APPLIED COGNITIVE PSYCHOLOGY
Appl. Cognit. Psychol. **22**: 1185–1194 (2008)
Published online 21 January 2008 in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/acp.1436

Was that a Man? Sex Identification as a Function of Menstrual Cycle and Masculinity

LUCY JOHNSTON[1*,†], LYNDEN MILES[1,2] and C. NEIL MACRAE[2]

[1]*Department of Psychology, University of Canterbury, New Zealand*
[2]*Department of Psychology, University of Aberdeen, New Zealand*

SUMMARY

The accuracy of female perceivers on a face sex-categorization task was investigated as a function of perceivers' menstrual cycle and target facial qualities. Regularly ovulating female participants completed a sex-categorization task twice, once during ovulation (high fertility) and once during menstruation (low fertility). Perceivers made more errors in identifying male than female faces at both testing sessions. Fewer errors were made in identifying male targets rated high on masculinity, but only during periods of high fertility. For female targets accuracy was negatively associated with masculinity and positively associated with attractiveness ratings, at both high and low fertility testing sessions. Results are discussed in terms of adaptive person construal. Copyright © 2008 John Wiley & Sons, Ltd.

Regularly ovulating women have been shown to be especially attuned to information specifying that a target is male during periods of high fertility (Johnston, Arden, Macrae, & Grace, 2003; Macrae, Alnwick, Milne, & Schloerscheidt, 2002). Females were faster to correctly identify the sex of unknown males at ovulation (high fertility) than they were at menstruation (low fertility), but showed no difference in the speed to correctly categorize female targets. These findings have been interpreted as indicating that females are more highly attuned to the identification of males during periods of high fertility, or conception likelihood (Johnston et al., 2003; Macrae et al., 2002). Given the limited fertile period for females (both across the lifespan and within a given menstrual cycle), such findings are consistent with a functional view of perception with females being especially attuned to information that specifies that a target is male (i.e. a potential reproductive partner) at ovulation when likelihood of conception is greatest.[1]

Considering sex-based identification in terms of reproductive opportunities, incorrect identification of a target's sex may incur costs for female perceivers. Such incorrect identifications can take two forms—either misperceiving a male target as female or misperceiving a female target as male. The former can be considered to be a 'false

*Correspondence to: Lucy Johnston, Department of Psychology, University of Canterbury, Private Bag 4800, Christchurch, New Zealand. E-mail: lucy.johnston@canterbury.ac.nz
†Associate Professor.
[1]Further work with additional participant groups (e.g. women using a contraceptive pill; homosexual women) has led Johnston and colleagues to suggest that high sexual, rather than reproductive, desire underlies heightened sensitivity to potential sexual targets at ovulation (see Brinsmead-Stockham, Johnston, Miles, & Macrae, in press; Johnston et al., 2003).

negative' error and the latter a 'false positive' error. Both types of error may incur costs. A false negative could result in a missed reproductive opportunity. A false positive may result in the expenditure of resources (e.g. time and effort) on a non-reproductive partner, which might also result in reduced opportunity to identify and procure a potential mate. According to error management theory (Haselton & Buss, 2000), decision-making processes have evolved through natural or sexual selection to lead to the commitment of predictable errors. When there are costs associated with two types of error, there should be a bias toward committing those errors that are less costly, even if that leads to the commitment of a greater number of errors. In predicting the nature of sex-identification errors made by female perceivers, the question is whether the costs of a missed opportunity (false negative) are greater or less than the costs of investing in a non-reproductive partner (false positive) and whether such relative costs differ as a function of phase of the reproductive (menstrual) cycle. Given the limited reproductive opportunities for the female, one might predict that these costs would be especially pertinent during periods of high fertility (i.e. ovulation). Accordingly, one might predict the occurrence of fewer errors at high than at low fertility and, especially, a lower incidence of more costly errors.

It is unclear, however, whether the costs associated with a missed reproductive opportunity (i.e. false negatives) would exceed the costs of misdirected resources (i.e. false positives) or *vice-versa*. One might hypothesize that, assuming an adequate supply of males within a given population, during periods of high fertility females may err towards false negatives (i.e. risk misidentifying males as females) in order to maintain a strategy of selectivity. While this will risk missing potential reproductive partners, if the decision strategy employed takes some account of factors associated with male reproductive phenotypic and/or genotypic quality, candidates with low quality could be excluded at this initial stage of partner identification. Alternatively, it might be argued that women should err toward false positives in an attempt to identify all males. Such inclusivity would subsequently require some means to assess mate quality. The present research investigates the relative incidence of false positive and false negative errors at both high and low fertility. According to error management theory (Haselton & Buss, 2000) the most frequently occurring errors are the less costly type of error.

The sex-categorization task employed in each of these previous studies had head-and-shoulders frontal photographs of male and female targets presented individually and remaining on the computer screen until the participant pressed a response key to indicate whether the target was male or female (Johnston et al., 2003; Macrae et al., 2002). Error rates on this task were very low in each of the reported studies ($<1\%$ of trials). In order to increase the error rate in the present experiment, each target photograph in a sex-categorization task was only presented briefly before being replaced by a pattern mask such that the perceiver only had a short time to view each target and attend to information specifying sex.[2] Of course in many everyday settings strangers are not viewed under ideal conditions, but rather the sight of another person might be occluded, or may be a fleeting glance as a person passes by the perceiver. In such situations perceivers have a limited viewing opportunity. Correct detection of characteristics of the target, such as their sex, requires perceivers to quickly attend to the relevant information. Failure to do so may result in errors in perception. Those characteristics of targets which are most accurately

[2]It is acknowledged that under many viewing conditions perceivers may use information from sources apart from the face, such as body size, shape and gait, to identify the sex of targets. The present research is restricted, however, to consideration of facial information.

DOI: 10.1002/acp

identified under such limited viewing conditions, it could be argued, are those which are most salient and to which the perceiver most quickly attends. The present research also investigated the extent to which sex of targets is such a characteristic, by considering the accuracy of sex-identification under limited viewing conditions.

We predict that this modification of our sex-categorization task to reduce certainty will lead to lower levels of accuracy in sex-identification. Indeed, Pound and Penton-Voak (2004) did show reduced accuracy in sex-identification under conditions of reduced certainty, although they used a different method of reducing certainty (i.e. morphing of male and female faces) to that employed in the present research. In addition to the impact of reducing certainty on accuracy in sex-identification, the present research also considered the impact of female fertility on the number and type of errors made on the sex-categorization task. Given the costs of misperception to female perceivers, we hypothesized that fewer errors would be made when perceivers were tested at high fertility (ovulation) than at low fertility (menstruation).

In addition to the evidence that females are faster to identify potential reproductive partners (i.e. males) at ovulation (Johnston et al., 2003; Macrae et al., 2002), there is an extensive literature on female mate preferences showing that, across a number of sources of information (faces, voices, odours, behavioural displays), females display greater preference for masculine features during ovulation than at other phases of the menstrual cycle. For example, at ovulation females show a preference for more masculinized and less feminized male faces, a preference not shown at other phases of the menstrual cycle (Fink & Penton-Voak, 2002; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999). Similarly, androstenol, an important contributor to male body odour, is evaluated more favourably by women when they are at the ovulatory phase of their menstrual cycle (Grammer, 1993). Further, those features preferred by women at ovulation have been associated with better health (Rhodes, Chan, Zebrowitz, & Simmons, 2003), and with higher testosterone concentrations amongst males (Roney, Hanson, Durante & Maestripieri, 2006; see Penton-Voak & Perrett, 2001 for a review). Testosterone concentrations, and hence facial masculinity, has been proposed as a proxy for genetic quality on the basis of evidence that higher levels of testosterone result in more masculine facial features and that high levels of testosterone can only be sustained by healthier men since testosterone has immunosuppressive effects (Følstad & Karter, 1992; Grammer & Thornhill, 1994). Cycle-dependent sensitivity does, then, offer reproductive benefits to the female. The previous research investigating speed of sex-categorization as a function of fertility levels (Johnston et al., 2003; Macrae et al., 2002) has not considered the reproductive quality of the targets, simply whether they were male or female. That research indicates that females are especially attuned to facial features that specify ‘maleness’ at ovulation but it is unclear whether they are also attuned to features that specify the reproductive quality of the potential targets. Pound and Penton-Voak (2004) had perceivers identify the sex of male and female targets who were also rated by independent raters for masculinity, femininity and attractiveness. They showed error rates on sex identification to be related to ratings of masculinity and femininity. Masculine males and feminine females were more likely to be correctly identified than were less masculine or feminine targets, respectively. Only for the female targets, however, was there an inverse relationship between attractiveness ratings and error rates. Pound and Penton-Voak’s (2004) results are suggestive of a relationship between accuracy and the reproductive quality of the targets, as indexed by masculinity, femininity and attractiveness, with the relationship being stronger for female than for male targets. Pound and Penton-Voak’s (2004) results were, however, collapsed across male and

DOI: 10.1002/acp

female perceivers and no consideration was given to the phase of the menstrual cycle amongst the female perceiver.

In the present study we further considered the relationship between sex-categorization and target qualities for female perceivers as a function of the phase of their menstrual cycle. Based on the mate preference literature, it was predicted that female perceivers would be more accurate in identifying good quality males at ovulation than at menstruation. To test this prediction, each of the target photographs used in the present research were rated by independent raters on masculinity, attractiveness and femininity. Since combinations of high masculinity/low femininity and high attractiveness have been associated with higher genotypic quality amongst males (Følstad & Karter, 1992; Møller & Thornhill, 1997; Rhodes et al., 2003; Thornhill & Gangestad, 1999), we predicted that there would be negative correlations between the number of errors made for male targets and ratings of attractiveness and masculinity of those targets. Further, it was predicted that these correlations would be stronger at ovulation than at menstruation.

METHOD

Participants

Twenty-nine female participants who sustained a regular menstrual cycle and did not use hormonal contraceptives volunteered to participate in return for a voucher redeemable at local stores. Participants were recruited from first year psychology classes *via* an e-mail that invited them to take part in a study on social perception. Of those who replied to the e-mail approximately 25% were eligible for inclusion in the research. Most of those excluded were as a consequence of the use of hormonal contraception whilst a few were excluded as a consequence of having an irregular cycle.

Stimulus materials and procedure

In each testing session, participants completed a computer-based sex-categorization task (Walton, 2002) in which photographs of 50 unknown males and 50 unknown females were presented individually on the computer screen, in a unique random order for each participant. The stimulus faces were obtained from the Nottingham scans, accessed *via* the Psychological Image Collection at Stirling University, Scotland (PICS), and had been used in previous similar research (Johnston et al., 2003; Macrae et al., 2002). The photographs were black and white frontal head and shoulders pictures of young adults in neutral pose, with no apparent make-up or facial hair. Each of the target photographs was rated for masculinity, femininity and attractiveness (1—*not at all*; 7—*extremely*) by 20 male and 20 female students who did not take part in the sex-categorization task. For each rating there was a high correlation ($r > .82$) between the ratings given by the male and the female participants and, accordingly, a single rating, averaged across the male and female participants, was computed for each photograph. Means and distributions of these scores are shown in Table 1. Overall, the female faces were rated as more attractive than the male faces although the effect size was small, $F\ (1, 98) = 7.50$, $p < .01$, $\eta^2_p = .07$. As expected, the male faces were rated as more masculine than the female faces, $F\ (1, 98) = 294.53$, $p < .0001$, $\eta^2_p = .75$, and the female faces as more feminine than the male faces $F\ (1, 98) = 232.14$, $p < .0001$, $\eta^2_p = .70$. Comparisons between the male and female

DOI: 10.1002/acp

Table 1. Means and distributions of ratings of masculinity and attractiveness as a function of sex of photograph

	Male			Female		
Photographs	Mean (+SD)	Minimum	Maximum	Mean (+SD)	Minimum	Maximum
Composite masculinity	10.73 (1.86)	5.99	12.85	5.80 (1.03)	3.94	8.90
Attractiveness	3.03 (.66)	1.54	4.18	3.37 (.62)	2.10	4.65

photographs on congruent ratings (femininity ratings for female faces and masculinity ratings for male faces) and incongruent ratings (masculinity ratings for female faces and femininity ratings for male faces) revealed no significant effects, indicating that the female faces were seen to be as feminine as the male faces were masculine and *vice-versa*. Given the extremely high negative correlation between ratings of masculinity and femininity ($r(100) = -.981$, $p < .001$), a composite score of masculinity was computed for each photograph. Mean ratings of femininity were reverse-scored such that a higher score indicated less feminine (more masculine) ratings. The mean ratings for masculinity were then added to the mean reverse ratings of femininity to give a composite masculinity score (range 2–14). Higher scores on this composite measures indicated higher ratings of perceived masculinity.

On each trial, a fixation cross appeared on the computer screen and was replaced by a photograph. In order to prevent participants anticipating the appearance of the photograph, the fixation cross appeared on the screen for between 1500 and 3000 ms with the time interval randomly determined for each trial. Each photograph appeared on the screen for 50 ms before being replaced by a pattern mask which remained on the screen until the participant responded. For each photograph the participant had to indicate whether the photograph was of a male or a female by pressing the appropriate key on the computer keyboard. Participants were instructed to respond as quickly but as accurately as possible. Prior to the main task, participants were first given six practice trials to familiarize themselves with the experimental procedure. None of the photographs used in the practice trials were subsequently used in the main study. Potential participants were informed that the experiment was investigating factors that may influence the speed and accuracy with which women are able to identify the sex of strangers from photographs. It was explained that participation involved two experimental sessions held approximately 2 weeks apart. A screening questionnaire was administered asking about the nature of their menstrual cycle. For those women who maintained a regular cycle, a testing schedule was developed that ensured each participant was tested once during a period of high fertility (i.e. ovulation) and once during a period of low fertility (during menstruation). These periods in the menstrual cycle were calculated by using a backward method of counting introduced by Jöchle (1973) and adopted in previous research (Johnston et al., 2003; Johnston, Miles, Carter, & Macrae, 2005; Macrae et al., 2002). Regardless of cycle length, ovulation (i.e. high fertility) is assumed to occur almost exactly 14 days prior to the beginning of the participant's next cycle, indicated by the onset of menses. For example, if menses indicates day 1, in a 28 day cycle ovulation occurs on day 15 and in a 35 day cycle ovulation occurs on day 22. However, since menstrual hormones do not operate in a simple binary (i.e. on/off) manner, but as a continuum of increasing and decreasing activity, women 1 day either side of ovulation and the onset of menses were considered to still be in the corresponding

DOI: 10.1002/acp

stage of their cycle (i.e. high or low fertility), consistent with past research (Johnston et al., 2003, 2005; Macrae et al., 2002). That is, the high fertility period was defined as the day of ovulation (calculated from the backward counting procedure) and 1 day prior and 1 day after ovulation. The period of low fertility was defined as the day of onset of menses and 1 day prior and 1 day after onset. No testing took place on days outside of these two 3-day periods. Approximately half of the women performed the first testing session during high fertility and the other half during low fertility.

Participants were tested individually. In each testing session, the participant performed the computer task as described above. The experimenter left the room whilst the participant completed the task. Instructions were presented *via* the computer screen. After the second testing session the participant was debriefed, thanked for her participation and paid.

RESULTS

Preliminary analyses revealed no effect on error rates of test order; that is there was no effect of whether participants completed their first testing session during a period of high or low fertility. Accordingly, this factor was not included in the reported analyses.

Errors

Mean number of errors per participant was 59.07 (29.5%) with a range between 22 (11.0%) and 88 (44.0%), as shown in Table 2. A 2 (Fertility: high/low) $\times$ 2 (Sex of photograph: female/male) repeated measures ANOVA on the mean number of errors made by each participant revealed only a main effect of sex of photograph $F\ (1, 28) = 34.97$, $p < .0001$, $\eta^2_p = .56$, with more errors made for the male than the female faces (Ms = 20.53 *vs*. 9.00).[3] Neither the main effect of fertility, $F\ (1, 28) = 0.001$, $p = .98$, $\eta^2_p = 0$, nor the interaction between fertility and sex of photograph, $F\ (1, 28) = 0.370$, $p = .55$, $\eta^2_p = .013$, approached significance.

Relationship with facial features

Mean number of errors were computed for each photograph and correlations computed between the number of errors made for each photograph at high and at low fertility and the

Table 2. Mean number of errors (and standard deviation) as a function of sex of photograph and fertility level

Photographs	Male	Female
Fertility phase:		
High fertility	20.93 (10.07)	8.62 (4.88)
Low fertility	20.14 (8.94)	9.38 (5.47)

[3]Although response times are not central to the reported research, it is noted that response times for correct responses showed the same pattern as that seen in past research (Johnston et al., 2003; Macrae et al., 2002), with faster response times to male targets at high than low fertility testing sessions but no difference in response time across testing sessions for female targets. Full details can be obtained from the first author.

Table 3. Correlations between errors and the composite rating of masculinity and ratings of attractiveness as a function of sex of photograph and fertility level

Photographs	Male		Female	
Ratings	Composite masculinity	Attractiveness	Composite masculinity	Attractiveness
Low fertility	−.017	.108	.533***	−.267*
High fertility	−.267*	−.040	.424**	−.276**

*$p = .06$.
**$p < .05$.
***$p < .01$.

ratings of the photographs, separately for the male and female photographs. Correlations are shown in Table 3.

For the male photographs the negative correlation between the composite masculinity ratings and errors made at high fertility approached statistical significance. The more masculine the photographs were judged to be, the fewer categorization errors made. There were no significant correlations at low fertility. For the female photographs, there were significant positive correlations between the composite ratings of masculinity and errors made at both high and low fertility and significant negative correlations between attractiveness and error made at both high and low fertility. The less masculine and more attractive the photographs were judged to be, the fewer categorization errors were made. Equivalence tests (Statistica, 1994–2006; StatSoft) were used to test whether the size of the correlation coefficients at high and at low fertility were equivalent or whether there was a significant difference in the strength of these. There was no significant difference between the size of the correlation between errors made and masculinity at high and at low fertility ($p = .27$) or between errors and attractiveness ($p = .91$) at high and at low fertility.

DISCUSSION

The present research investigated the incidence of sex-categorization errors by female perceivers, as a function of phase of the menstrual cycle. Contrary to predictions, there was no effect of phase of menstrual cycle on the number of errors made by perceivers; perceivers were not more accurate during periods of high fertility. There was a greater incidence of false negative than false positive errors at both high and low fertility. That is, female perceivers were more likely to miscategorize a male as a female than miscategorize a female as a male. This finding would suggest that the costs associated with false positive errors are in fact greater than the costs associated with false negative errors. The costs associated with investment in a non-reproductive partner might outweigh those of missing the opportunity to mate with a potential reproductive partner. One possible explanation for this finding is the availability of males (potential reproductive partners) such that the costs of missing some reproductive opportunities (false negative errors) are less than in situations where potential reproductive partners are scarce. Indeed, in situations of multiple reproductive options, there may be greater differentiation of the possible reproductive opportunities such that each is not considered to be an equal opportunity. In these cases not all missed reproductive opportunities might be considered to be costly.

DOI: 10.1002/acp

We also considered whether characteristics of the target individuals were related to error rates. Based on the evidence that more masculine faces are associated with better health (Rhodes et al., 2003) and higher concentrations of testosterone (Følstad & Karter, 1992) amongst males, and that females are sensitive to such markers (Roney et al., 2006), it was predicted that for the male targets there would be a negative relationship between ratings of masculinity and errors made. The results supported these predictions, but at high fertility only. At high fertility, there was a marginally significant negative relationship between masculinity ratings and error rate; female perceivers made fewer errors in categorizing male targets the more masculine those targets were considered to be. At low fertility, however, there was no relationship between error rate and ratings of masculinity. These findings are consistent with the mate preference literature that has shown females to show a preference for more masculinized and less feminized faces only at ovulation and not at other phases of the menstrual cycle (Fink & Penton-Voak, 2002; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999). When male targets were visible for only a limited time period, female perceivers at ovulation were more accurate at identifying more masculinized targets, suggesting that they were more highly attuned to attend to such information under such conditions. The lack of any relationship between error rates and attractiveness across conditions was consistent with the findings of Pound and Penton-Voak, (2004). It is also worth noting that overall the relationships between error rates and characteristics of male faces were relatively weak. It is possible that the variability in the target faces in the present study was too low to reveal strong relationships. All of the target photographs depicted healthy young males who were rated to be of moderate attractiveness, such that all were potentially viable reproductive partners. If more extreme faces were included in the target set, especially male faces of very low attractiveness it is possible that stronger relationships would have been found (Zebrowitz & Rhodes, 2004). Extremely unattractive faces often identify individuals with congenital or genetic abnormalities that impair their genetic fitness (Zebrowitz, Fellous, Mignault & Andreoletti, 2003) which may lead to over-generalization effects with unattractive males being deemed not to be suitable reproductive partners and hence more likely to be incorrectly identified in a sex-categorization task.

In addition to the predicted relationships between masculinity ratings and error rates for male targets, our results also revealed significant correlations for female targets between ratings of masculinity and error rates and between ratings of attractiveness and error rates. There were significant positive relationships between error rate and ratings of masculinity and significant negative relationships between error rate and ratings of attractiveness. The less masculine and the more attractive female targets were considered to be, the fewer errors were made in categorizing them as female. These findings mirror those reported by Pound and Penton-Voak (2004) for female targets. It is noteworthy, however, that these relationships were present at both high and low fertility testing sessions, and a comparison of the strength of the relationships revealed no difference between high and low fertility testing sessions. The results suggest, then, that female perceivers are sensitive to markers of femininity (or lack of markers of masculinity) at both high and low fertility phases of their menstrual cycle. This result is consistent with findings from the speed of categorization studies (Johnston et al., 2003; Macrae et al., 2002) that showed a difference in categorization speed between testing sessions for correctly categorizing male targets but no difference for female targets. Why female perceivers show a stable pattern of sensitivity to markers of femininity at all is unclear. One possible explanation that warrants further research is in terms of mate competition, that females are sensitive to markers of femininity in order to identify potential rivals for male attention.

DOI: 10.1002/acp

These findings extend the previous work on sex-categorization (Johnston et al., 2003; Macrae et al., 2002) and on mate preference (Møller & Thornhill, 1997; Roney et al., 2006; Thornhill & Gangestad, 1999). Under conditions of limited viewing, female perceivers made more errors in identifying male than female targets. According to error management theory (Haselton & Buss, 2000) this suggests that misidentifying a female as a male (i.e. a false positive) is associated with more cost to the perceiver than mistaking a male for a female (i.e. a false negative). Further, error rates varied as a function of characteristics of the targets, with more masculine and less feminine male faces being identified with greater accuracy. This effect was seen only at high fertility, however, when sensitivity to markers of mate quality is especially important for female perceivers.

ACKNOWLEDGEMENTS

The authors thank Katie Brinsmead-Stockham and Meredith Blampied for their help with data collection and Paul Walton for writing the software used in this study. This research was supported by grant D3336 from the University of Canterbury. Dr Miles is now at the University of Aberdeen.

REFERENCES

Brinsmead-Stockham, K., Johnston, L., Miles, L., & Macrae, C. N. (in press). Female sexual orientation and menstrual influences on person perception. *Journal of Experimental Social Psychology.*

Fink, B., & Penton-Voak, I. (2002). Evolutionary psychology of facial attractiveness. *Current Directions in Psychological Science*, *11*, 154–158.

Følstad, I., & Karter, A. (1992). Parasites, bright males, and the immunocompetence handicap. *American Naturalist*, *139*, 603–622.

Grammer, K. (1993). 5-α-androst-16en-3α-on: A male pheromone? A brief report. *Ethology and Sociobiology*, *14*, 201–208.

Grammer, K., & Thornhill, R. (1994). Human (Homo sapiens) facial attractiveness and sexual selection: The role of symmetry and averageness. *Journal of Comparative Psychology*, *108*, 233–242.

Haselton, M. G., & Buss, D. M. (2000). Error management theory: A new perspective on biases in cross-sex mind reading. *Journal of Personality and Social Psychology*, *78*, 81–91.

Jöchle, W. (1973). Coitus induced ovulation. *Contraception*, *1*, 523–564.

Johnston, L., Arden, K., Macrae, C. N., & Grace, R. C. (2003). The need for speed: The menstrual cycle and person construal. *Social Cognition*, *21*, 89–99.

Johnston, L., Miles, L., Carter, C., & Macrae, C. N. (2005). Menstrual influences on person perception: Male sensitivity to fluctuating female fertility. *Social Cognition*, *23*, 279–290.

Macrae, C. N., Alnwick, K. A., Milne, A. B., & Schloerscheidt, A. M. (2002). Person perception across the menstrual cycle: Hormonal influences on social-cognitive functioning. *Psychological Science*, *13*, 532–536.

Møller, A. P., & Thornhill, R. (1997). A meta-analysis of the heritability of developmental stability. *Journal of Evolutionary Biology*, *10*, 1–16.

Penton-Voak, I. S., & Perrett, D. I. (2000). Female preferences for male faces change cyclically: Further evidence. *Evolution and Human Behavior*, *21*, 39–48.

Penton-Voak, I. S., & Perrett, D. I. (2001). Male facial attractiveness: Perceived personality traits and shifting female preferences for male traits across the menstrual cycle. *Advances in the Study of Behavior*, *30*, 219–259.

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 perception. *Nature*, *399*, 741–742.

DOI: 10.1002/acp

Pound, N., & Penton-Voak, I. S. (2004). A new technique for assessing facial masculinity. Paper presented at the 16th Annual Meeting of the Human Behavior and Evolution Society. Freie Universität, Berlin, July 21st–25th.

Rhodes, G., Chan, J., Zebrowitz, L. A., & Simmons, L. W. (2003). Does sexual dimorphism in human faces signal health ? *Proceedings of the 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. *Proceedings of the Royal Society Biological Sciences*, *273*, 2169–2175.

Statistica. (1994–2006). StatSoft Inc. Tulsa, OK.

Thornhill, R., & Gangestad, S. W. (1999). The scent of symmetry: A human sex pheromone that signals fitness? *Evolution and Human Behavior*, *20*, 175–191.

Walton, P. R. (2002). The Lexical Decision Computer Task. *Dexterware.*

Zebrowitz, L. A., Fellous, J.-M., Mignault, A., & Andreoletti, C. (2003). Trait impressions as overgeneralized responses to adaptively significant facial qualities: Evidence from connectionist modeling. *Personality and Social Psychology Review*, *7*, 194–215.

Zebrowitz, L. A., & Rhodes, G. (2004). Sensitivity to bad genes and the anomalous face overgeneralization effect: Cue validity, cue utilization and accuracy in judging intelligence and health. *Journal of Nonverbal Behavior*, *28*, 167–185.

DOI: 10.1002/acp