pronounced brows and large jaws) are positively related to their circulating testosterone levels (Roney, Hanson, Durante, & Maestripieri, 2006) and may signal good medical health if only men with strong immune systems are able to withstand the immunosuppressive effects of high testosterone (Gangestad & Simpson, 2000). Consistent with this proposal, recent studies have confirmed that masculine facial characteristics are negatively associated with men's incidence of past health problems (Rhodes, Chan, Zebrowitz, & Simmons, 2003; Thornhill & Gangestad, 2006). Furthermore, studies of offspring viability in many non-human species have shown that male masculinity is positively associated with measures of offspring health (e.g. Byers & Waits, 2006; Petrie, 1994), suggesting that the good medical health associated with men's masculinity may be heritable.

While the findings described above present evidence that masculinity in men is associated with some characteristics that are desirable in a romantic partner (i.e. good medical health, increased offspring viability), masculine facial cues are also associated with anti-social behaviors in men that are not desirable in a romantic partner (Gangestad & Simpson, 2000). For example, masculine men are less willing to invest in their partners and offspring (Gangestad & Simpson, 2000) and are perceived as less likely to be good parents (Perrett et al., 1998) than relatively feminine men. Given the trade-off between the positive and negative traits that are signalled by men's masculinity (Gangestad & Simpson, 2000), it is perhaps unsurprising that the extent to which women are attracted to masculinity in men's faces varies greatly. For example, some studies have found that women generally prefer feminine male faces, while others have found that women generally prefer masculine male faces (see Rhodes, 2006). These differences among studies cannot be explained by differences in the computer graphic methods used to manipulate masculinity in images, but appear to reflect systematic variation in preferences for masculine men (DeBruine et al., 2006).

Many studies have investigated possible sources of systematic variation in women's preferences for masculinity in men's faces (for a review see DeBruine et al., 2006). For example, women's preferences for masculinity are stronger around ovulation than at other times during the menstrual cycle (e.g. Penton-Voak et al., 1999; Welling et al., 2007). Perceptions of own attractiveness also predict women's preferences for masculinity in men's faces, with particularly attractive women demonstrating particularly strong preferences for masculine men (Little, Burt, Penton-Voak, & Perrett, 2001; Little & Mannion, 2006). These findings have typically been interpreted as evidence that women's preferences for cues of men's long-term medical health are particularly pronounced around ovulation (Penton-Voak et al., 1999; Welling et al., 2007) and in attractive women (Little et al., 2001; Little & Mannion, 2006).

In addition to these sources of variation in women's preferences for masculine men, the extent to which women are attracted to masculinity in men's faces varies as a function of the temporal context of the relationship sought. Several studies (e.g. Little et al., 2001, Little, Jones, Penton-Voak, Burt, & Perrett, 2002) have found that women demonstrate stronger attraction to masculinity when judging men's attractiveness for short-term relationships (e.g. one-night stands) than when judging men's attractiveness for long-term relationships (e.g. marriage). This difference in women's preferences for masculine and feminine men for short- and long-term relationships is thought to occur because the costs of choosing a masculine partner for long-term relationships

are considerably more pronounced than for short-term relationships (Gangestad & Simpson, 2000).

Given that most studies of individual differences in women's preferences for masculine men have emphasized the importance of the possible indirect benefits of choosing a masculine partner (i.e. benefits that are inherited by offspring), it is perhaps surprising that there have been no studies of whether women's sex drive is associated with the extent to which they prefer masculine men. Lippa (2006) recently found that reported sex drive was positively associated with heterosexual women's attraction to both men and women. Lippa (2006) interpreted this finding as evidence that sex drive in heterosexual women is a generalized energizer of sexual behaviors, rather than energizing behaviors and responses towards potential mates only. That women demonstrate stronger preferences for masculinity in men's faces when judging their attractiveness for short-term relationships (i.e. relationships that contain a large sexual component but for which pro-social attributes are relatively unimportant) than for long-term relationships (i.e. relationships that contain a large pro-social component) suggests that masculine men are considered *sexually* attractive by women (Little et al., 2002). If increasing sex drive increases the extent to which sexual attraction is reflected in women's attractiveness judgments, sex drive may be positively associated with heterosexual women's preferences for masculine men.

Many studies have shown that women demonstrate very strong preferences for femininity in other women's faces (see Rhodes, 2006 for a review). Lippa's (2006) findings for positive associations between sex drive and heterosexual women's ratings of the attractiveness of other women therefore raise the possibility that sex drive will be positively associated with women's preferences for femininity in female faces in addition to being positively associated with women's preferences for masculinity in men's faces. By contrast, if sex drive only alters responses to potential mates, heterosexual women's sex drive may be positively associated with the strength of their preferences for masculinity in men's faces only.

We investigated the relationship between heterosexual women's self-reported sex drive and the strength of their preferences for masculinity in men's faces and femininity in women's faces in 2 studies. One study was conducted online (Study 1) and one study was conducted in the laboratory (Study 2).

2. Study 1

In study 1 we tested for positive associations between heterosexual women's reported sex drive and the strength of their preferences for masculinity in men's faces and femininity in women's faces (i.e. preferences for sexual dimorphism in faces).

2.1. Methods

2.1.1. Stimuli

Following previous studies of systematic variation in the strength of women's preferences for masculinity–femininity (i.e. sexual dimorphism) in face images (DeBruine et al., 2006; Little et al., 2001; Penton-Voak et al., 1999), prototype-based image transformations were used to manipulate sexual dimorphism of 2D shape in face images. First, male and female prototype

(i.e. average) faces were manufactured using established and widely used computer graphic methods (e.g. DeBruine et al., 2006; Penton-Voak et al., 1999; Welling et al., 2007). Prototypes are composite images that are constructed by averaging the shape, color and texture of a group of faces, such as male or female faces. These prototypes can then be used to transform images by calculating the vector differences in position between corresponding points on two prototype images and changing the position of the corresponding points on a third image by a given percentage of these vectors (see Rowland & Perrett, 1995; Tiddeman, Burt, & Perrett, 2001 for technical details).

Here, 50% of the linear differences in 2D shape between symmetrized versions of the male and female prototypes were added to or subtracted from face images of 8 young adult White men (age: $M = 17.88$ years, $SD = 0.99$) and 8 young adult White women (age: $M = 17.68$ years, $SD = 0.92$). This process creates masculinized and feminized versions of the individual face images that differ in sexual dimorphism of 2D shape and are matched in other regards (e.g. skin color and texture, identity, DeBruine et al., 2006). Examples of masculinized and feminized versions of male and female face images are shown in Fig. 1. The male prototype that was used to vary sexual dimorphism of 2D shape was manufactured from face images of 20 young adult heterosexual White men (age: $M = 19.5$ years, $SD = 2.3$). The corresponding female prototype was manufactured from face images of 20 young adult heterosexual White women (age: $M = 18.4$ years, $SD = 0.7$). Sixteen pairs of images were produced in total (8 pairs of female face images and 8 pairs of male face images) with each pair consisting of a masculinized and a feminized version

Fig. 1. Examples of masculinized (left column) and feminized (right column) male and female faces.

of the same individual. Manipulating sexual dimorphism in face images using this method produces face images that differ reliably in perceptions of their masculinity–femininity (DeBruine et al., 2006; Welling et al., 2007).

2.1.2. Participants

Women who participated in Study 1 ($N = 131$; age: $M = 26.51$ years, SD = 7.31, range = 18–48 years old) were selected for reporting that their preferred partner sex was male when they were asked to choose from the options 'male', 'female' and 'either male or female', and were therefore considered heterosexual for the purposes of this study. Participants were recruited by following links from lists of online psychology experiments.

2.1.3. Procedure

The University of Aberdeen (School of Psychology) Ethics Committee approved all aspects of our procedure. The 131 heterosexual women in our study were shown the 16 pairs of face images and were asked to choose the face in each pair that was more attractive. Participants also indicated the strength of these preferences by choosing from the options 'slightly more attractive', 'somewhat more attractive', 'more attractive', and 'much more attractive'. The order in which pairs of faces were shown was fully randomized for each participant and the side of the screen on which any particular image was shown was also fully randomized.

Immediately after completing the face preference test, participants were asked to rate their general sex drive ('In general, how would you rate your sex drive?') on a 1 (low) to 7 (high) scale. Previous studies (Ostovich, 2005) have found that simple ratings of general sex drive correlate highly with other well-validated self-report measures of sex drive/desire, such as the sexual desire inventory (Spector, Carey, & Steinberg, 1996). The rating of general sex drive we used is very similar to that used by Lippa (2006, Study 1) to investigate the relationship between sex drive and attraction to men and women. Lippa also showed that simple ratings of reported sex drive show associations with attraction that are identical to those that occur when more detailed sex drive questionnaires are used (Lippa, 2006, Study 3).

All testing took place online. Previous studies of systematic variation in face preferences have shown equivalent patterns of results in both online and laboratory studies (e.g. Jones et al., 2005).

2.1.4. Initial processing of data

Responses on the face preference test were coded as strength of preference for sexual dimorphism (i.e. masculinity in male faces and femininity in female faces) using a 0 (masculine female or feminine male face rated 'much more attractive') to 7 (feminine female or masculine male face rated 'much more attractive') scale.

For each participant, the average strength of preference for sexual dimorphism was calculated separately for men's and women's faces.

2.2. Results

One-sample *t*-tests comparing preferences for sexual dimorphism with what would be expected by chance alone (i.e. 3.5) showed that women generally preferred femininity in both women's

($t(130) = 18.03$, 2-tailed $p < 0.001$; $M = 4.67$, SE = 0.06) and men's faces ($t(130) = -4.12$, 2-tailed $p < 0.001$; $M = 3.21$, SE = 0.07). Mean reported sex drive for this sample was 4.47 (SD = 1.54).

Responses were analyzed further using an ANCOVA (dependent variable: strength of preference for sexual dimorphism; within-subjects factor: sex of face (male, female); covariates: age, reported sex drive). An ANCOVA was used as it can test for both a general relationship between sex drive and preferences for sexual dimorphism while also testing for significant differences in the nature of this relationship for judgments of men's and women's faces. Age was included as a covariate since some previous studies have found that women's age is associated with the strength of their face preferences (Jones et al., 2005).

Our ANCOVA revealed a significant main effect of sex of face ($F(1,128) = 9.66$, $p = 0.002$, $\partial\eta^2 = 0.070$), whereby women preferred greater sexual dimorphism in female faces than male faces. There was also a significant main effect of reported sex drive ($F(1,128) = 3.98$, $p = 0.048$, $\partial\eta^2 = 0.030$), whereby women with high reported sex drive demonstrated stronger preferences for sexual dimorphism than did women with relatively low reported sex drive ($r = 0.186$, $N = 31$, $p = 0.033$). However, the effect of reported sex drive did not interact with sex of face ($F(1,128) = 0.03$, $p = 0.868$, $\partial\eta^2 < 0.001$). A significant main effect of age ($F(1,128) = 4.23$, $p = 0.042$, $\partial\eta^2 = 0.032$) indicated that younger people had stronger preferences for sexual dimorphism than did older participants ($r = -0.179$, $N = 131$, $p = 0.037$). There were no other significant effects (all $F(1,128) < 0.47$, all $p > 0.49$, all $\partial\eta^2 < 0.005$).

Repeating the analysis described above, but excluding the covariate age, did not alter our findings. The main effects of sex drive ($F(1,129) = 4.64$, $p = 0.033$, $\partial\eta^2 = 0.035$) and sex of face ($F(1,129) = 15.95$, $p < 0.001$, $\partial\eta^2 = 0.108$) remained significant and there was no significant interaction between sex drive and sex of face ($F(1,129) = 0.05$, $p = 0.821$, $\partial\eta^2 < 0.001$).

3. Study 2

In Study 1 we found that heterosexual women's reported sex drive was positively associated with the strength of their preference for masculinity in men's faces and femininity in women's faces. This finding complements Lippa's (2006) finding that women's sex drive is positively related to their attraction to both men and women. The aim of Study 2 was to replicate this finding in a laboratory study. Since women's sex drive and perceptions of their own attractiveness may be positively related (Koch, Mansfield, Thureau, & Carey, 2005), and self-rated attractiveness may also be associated with variation in face preferences (e.g. Little et al., 2001; Little & Mannion, 2006), we also controlled for possible effects of self-rated attractiveness in Study 2 (this potential confound was not investigated in Study 1). Women were tested on 2 occasions (approximately 2 weeks apart) so that we could assess the test-retest reliability of self-reported sex drive.

3.1. Methods

3.1.1. Stimuli

Stimuli used in Study 2 were the 8 masculine–feminine male face pairs and the 8 masculine–feminine female face pairs used in Study 1 and a further 12 White adult heterosexual male masculine–

feminine face pairs (age: $M = 18.08$ years, SD = 1.31) and 12 White adult heterosexual female masculine–feminine face pairs (age: $M = 17.92$ years, SD = 1.24). These additional 24 face pairs had been manufactured in the same way as the 16 face pairs used in Study 1 and using the same male and female prototypes.

3.1.2. Participants

All women who participated in the study ($N = 43$, age: $M = 19.01$ years, SD = 1.52, range = 17–24 years, all undergraduate students) indicated that they preferred male romantic partners when asked to indicate if they preferred their romantic partners to be 'male', 'female' or 'either male or female'. Twenty-one women reported that they were currently using some form of hormonal contraceptive. The other 22 women reported no use of hormonal contraceptives and normal menstrual cycles. Twenty-two of the women reported currently being in a romantic relationship. The other 21 women reported that they were not currently in a romantic relationship. Thirty-nine of the women were White, 1 woman was West Asian, 1 woman was East Asian, and the 2 remaining women were Black African.

3.1.3. Procedure

The procedure was identical to that used in Study 1 except that our female participants were each tested on two occasions, approximately 2 weeks apart. Participants also completed an unrelated economic decision task on each occasion, data from which has been reported elsewhere (Smith et al., 2007). In each test session, participants also rated their own attractiveness using a 1 (very unattractive) to 7 (very attractive) scale. By contrast with Study 1, which was run online, Study 2 was conducted in the laboratory.

3.1.4. Initial processing of data

Responses on the face preference test were coded using the same algorithm that was used in Study 1. Preferences for masculinity in men's faces in each test session were significantly and positively related ($r = 0.81$, $N = 43$, 2-tailed $p < 0.001$), as were preferences for femininity in women's faces ($r = 0.58$, $N = 43$, 2-tailed $p < 0.001$). Ratings of sex drive in each test session were also significantly and positively related ($r = 0.86$, $N = 43$, 2-tailed $p < 0.001$), as were ratings of own attractiveness ($r = 0.92$, $N = 43$, 2-tailed $p < 0.001$). We therefore calculated 4 scores for each participant by averaging scores across test sessions: mean strength of preference for masculine men, mean strength of preference for feminine women, mean reported sex drive, and mean self-rated attractiveness.

3.2. Results

One-sample t-tests comparing face preferences with what would be expected by chance alone (i.e. 3.5) showed that women preferred feminine versions of women's faces ($t(42) = 8.83$, 2-tailed $p < 0.001$; $M = 4.15$, SE = 0.07), but not feminine versions of men's faces ($t(42) = -1.42$, 2-tailed $p = .163$, $M = 3.42$, SE = 0.06). The mean reported sex drive for the sample was 4.65 (SD = 1.18). Mean self-rated attractiveness for the sample was 3.87 (SD = 1.09).

Responses were further analyzed using an ANCOVA (dependent variable: strength of preference for sexual dimorphism; within-subjects factor: sex of face (male, female); covariates: reported

sex drive, self-rated attractiveness). Self-rated attractiveness was included as a covariate as it was positively related to reported sex drive in both previous studies (e.g. Koch et al., 2005) and also in the current study ($r = 0.539$, $N = 43$, $p < 0.001$). The ANCOVA revealed a significant main effect of reported sex drive ($F(1,40) = 4.17$, $p = 0.048$, $\partial\eta^2 = 0.094$), whereby women reporting high sex drive demonstrated stronger preferences for sexual dimorphism than did women reporting relatively low sex drive ($r = 0.351$, $N = 43$, $p = 0.021$). As in Study 1, the effect of sex drive did not interact with sex of face ($F(1,40) = 0.57$, $p = 0.454$, $\partial\eta^2 = 0.014$). There were no other significant effects (all $F(1,40) < 0.58$, all $p > 0.45$, all $\partial\eta^2 < 0.015$).

Repeating the analysis described above, but excluding the covariate self-rated attractiveness, did not alter our finding for women's sex drive. The main effect of sex drive remained significant ($F(1,41) = 5.746$, $p = 0.021$, $\partial\eta^2 = 0.123$) and there were no other significant effects (all $F(1,42) < 1.3$, all $p > 0.28$, all $\partial\eta^2 < 0.03$).

4. Discussion

In both studies we found that reported sex drive was positively associated with heterosexual women's preferences for sexual dimorphism in faces. Reported sex drive did not interact with sex of face judged in either study, indicating that the relationships between reported sex drive and face preferences were not significantly different for judgments of men's and women's faces. Our findings for reported sex drive and face preferences could not be explained by possible effects of women's perceptions of their own attractiveness on preferences (Little et al., 2001; Little & Mannion, 2006), since we controlled for these in Study 2.

Although many studies have found that women's preferences for masculine men (e.g. Penton-Voak et al., 1999; Welling et al., 2007) are increased around ovulation and some studies have also found that reported sex drive is also increased around ovulation (e.g. Stanislaw & Rice, 1988), it is unlikely that our findings solely reflect correlated changes in women's face preferences and sex drive during the menstrual cycle. Studies of cyclic variation in women's face preferences have found increased attraction to masculinity in both men's and women's faces around ovulation (Welling et al., 2007), or have found that cyclic variation in women's preferences for masculinity affect only judgments of men's faces (Johnston, Hagel, Franklin, Fink, & Grammer, 2001). Thus, our findings of positive associations between sex drive and women's preferences for masculine men and feminine women cannot be explained by correlated changes in women's face preferences and sex drive during the menstrual cycle.

Our findings for positive associations between reported sex drive and heterosexual women's preferences for sexual dimorphism in men's and women's faces complement Lippa's (2006) finding that sex drive is positively related to heterosexual women's ratings of the attractiveness of both men and women. Moreover, our findings also present novel converging evidence for Lippa's (2006) proposal that sex drive in women is a generalized energizer of sexual behaviors, rather than an energizer of sexual behaviors and responses to potential mates only (i.e. dominant sexual behaviors). While both our own studies and those reported by Lippa (2006) show positive associations between *reported* sex drive and women's judgments of others' attractiveness, future studies employing more objective measures of women's sexual arousal would be desirable. Although both our own and Lippa's (2006) studies show associations between attraction and individual

differences in general sex drive, it remains unclear how changes in sex drive that occur within individuals affect preferences. The extent to which our findings for associations between women's sex drive and preferences for feminine women reflect sexual attraction or more general aspects of attraction (e.g. positive regard) is also unclear.

Lippa (2006) showed that reported sex drive was positively associated with heterosexual women's and lesbian women's attractiveness ratings of both men and women. By contrast, sex drive was positively associated with heterosexual men's ratings of the attractiveness of women only and homosexual men's ratings of the attractiveness of men only (Lippa, 2006). While our current study was limited to investigating the relationship between sex drive and heterosexual women's preferences for masculine men and feminine women, the nature of these relationships remains to be investigated among lesbian women, homosexual men and heterosexual men. Following Lippa's findings (Lippa, 2006) and those of our current studies, we would anticipate that lesbian women may show a similar pattern of results to those we observed for heterosexual women, but that the nature of the relationships between sex drive and men's preferences for sexual dimorphism in faces would be modulated by men's sexual orientation. Sex drive may be positively related to heterosexual men's preferences for sexual dimorphism in women's faces, but not men's faces, while sex drive may be positively associated to homosexual men's preferences for sexual dimorphism in men's faces only.

Many studies have investigated possible sources of systematic variation in women's preferences for sexual dimorphism in men's faces. Our findings for associations between women's reported sex drive and face preferences reveal sex drive as an additional source of individual differences in women's preferences for sexual dimorphism in men's faces and also women's faces. From an evolutionary perspective, increased attraction to masculine men when women's sex drive is high may function to increase the likelihood of women having healthy offspring, since men's facial masculinity is positively related to their medical health (Rhodes et al., 2003; Thornhill & Gangestad, 2006). Increased attraction to sexual dimorphism more generally (e.g. in women's faces) may be a low-cost, functionless by-product of a mechanism for increasing preferences for masculine men when sex drive is high. Indeed, this explanation has previously been advanced to explain variation in women's preferences for sexual dimorphism in women's faces during the menstrual cycle (e.g. Welling et al., 2007). Importantly, our findings, together with those of Lippa (2006), suggest that sex drive energizes sexual behavior in women generally, rather than energizing responses to potential mates only.

References

Byers, J. A. & Waits, L. (2006). Good genes sexual selection in nature. In *Proceedings of the National Academy of Sciences of the United States of America*, *103*, 16343–16345.

DeBruine, L. M., Jones, B. C., Little, A. C., Boothroyd, L. G., Perrett, D. I., & Penton-Voak, I. S. (2006). Correlated preferences for facial masculinity and ideal or actual partner's masculinity. In *Proceedings of the Royal Society of London B*, *273*, 1355–1360.

Gangestad, S. W., & Simpson, J. A. (2000). The evolution of human mating: Trade-offs and strategic pluralism. *Behavioral and Brain Sciences, 23*, 573–644.

Johnston, V. S., Hagel, R., Franklin, M., Fink, B., & Grammer, K. (2001). Male facial attractiveness: Evidence for a hormone-mediated adaptive design. *Evolution and Human Behavior, 22*, 251–267.

Jones, B. C., Perrett, D. I., Little, A. C., Boothroyd, L. G., Cornwell, R. E., & Feinberg, D. R. (2005). Menstrual cycle, pregnancy and oral contraceptive use alter attraction to apparent health in faces. In *Proceedings of the Royal Society of London* B, *272*, 347–354.

Koch, P. B., Mansfield, P. K., Thureau, D., & Carey, M. (2005). ''Feeling frumpy'': The relationships between body image and sexual response changes in midlife women. *The Journal of Sex Research, 42*, 1–9.

Lippa, R. A. (2006). Is high sex drive associated with increased sexual attraction to both sexes? It depends on whether you are male or female. *Psychological Science, 17*, 46–52.

Little, A. C., Burt, D. M., Penton-Voak, I. S., & Perrett, D. I. (2001). Self-perceived attractiveness influences human female preferences for sexual dimorphism and symmetry in male faces. In *Proceedings of the Royal Society of London B*, *268*, 39–44.

Little, A. C., Jones, B. C., Penton-Voak, I. S., Burt, D. M., & Perrett, D. I. (2002). Partnership status and the temporal context of relationships influence human female preferences for sexual dimorphism in male face shape. In *Proceedings of the Royal Society London B*, *269*, 1095–1100.

Little, A. C., & Mannion, H. (2006). Viewing attractive or unattractive same-sex individuals changes self-rated attractiveness and face preferences in women. *Animal Behaviour, 72*, 981–987.

Ostovich, J. M. (2005). Sex drive, sexual attitudes, and sexual behaviors. Ph.D dissertation presented to the faculties of the University of Pennsylvania, USA.

Penton-Voak, I. S., Perrett, D. I., Castles, D. L., Kobayashi, T., Burt, D. M., Murray, L. K., et al. (1999). Menstrual cycle alters face preference. *Nature, 399*, 741–742.

Perrett, D. I., Lee, K. J., Penton-Voak, I. S., Rowland, D. R., Yoshikawa, S., Burt, D. M., et al. (1998). Effects of sexual dimorphism on facial attractiveness. *Nature, 394*, 884–887.

Petrie, M. (1994). Improved growth and survival of offspring of peacocks with more elaborate trains. *Nature, 371*, 598–599.

Rhodes, G. (2006). The evolution of facial attractiveness. *Annual Review of Psychology, 57*, 199–226.

Rhodes, G., Chan, J., Zebrowitz, L. A., & Simmons, L. W. (2003). Does sexual dimorphism in human faces signal health? *Proceedings Royal Society of London B, 270*, S93–S95.

Roney, J. R., Hanson, K. N., Durante, K. M., & Maestripieri, D. (2006). Reading men's faces: women's mate attractiveness judgments track men's testosterone and interest in infants. In *Proceedings of the Royal Society of London B*, *273*, 2169–2175.

Rowland, D. A., & Perrett, D. I. (1995). Manipulating facial appearance through shape and color. *IEEE Computer Graphics and Applications, 15*, 70–76.

Smith, F. G., DeBruine, L. M., Jones, B. C., Krupp, D. B., Conway, C. A., & Welling, L. L. M. (2007). Own attractiveness affects strategies in an economic game. In *Paper presented at the 19th annual meeting of the Human Behavior and Evolution Society*, Virginia USA, June 2007.

Spector, I. P., Carey, M. P., & Steinberg, L. (1996). The sexual desire inventory: Development, factor structure, and evidence of reliability. *Journal of Sex and Marital Therapy, 22*, 175–190.

Stanislaw, H., & Rice, F. J. (1988). Correlation between sexual desire and menstrual cycle characteristics. *Archives of Sexual Behavior, 17*, 499–508.

Thornhill, R., & Gangestad, S. W. (2006). Facial sexual dimorphism, developmental stability, and susceptibility to disease in men and women. *Evolution and Human Behavior, 27*, 131–144.

Tiddeman, B., Burt, M., & Perrett, D. (2001). Prototyping and transforming facial textures for perception research. *IEEE Computer Graphics and Applications, 21*, 42–50.

Welling, L. L. M., Jones, B. C., DeBruine, L. M., Conway, C. A., Law Smith, M. J., Little, A. C., et al. (2007). Raised salivary testosterone in women is associated with increased attraction to masculine faces. *Hormones and Behavior, 52*, 156–161.