



Estimated hormones predict women's mate preferences for dominant personality traits

Aaron W. Lukaszewski, James R. Roney*

Department of Psychology, University of California, Santa Barbara, CA 93106-9660, USA

ARTICLE INFO

Article history:

Received 12 November 2008
Received in revised form 24 February 2009
Accepted 26 February 2009
Available online 5 April 2009

Keywords:

Dominance
Estrogen
Mate preference
Menstrual cycle
Personality

ABSTRACT

Recent studies have reported that women exhibit elevated preferences for behavioral dominance in potential mates on higher fertility days of the menstrual cycle. This study was designed to test which hormonal signals may be associated with such cycle phase shifts in dominance preferences. Women indicated their mate preferences for dominant personality traits, and self-reported cycle day was used to estimate each woman's levels of estrogen, FSH, LH, progesterone, prolactin, and testosterone on her day of testing. Women's preferences for dominance in long-term mates were elevated on cycle days when estrogen is typically elevated, including during the luteal phase when conception is not possible. Preferences for dominance in short-term mates were highest on cycle days when LH and FSH are typically peaking. These findings support the existence of two types of hormone-regulated psychological mechanisms, each of which is proposed by a distinct functional theory of menstrual phase preference shifts: (1) a between-cycle mechanism that increases preferences for dominance in long-term mates during more fertile cycles characterized by higher estrogen, and (2) a within-cycle mechanism that couples enhanced preferences for dominance in short-term mates to the timing of ovulation.

© 2009 Elsevier Ltd. All rights reserved.

1. Introduction

Accumulating evidence indicates that women express stronger attraction to putative markers of phenotypic quality in men (such as masculinized or symmetrical features) when tested near ovulation than when tested at other times in the menstrual cycle (for reviews, see Gangestad & Thornhill, 2008; Jones et al., 2008). Although most of this research has focused on physical traits, two recent studies have reported that women tested near ovulation also show elevated preferences for videotaped displays of men's dominance-related behaviors (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007; Gangestad, Simpson, Cousins, Garver-Apgar, & Christensen, 2004). Dominant behaviors may signal direct benefits via greater access to material resources (see Sadalla, Kenrick, & Vershure, 1987); alternatively, the stronger preferences for such behaviors near ovulation have been interpreted as evidence that dominance-related behaviors may complement morphological features in acting as cues to men's heritable health and fitness (Gangestad et al., 2004). On either account, cycle phase shifts in preferences for dominance may represent stronger attraction to behavioral signals of phenotypic quality during times of higher fertility.

Because the menstrual cycle is regulated by reliable shifts in hormone concentrations, recent studies have begun to identify the proximate hormonal signals that may regulate fertility-related shifts in women's mate preferences (Garver-Apgar, Gangestad, & Thornhill, 2008; Jones et al., 2005a; Puts, 2006; Roney & Simmons, 2008; Welling et al., 2007). A primary goal of this study is to extend these findings and integrate them with the findings regarding cycle phase shifts in women's preferences for dominant behavior. To this end, the present research examines women's estimated hormone concentrations across the menstrual cycle in relation to their self-reported preferences for dominant personality traits.

At least two functional theories have been proposed to explain menstrual phase shifts in women's attractiveness judgments. The most prominent of these we will refer to as "mixed-mating theory" (see Gangestad & Thornhill, 2008; Penton-Voak et al., 1999). Mixed-mating theory proposes the existence of mechanisms that increase attraction to masculine features during the "fertile window" (the days of a cycle when conception is possible – approximately, the day of ovulation and the preceding five days), which evolved to motivate copulation with men who had higher quality genes than may have been available from a woman's primary partner. This argument posits that the potential costs to a woman from cheating on her primary partner (e.g., abandonment or violence if an infidelity was discovered) would have been constant across the menstrual cycle, but the potential benefits of obtaining higher quality genes could only have been realized within the fertile

* Corresponding author. Tel.: +1 805 893 4871; fax: +1 805 893 4303.
E-mail address: roney@psych.ucsb.edu (J.R. Roney).

window when conception could occur. As such, proponents of this position argue that it may have been functional to down-regulate interest in cues to genetic quality during infertile times of the cycle in order to reduce the motivation for infidelity and thus maintain the benefits of a long-term relationship, while up-regulating interest in cues to genetic quality during the fertile window in order to motivate an opportunistic search for the best genes for one's offspring.

Between-cycle theory (Roney, 2009; Roney & Simmons, 2008), by contrast, proposes mechanisms designed to produce preference shifts *between different menstrual cycles*, with stronger attraction to masculine traits across cycle days in more vs. less fertile cycles. Given that pregnancy, lactation, and energy shortage can suppress or eliminate women's fertility (for a review, see Ellison, 2001), it is likely that women throughout most of human evolution experienced fertile cycles quite rarely – given typical birth spacing in modern natural fertility populations, women in ancestral environments may have experienced fully fertile cycles for only a few months every 4–5 years (see Strassmann, 1997). Estrogen concentrations, furthermore, are known to index cycle fertility, with higher probabilities of conception in cycles with higher estrogen (e.g., Lipson & Ellison, 1996). Brain mechanisms could thus use estrogen as an index of the fertility of a given menstrual cycle and increase scrutiny of men's mate attractiveness during more fertile cycles. This may have functioned to adaptively allocate attention: during long stretches of suppressed fertility, reduced attention to men's sexual attractiveness may have facilitated motivational prioritization of adaptive problems such as foraging or care of young children; during the rare fertile cycles, though, increased attraction to masculine traits (across the cycle and not just during the fertile window, since courtship and mate choice can occur on any cycle day) may have increased the probability of mate choice leading to the production of healthier offspring. Since estrogen generally peaks near ovulation within cycles in addition to indexing fertility between cycles, an estrogen-based between-cycle mechanism might also generate within-cycle preference shifts even if it were primarily designed to change psychology across different cycles.

Although within- and between-cycle mechanisms are likely not mutually exclusive, pure versions of the mixed-mating and between-cycle theories do generate some conflicting empirical predictions. Mixed-mating theory predicts that preference shifts should be coupled to the timing of the fertile window, since this is the only time that women could acquire the genetic benefits that might outweigh the potential costs of an infidelity. Between-cycle theory, on the other hand, predicts stronger attraction to more masculine features on any cycle days with elevated estrogen, since higher fertility cycles tend to exhibit higher estrogen across most days of the cycle. Because estrogen peaks during the fertile window within cycles in addition to indexing fertility between cycles, both theories can predict positive correlations between estrogen and markers of phenotypic quality. However, estrogen also typically exhibits a secondary elevation in the luteal phase (the second half of the cycle, after ovulation) of ovulatory cycles and in some cases shows a sustained luteal elevation that may be greater than concentrations seen during the follicular phase (see Allende, 2002). As such, preference shifts that track estrogen alone would not be restricted to the fertile window, and mixed-mating theory should therefore predict that other signals may supplement estrogen in more tightly demarcating within-cycle fertility. These signals might be provided by other hormones that peak sharply near ovulation (e.g., luteinizing hormone (LH), follicle-stimulating hormone (FSH), prolactin; see Puts, 2006) or by a hormone like progesterone that peaks during the luteal phase and thus could act as a stop signal for preference shifts (see Jones et al., 2005a).

Previous studies have provided conflicting evidence regarding which hormones correlate with women's preference judgments. Two studies have reported that estrogen concentrations are positively associated with preferences for putative cues to phenotypic quality. Garver-Apgar et al. (2008) estimated six cyclically-fluctuating hormones, and found that estrogen positively predicted women's preferences for the scent of men's symmetry when associations with all other hormones were statistically controlled. Similarly, Roney and Simmons (2008) found that salivary estrogen (and not testosterone or progesterone) was the lone predictor of women's preference for facial cues of men's actual testosterone concentrations. Other studies, though, have reported that preferences for masculinized features are negatively correlated with estimated progesterone (Jones et al., 2005a; Puts, 2006), positively correlated with salivary testosterone (Welling et al., 2007), and positively correlated with estimated prolactin (Puts, 2006). Only Roney and Simmons (2008), however, examined correlations by phase of the cycle and showed that women's testosterone preferences continued to track their estradiol concentrations beyond the fertile window and into the luteal phase, which is an empirical pattern specifically predicted by between-cycle theory.

This study tested for hormonal correlates of possible cycle phase shifts in women's self-reported preferences for dominant personality traits. Following others (DeBruine, Jones, & Perrett, 2005; Garver-Apgar et al., 2008; Jones et al., 2005a; Puts, 2006), we assigned estimated values of six cyclically-fluctuating hormones to the cycle days on which women were tested based on published estimates of the typical values of these hormones on the days in question. We then related these estimated hormones to women's ratings of personality trait terms representing dominance, kindness, and trustworthiness. Because Gangestad et al. (2007) reported cycle phase shifts in preferences for perceived dominance but not for traits such as warm or intelligent, we expected that only preferences for dominance would correlate with estimated hormone values. Based on between-cycle theory, we specifically predicted estimated estrogen to positively correlate with preferences for dominance, while no strong predictions were made regarding the other hormones.

2. Methods

2.1. Participants

Participants were 240 undergraduate women (M age = 19.68 years, $SD = 1.0$) enrolled in undergraduate courses at UCSB, who either volunteered or were issued partial course credit for participation.

2.2. Procedures and materials

After completing an informed consent document, women completed a trait preference survey and a menstrual cycle survey, each described below, in groups of 5–30.

2.2.1. Trait preference survey

The authors compiled a large list of personality trait terms from which two graduate students and the authors themselves nominated terms that met one of the following definitions:

(1) *Dominance*: the tendency to use forceful and competitive tactics as a means of promoting desired outcomes and achieving status in a social hierarchy; (2) *Kindness*: a tendency to benefit others by providing resources or social support at a cost to oneself (or behavior that communicate one's willingness to do so); (3) *Trustworthiness*: a tendency to behave in accord with one's expressed intentions over the short- and long-term, including those to remain

faithful and persist in the relationship. Those items that were unanimously nominated as exemplars of the respective categories were included in the composite trait scales:

- (1) *Dominance*: aggressive, assertive, bold, brave, competitive, dominant, leader, masculine, powerful, strong, take-charge, tough ($\alpha = .89$).
- (2) *Kindness*: affectionate, considerate, generous, gentle, helpful, kind, sensitive, supportive, sympathetic, thoughtful ($\alpha = .91$).
- (3) *Trustworthiness*: committed, dependable, devoted, honest, loyal, reliable, sincere, trustworthy ($\alpha = .95$).

Participants were instructed to rate each trait term for importance in evaluating either a partner for “a brief sexual affair” ($n = 118$) or for “a committed romantic relationship such as marriage” ($n = 122$). The rating scale ranged from 1 (not important) to 7 (very important). Trait terms appeared in a scrambled order and were not organized by the broader composites. Although only items representing the positive pole of each trait construct were included (e.g., ‘strong’ is assessed but not ‘weak’), previous research has shown that subjects represent personality in a bipolar manner such that targets who are perceived to be high on traits like dominance are also perceived to be low on opposite traits such as submissiveness (see Trapnell & Wiggins, 1990). As such, ratings of the positive poles should accurately represent overall preferences for the traits in question.

2.2.2. Menstrual cycle survey

Women were asked to (1) indicate the first day of their last episode of menstrual bleeding, (2) estimate the number of days until they expected to begin their next episode of bleeding, and (3) estimate the duration of their typical cycles. Women also indicated whether they were currently using hormonal contraceptives.

2.3. Hormone estimation

Day of cycle was set equal to the number of days elapsed since women’s self-reported first day of last menses. Women who indicated a cycle day above 30 ($n = 28$) were excluded from the sample because estimated hormone values are not available for these cycle days. We next used two survey items to check the accuracy of self-reported cycle days. If women provided accurate reports about the timing of their menstrual events, their self-reported cycle day should = [typical cycle length – number of days until next anticipated episode of bleeding]. When these estimates of cycle day were > 5 days apart, this was taken as evidence of having answered the survey inaccurately, and these women were therefore excluded from the sample unless they reported having begun bleeding within the past 10 days (it was assumed that a woman’s memory of a menstrual period would not degrade within this brief time period). These criteria retained 194 women in the final sample (92 not using hormonal contraceptives; 102 using hormonal contraceptives).

Estimated concentrations of estrogen, LH, FSH, and progesterone were assigned to each cycle day based on the median values obtained on those days in a sample of 20 women who provided daily serum samples (Stricker et al., 2006). Estimates of prolactin and testosterone were assigned to cycle days based on the day-specific values reported in Garver-Apgar et al. (2008). Estimated hormone values in these studies were reported relative to the day of the LH surge, which has been estimated to occur on average about 15 days before the end of the menstrual cycle (Fehring, Schneider, & Raviele, 2006). Because the women in our final sample reported an average cycle length of 30.5 days, we estimated the LH surge as occurring on day 15, with estimated hormone values assigned accordingly. The women in our sample were slightly youn-

ger than the women in the studies from which day-specific hormone concentrations were computed, and so may have been more likely to experience irregular cycles with suppressed hormone concentrations. If anything, however, this should make the detection of hormone-preference associations more difficult, such that any positive findings may underestimate the true effect sizes.

2.4. Statistical analyses

Associations between estimated hormones and personality preferences were first tested using Pearson product-moment correlations. Because cyclically-fluctuating hormones are inter-correlated, it is potentially important to determine whether zero-order hormonal correlates of preferences hold when the influences of other hormones are statistically controlled. As such, we next conducted multiple regression analyses wherein personality trait preferences were regressed simultaneously on all hormone concentrations (exploratory analyses also tested for possible interactions between estrogen and progesterone, but such effects did not approach significance in any of the regression models). Because LH and FSH are highly correlated, they posed problems of multicollinearity; the regression analyses were therefore run twice – once with LH entered and once with FSH – and any significant differences between these models are noted in the results. Analyses were first run collapsed across mating contexts as a means of testing overall patterns with greater power, and were then conducted separately for women who rated traits for long- and short-term mate attractiveness, respectively. Reported significance levels are two-tailed.

3. Results

3.1. Findings collapsed across rating contexts

Table 1 presents associations between each estimated hormone and preferences for dominance in the full sample of women who reported not using hormonal contraceptives. It can be seen that estrogen was the only significant predictor, both when considering zero-order correlations and when all hormones were entered simultaneously into a multiple regression model. Furthermore, Fig. 1 demonstrates that the positive relationship between estrogen and preferences for dominance extended across the entire cycle and was not driven solely by mid-cycle peaks in both variables. In fact, if the sample is restricted to women tested after day 16 in the luteal phase (thus excluding the fertile window; $n = 37$), estimated estrogen concentrations are still significantly correlated with preferences for dominance, $r = .46$, $p = .004$.

As expected, there were no significant correlations between preferences for dominance and any of the estimated hormones among women using hormonal contraceptives; since this was also true within the sub-samples rating for long- and short-term mate attractiveness, these women are not discussed further. Likewise,

Table 1

Multiple regression model predicting preferences for dominant personality traits among women not using hormonal contraceptives ($n = 92$).

Estimated hormone	Standardized beta	Zero-order correlation
Estrogen	0.43**	0.27*
Progesterone	–0.04	0.07
Testosterone	–0.22	0.11
Prolactin	–0.28	0.04
LH	0.22	0.11

* $p < .05$.

** $p < .01$.

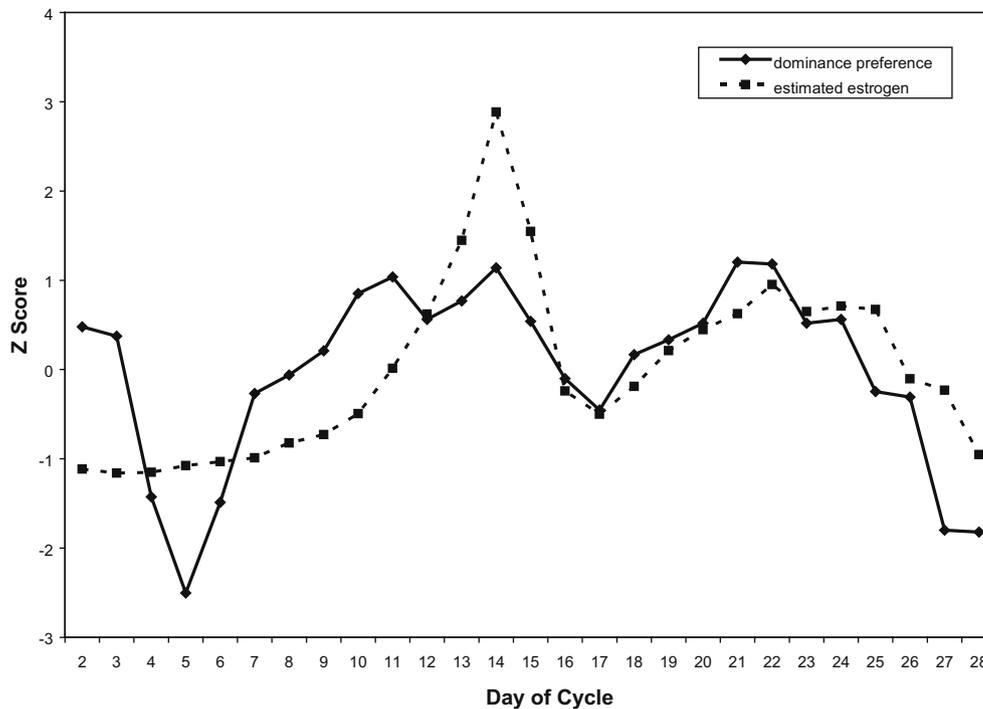


Fig. 1. Women's dominance preferences (collapsed across rating contexts) and estimated estrogen concentrations as a function of cycle day. Preference values are three-day moving averages and both variables are standardized in order to depict them on the same axis.

preferences for trustworthiness and kindness were not correlated with any hormones and are not discussed further.

3.2. Results for ratings of long-term mate attractiveness

Among the sub-sample of women not using hormonal contraceptives who rated traits for long-term mate attractiveness ($n = 42$), the zero-order correlation between estimated estrogen and dominance preference was marginally significant, $r = .30$, $p = .057$. However, the effect of estrogen became much stronger when dominance preferences were simultaneously regressed on all of the hormones presented in Table 1, $\beta = .57$, $p = .008$ (no other hormones exerted significant influences in this model). Fig. 2A suggests that this estrogen effect was generated as much by an elevation of dominance preferences in the mid-luteal phase (when estrogen is also elevated) as by an elevation during the fertile window; consistent with this, the size of the zero-order correlation between estrogen and dominance preference became slightly larger when analyses were restricted to women tested during the luteal phase ($n = 17$), $r = .37$, $p = .145$.

3.3. Results for ratings of short-term mate attractiveness

A somewhat different pattern emerged among the sub-sample of women who rated traits for short-term mate attractiveness ($n = 50$). The zero-order correlation between estimated estrogen and dominance preference was positive but not significant, $r = .22$, $p = .13$, whereas both estimated LH, $r = .31$, $p = .03$, and estimated FSH, $r = .30$, $p = .032$ were significantly correlated with dominance preferences. When dominance preferences were regressed on all of the hormones presented in Table 1, there was a marginally significant positive effect only for LH, $\beta = .47$, $p = .081$. When FSH was substituted for LH in the model, FSH became the only significant predictor of dominance preferences, $\beta = .44$, $p = .043$ (the influence of estrogen in this model was positive but not significant, $\beta = .33$, $p = .174$). Fig. 2B suggests that this LH/FSH effect was likely

a product of the sharp mid-cycle peak in dominance preferences seen among women rating for short-term mate attractiveness.

4. Discussion

This study is the first to demonstrate that women's self-reported preferences for dominant personality traits fluctuate across the menstrual cycle. For both ratings of long-term mate attractiveness and for the results collapsed across rating contexts, preferences for dominance were highest on cycle days when estrogen tends to be highest; for ratings of short-term mate attractiveness, these preferences were strongest on days when LH and FSH are typically elevated. Estimated hormones were not correlated with dominance preferences among women using hormonal contraceptives, which provides further evidence that the observed cycle phase shifts were causally related to hormonal fluctuations as opposed to other variables that were associated with day of cycle (e.g., proximity to menstruation). In addition, cycle phase shifts were restricted to dominance preferences, as estimated hormone values failed to predict preferences for kindness and trustworthiness. This selectivity in cycle phase shifts complements findings from Gangestad et al. (2007) who reported stronger attraction to perceived competitiveness but not perceived investment-related traits (warm, financially successful) among women tested closer to ovulation.

The positive results for estrogen complement other recent studies that have provided evidence that women's attractiveness judgments may track fluctuations in estrogen (Garver-Apgar et al., 2008; Roney & Simmons, 2008; but for negative findings, see Jones et al., 2005a; Puts, 2006; Welling et al., 2007). Other research is likewise converging in finding broad effects of estrogen on aspects of women's mood and cognition (for a review, see Soares & Zitek, 2008). The conjunction of these findings raises interesting questions regarding whether the effects of estrogen on mood, cognition, and mating psychology may interact or mediate one another, and investigations of these possibilities present opportunities for future research. Estrogen associations with personality preferences

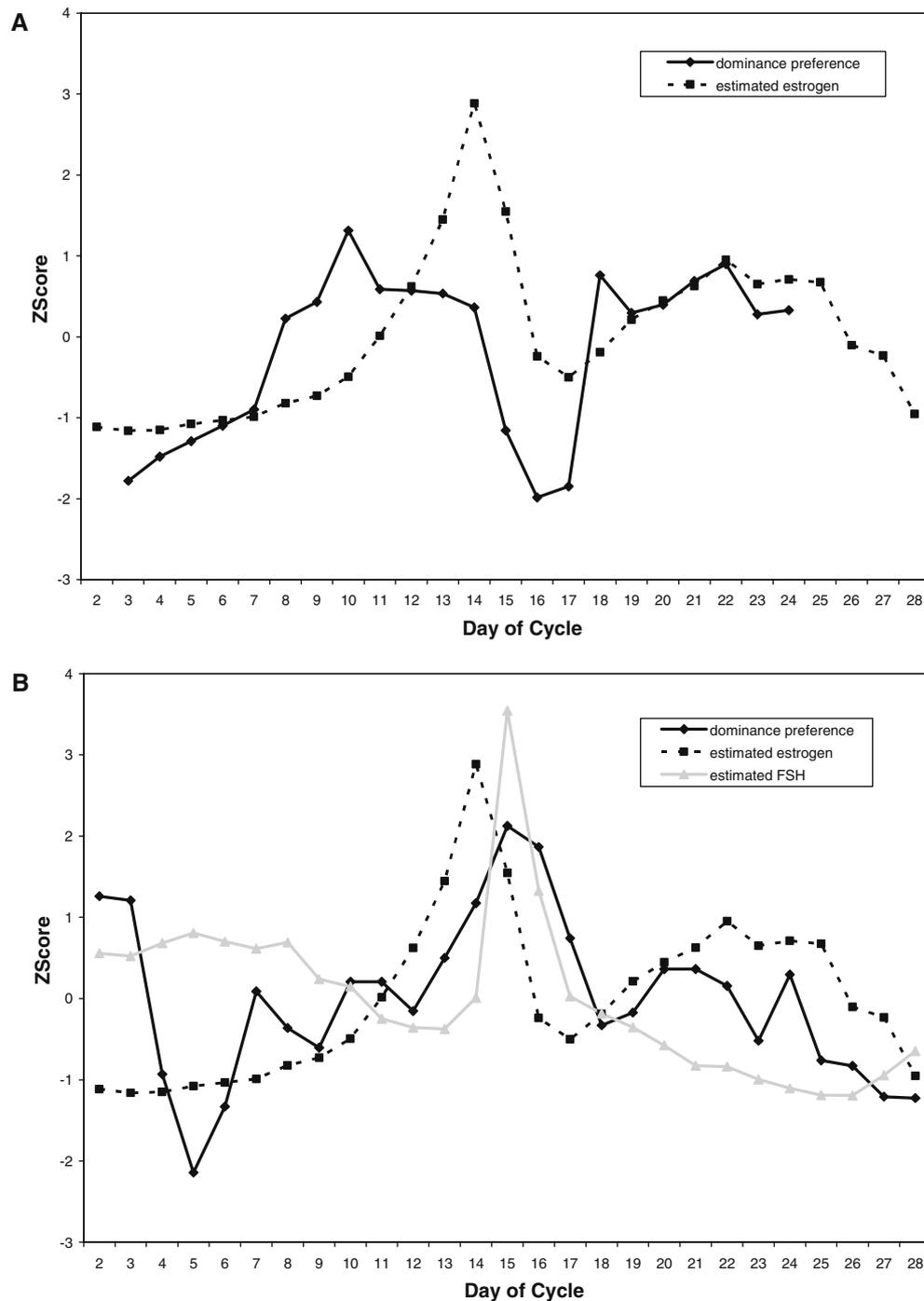


Fig. 2. Women's dominance preferences and estimated hormone concentrations as a function of day of cycle. Preference values are three-day moving averages and all variables are standardized. (A) Women rating for long-term mate attractiveness. (B) Women rating for short-term mate attractiveness (LH is not depicted, but peaks on the same day as FSH).

also pose the possibility that such preferences may shift during pregnancy when estrogen concentrations are known to rise dramatically; although one could imagine pregnancy-specific signals that prevent such effects, this is an empirical issue that presents another interesting avenue for future research (for evidence of other preference shifts during pregnancy, see Jones et al., 2005b).

4.1. Implications for functional theories of menstrual phase shifts in preferences

Our findings did not unambiguously support either mixed-mating or between-cycle theory, and may instead support a hybrid

model that combines elements of both theories. In particular, the results for ratings of long-term mate attractiveness (and for the combined ratings) appear more consistent with the predictions of between-cycle theory, whereas the findings for short-term attractiveness judgments appear more consistent with the predictions of mixed-mating theory.

Between-cycle theory proposes mechanisms that read estrogen concentrations as evidence of the fertility of a current cycle in order to up-regulate scrutiny of men's sexual attractiveness in more vs. less fertile cycles. The theory posits a simple prediction that higher estrogen will be associated with stronger attraction to components of sexual attractiveness, regardless of whether the

estrogen elevations occur during the fertile window. Our findings for ratings of long-term mate attractiveness (and for results collapsed across rating contexts) were consistent with this prediction, as we found elevated preferences for dominance on days when estrogen tends to be elevated, including during parts of the luteal phase when conception is not possible. Mixed-mating theory does not directly predict such luteal phase preference elevations, although the luteal phase patterns could be by-products of a mechanism that uses estrogen to index the timing of the fertile window. In sum, the results for ratings of long-term attractiveness were directly consistent with the predictions of between-cycle theory, but might also be explained as by-products of the mechanisms proposed by mixed-mating theory.

Preferences for dominance in short-term mates, on the other hand, were more tightly coupled to the fertile window, with a pronounced peak on the days that LH and FSH are typically peaking. This pattern is consistent with mixed-mating theory's postulation of evaluative mechanisms that hone in on markers of phenotypic quality in potential sexual partners on the precise days of the cycle that conception is most likely. In conjunction with the findings for long-term ratings, then, our overall findings are consistent with the existence of two general types of mechanisms: a between-cycle mechanism that reads estrogen concentrations and operates specifically on judgments of potential long-term mates, and a within-cycle mechanism that reads hormonal signals associated with the fertile window and operates specifically on judgments of potential short-term sexual partners.

4.2. Limitations and conclusions

One limitation of this study was its use of a cross-sectional design in which women were tested once on a single cycle day. Evidence for within-cycle shifts would be more compelling with a within-subjects design in which the same women are tested multiple times across different cycle days. Likewise, the most direct tests of between-cycle effects would come from studies in which the same women are assessed across different cycles that vary in their hormone concentrations. Despite these limitations, the cross-sectional data nonetheless add evidence regarding the possible hormonal regulation of cycle phase shifts and demonstrate patterns that may productively guide hypotheses in designing more extensive within-subject studies. The pattern of dominance preferences depicted in Fig. 1, for instance, strongly suggests that preference shifts may not be restricted to the fertile window and thus recommends the importance of designing future studies that can both detect and explain preference shifts in other regions of the cycle.

A second limitation of this study is its use of estimated hormone values in conjunction with counting methods to determine day of cycle. Because some hormones concentrations exhibit transient peaks on specific cycle days, errors of even one or two days in estimated day of cycle can potentially alter correlations between estimated hormones and preferences. Notice, however, that the co-variation between estimated estrogen and preference judgments across cycle days in this study (Figs. 1 and 2A) was very similar to results reported in a study that measured women's actual estrogen concentrations (Roney & Simmons, 2008; but see Welling et al., 2007). In addition, random measurement error associated with estimation should be attenuated as sample size increases, and thus the patterns depicted among 92 women in Fig. 1 may represent

a reasonable approximation of how preferences for dominance fluctuate across the cycle. Therefore, although these results should be replicated with actual hormone measurements, the findings nonetheless add evidence regarding the proximate signals that regulate cycle phase shifts, and suggest that both between and within-cycle mechanisms may contribute to temporal fluctuations in women's attractiveness judgments.

References

- Alliende, M. E. (2002). Mean versus individual hormone profiles in the menstrual cycle. *Fertility and Sterility*, 78, 90–95.
- DeBruine, L. M., Jones, B. C., & Perrett, D. I. (2005). Women's attractiveness judgments of self-resembling faces change across the menstrual cycle. *Hormones and Behavior*, 47, 379–383.
- Ellison, P. T. (2001). *On fertile ground: A natural history of human reproduction*. Cambridge, MA: Harvard University Press.
- Fehring, R. J., Schneider, M., & Ravele, K. (2006). Variability in the phases of the menstrual cycle. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, 35, 376–384.
- Gangestad, S. W., Garver-Apgar, C. E., Simpson, J. A., & Cousins, A. J. (2007). Changes in women's mate preferences across the ovulatory cycle. *Journal of Personality and Social Psychology*, 92, 151–163.
- Gangestad, S. W., Simpson, J. A., Cousins, A. J., Garver-Apgar, C. E., & Christensen, P. N. (2004). Women's preferences for male behavioral displays change across the menstrual cycle. *Psychological Science*, 15, 203–207.
- Gangestad, S. W., & Thornhill, R. (2008). Human oestrus. *Proceedings of the Royal Society of London B*, 275, 991–1000.
- Garver-Apgar, C. E., Gangestad, S. W., & Thornhill, R. (2008). Hormonal correlates of women's mid-cycle preferences for the scent of symmetry. *Evolution and Human Behavior*, 29, 223–232.
- Jones, B. C., DeBruine, L. M., Perrett, D. I., Little, A. C., Feinberg, D. R., & Law Smith, M. J. (2008). Effects of menstrual cycle phase on face preferences. *Archives of Sexual Behavior*, 37, 78–84.
- Jones, B. C., Little, A. C., Boothroyd, L., DeBruine, L. M., Feinberg, D. R., Law Smith, M. J., et al. (2005a). Commitment to relationships and preferences for femininity and apparent health in faces are strongest on days of the menstrual cycle when progesterone level is high. *Hormones and Behavior*, 48, 283–290.
- Jones, B. C., Perrett, D. I., Little, A. C., Boothroyd, L., Cornwell, R. E., Feinberg, D. R., et al. (2005b). Menstrual cycle, pregnancy and oral contraceptive use alter attraction to apparent health in faces. *Proceedings of the Royal Society of London B*, 272, 347–354.
- Lipson, S. F., & Ellison, P. T. (1996). Comparison of salivary steroid profiles in naturally-occurring conception and non-conception cycles. *Human Reproduction*, 11, 2090–2096.
- Penton-Voak, I. S., Perrett, D. I., Castles, D., Burt, M., Koyabashi, T., & Murray, L. K. (1999). Menstrual cycle alters face preference. *Nature*, 399, 741–742.
- Puts, D. A. (2006). Cyclic variation in women's preferences for masculine traits. *Human Nature*, 17, 114–127.
- Roney, J. R. (2009). The role of sex hormones in the initiation of human mating relationships. In P. B. Gray & P. T. Ellison (Eds.), *The endocrinology of social relationships* (pp. 246–269). Cambridge, MA: Harvard University Press.
- Roney, J. R., & Simmons, Z. L. (2008). Women's estradiol predicts preference for facial cues of men's testosterone. *Hormones and Behavior*, 53, 14–19.
- Sadalla, E. K., Kenrick, D. T., & Vershure, B. (1987). Dominance and heterosexual attraction. *Journal of Personality and Social Psychology*, 52, 730–738.
- Soares, C. N., & Zitek, B. (2008). Reproductive hormone sensitivity and risk for depression across the female life cycle: A continuum of vulnerability? *Journal of Psychiatry Neuroscience*, 33, 331–343.
- Strassmann, B. I. (1997). The biology of menstruation in homo sapiens: Total lifetime menses, fecundity, and nonsynchrony in a natural fertility population. *Current Anthropology*, 38, 123–129.
- Stricker, R., Eberhardt, R., Chevallier, C., Quinn, F. A., Bischof, P., & Stricker, R. (2006). Establishment of detailed reference values for luteinizing hormone, follicle stimulating hormone, estradiol, and progesterone during different phases of the menstrual cycle on the Abbott ARCHITECT analyzer. *Clinical Chemistry and Laboratory Medicine*, 44, 883–887.
- Trapnell, P. D., & Wiggins, J. S. (1990). Extensions of the interpersonal adjective scales to include the big five dimensions of personality. *Journal of Personality and Social Psychology*, 59, 781–790.
- 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 is associated with increased attention to masculine faces. *Hormones and Behavior*, 52, 156–161.