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Changes in women's feelings about their romantic relationships across the ovulatory cycle

Christina M. Larson [a,*], Martie G. Haselton [a,b], Kelly A. Gildersleeve [a], Elizabeth G. Pillsworth [c,1]

[a] Department of Psychology, University of California, Los Angeles, 1285 Franz Hall University of California, Los Angeles Box 951563, Los Angeles, CA 90095, USA
[b] Department of Communication Studies, University of California, Los Angeles, 2303 Rolfe Hall University of California, Los Angeles Box 951538, Los Angeles, CA 90095, USA
[c] Department of Anthropology, University of California, Los Angeles, 341 Haines Hall University of California, Los Angeles Box 951553, Los Angeles, CA 90095, USA

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ABSTRACT

According to the dual mating hypothesis, women possess two overlapping suites of mate-choice mechanisms: one leading to preferences for sexually desirable men who have high-fitness genes and one leading to preferences for men who are able to invest in a woman and her children. Evidence increasingly demonstrates that women's preference for sexual desirability (but not investment attractiveness) increases when women are most fertile within the ovulatory cycle. Little is known, however, about the implications of these preference shifts for women's relationships with their long-term partners. Using luteinizing hormone tests to verify ovulation, across two studies (Samples 1 and 2), we found that women whose partners were relatively low in sexual desirability felt less close to their partner (Samples 1 and 2) and were more critical of their partner's faults (Sample 2) on high-fertility days of the cycle just prior to ovulation compared with low-fertility days of the cycle. Women whose partners were relatively high in sexual desirability felt closer to their partner (Sample 1) and more satisfied with their relationship (Sample 2) on high- than low-fertility days of the cycle. There were no such shifts in women's commitment to their relationship. Therefore, partner sexual desirability predicts women's high-fertility assessments of relationship quality but not their intentions to stay in their relationship, consistent with the dual mating hypothesis. These findings suggest that variations across the ovulation cycle in women's reproductive hormones play an important role in relationship dynamics.

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Introduction

A growing body of research indicates that women's mate preferences and attractions shift systematically across the ovulation cycle (reviewed by Gangestad and Thornhill, 2008; Haselton and Gildersleeve, 2011). This raises the question of whether there are corresponding changes across the cycle in women's feelings about their long-term romantic relationship. Virtually no prior work has investigated this question, despite romantic relationship feelings being central to the study of human behavior. We present evidence from two studies involving multiple assessments of women's relationship feelings and rigorous measures of cycle position. The studies show that women's feelings about their long-term relationship do change across the cycle. We report findings that suggest that variations across the cycle in women's reproductive hormones might play an important role in romantic relationship dynamics.

Many studies have demonstrated that women express stronger preferences for male characteristics that are hypothesized indicators of high-fitness genes on high- relative to low-fertility days of the cycle (reviewed in DeBruine et al., 2010; Thornhill and Gangestad, 2008). These characteristics include masculine faces (reviewed in DeBruine et al., 2010), masculine bodies (Gangestad et al., 2007; Little, et al., 2007), and the natural body odors of men who have symmetrical faces and bodies (Gangestad and Thornhill, 1998; Rikowski and Grammer, 1999; Thornhill and Gangestad, 1999; Thornhill et al., 2003). These characteristics are associated with men's sexual attractiveness and men's desirability as short-term sex partners (Frederick and Haselton, 2007; Gangestad and Thornhill, 1997; Gangestad et al., 2007), and, indeed, increased preferences for sexually desirable characteristics at high-fertility are particularly pronounced—and sometimes only present—when women are considering men as short-term sex partners, rather than long-term relationship partners

* Corresponding author at: 2455 Franz Hall Department of Psychology, University of California, Los Angeles, Los Angeles, CA 90095, USA. Fax: +1 310 206 2371.
E-mail addresses: cmlarson1@ucla.edu (C.M. Larson), haselton@ucla.edu (M.G. Haselton), kellygildersleeve@gmail.com (K.A. Gildersleeve), epillsworth@fullerton.edu (E.G. Pillsworth).
[1] Present address: Department of Anthropology, California State University Fullerton. 800N. State College Boulevard Fullerton, CA 92831-3547, USA.

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(Gangestad et al., 2004, 2007; Little et al., 2007; Penton-Voak et al., 1999). In contrast, women's preferences for characteristics that are desirable in a long-term romantic partner but are not strongly associated with sexual desirability, such as warmth, financial success, and faithfulness, either do not change across the cycle or are *weaker* on high- than low-fertility days of the cycle (Gangestad et al., 2007; Lukaszewski and Roney, 2009).

These preference shifts have been explained in terms of the *dual mating hypothesis*, which entails the notion that women's mate preferences serve two functions (Haselton and Gangestad, 2006; Pillsworth and Haselton, 2006b; Thornhill and Gangestad, 2008). First, women's choices of long-term relationship partners influenced the material and social resources available to their children. All else being equal, an ancestral woman who formed a relationship with a man who invested highly in her and her children probably had children who were more likely to survive than the children of a woman who had a less investing partner (Buss, 1994; Pillsworth and Haselton, 2006b). Therefore, it is plausible that women possess evolved preferences for long-term relationship partners who are high in *investment attractiveness* (possessing characteristics that indicate they are able to invest highly in a woman and her children).

Second, ancestral women's choices of sex partners influenced the genes her future children could inherit. All else being equal, a woman who conceived children with men who possessed high fitness genes (e.g., relatively free of deleterious genetic mutations) probably had children who were more likely to survive and later reproduce than the children of a woman who chose a less genetically fit partner (Gangestad and Simpson, 2000). Therefore, it is also plausible that women possess adaptive preferences for sex partners who are high in *sexual desirability* (possessing characteristics that indicate they have high-fitness genes they can pass on to offspring). Sexually desirable characteristics such as symmetry and masculinity are hypothesized to have been indicators of high-fitness genes in men in ancestral environments (Gangestad and Simpson, 2000). For example, a recent meta-analyses found that men's symmetry was a small but robust predictor of a number of fitness-relevant outcomes, such as health and sex partner number (Van Dongen and Gangestad, 2011).

Because women can only secure genetic benefits for offspring when fertile, the logic of the dual mating hypothesis leads to the prediction that women's preference for sexually desirable characteristics that ancestrally indicated high-fitness genes will be greatest within the fertile window of the ovulatory cycle (Pillsworth and Haselton, 2006b; Thornhill and Gangestad, 2008). In contrast, because women could secure material and social benefits for offspring throughout the cycle, the dual mating hypothesis leads to no expectation that women's preference for characteristics contributing to a man's investment attractiveness will shift across the cycle. These predictions have been supported by a number of studies (reviewed in DeBruine et al., 2010; Thornhill and Gangestad, 2008).

The dual mating hypothesis has implications for women's long-term romantic relationships. An ancestral woman who partnered with a man who was high in sexual desirability and investment attractiveness could have gained both genetic and investment benefits from a single long-term relationship. In contrast, an ancestral woman partnered with a man who was high in investment attractiveness but low in sexual desirability could have enhanced her reproductive success through engaging in surreptitious sexual affairs with men other than her primary partner on high-fertility days of the cycle (Gangestad and Simpson, 2000; Pillsworth and Haselton, 2006b; Thornhill and Gangestad, 2008). Consistent with this logic, women in relationships with men who lack characteristics hypothesized to indicate high-fitness genes report feeling more attracted to men other than their primary partner on high-relative to low-fertility days of the cycle (reviewed in Larson, et al., 2012; also see Puts et al., 2012a, 2012b; Thornhill et al., 1995 for related evidence).

Changes in relationship feelings

Whether these fertility-based changes in preferences and desires across the cycle affect women's long-term romantic relationships remains unknown. Based on the research described above, one might expect that women's feelings about their relationship will also change across the cycle, such that women partnered with men who are relatively low in sexual desirability will feel more negatively about their relationship at high relative to low fertility.

Only one prior study examined changes in women's relationship feelings across the cycle. Jones and colleagues asked 93 naturally cycling women how happy and committed they were in their romantic relationship and estimated each woman's progesterone and estrogen levels based on women's recalled last menstrual onset (Jones et al., 2005). They did not observe a significant association between relationship happiness and estimated hormone levels, but found a positive association between relationship commitment and estimated progesterone levels, suggesting that women's commitment to their relationship might change across the cycle. However, the study used a forward-counting method relying on a women's recalled last menstrual onset, which can be imprecise (Chiazze et al., 1968; Fehring et al., 2006; Waller et al., 2000). The study also did not examine whether the women in the study had partners who possessed the characteristics women find especially attractive at high fertility. This important factor is likely to moderate changes in women's relationship feelings across the cycle. Given these issues, how women's relationship feelings change across the cycle and for which women these changes are most pronounced remain open questions.

The current research

In a set of two similar studies (presented as Sample 1 and Sample 2), we examined how women's feelings about their relationship changed across the ovulation cycle and whether these changes depended on women's ratings of their partner's sexual desirability. Women rated their relationship along various dimensions at high and low fertility. This within-woman design eliminates noise created by between-women variation, therefore providing a sensitive test of changes across the cycle. Hormone tests confirmed that all women in the sample ovulated near their high-fertility session, indicating that all putatively high-fertility sessions were, in fact, scheduled on high-fertility days of the cycle. Details on participant characteristics and scheduling presented separately for each sample can be found in the supplemental materials.

Methods

Participants

Participants were 108 heterosexual women involved in a romantic relationship (41 from Sample 1, 67 from Sample 2). None of the participants had used any form of hormonal contraceptives within the past three months (e.g., birth control pills, Norplant, vaginal ring, birth control patch, Depo-Provera, Mirena IUD), nor were they pregnant or breastfeeding a child. All participants reported regular menstrual cycles lasting 25 to 33 days. Participants were recruited from the UCLA campus and participated for payment or to fulfill course research requirements. On the basis of an ovulation test (Clearblue™ Easy Ovulation Test), we verified that participants experienced a luteinizing hormone (LH) surge between 2 days before and 3 days after their high-fertility session. Evidence of an LH surge using these

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tests is 97% concordant with ovulation confirmed by ultrasonography (Guermandi et al., 2001).[2]

The mean age of participants was 21.0 years ($SD = 4.1$, range = 17–40); 45.4% of the participants self-identified as Asian, 18.5% as Hispanic, 14.8% as Caucasian, 3.7% as African American, and 17.6% as "other" or multiple ethnicities. All women reported being involved in a committed, heterosexual romantic relationship. Mean relationship length was 23.4 months ($SD = 24$, range = 1–192 months).

Procedure

Participants in Sample 1 completed an initial session during which they provided informed consent, information about their menstrual cycles, and responses to several computer-based demographic and partner rating questionnaires, whereas participants in Sample 2 provided menstrual cycle information during a preliminary phone interview, and then provided informed consent and responses to demographic and partner rating questionnaires during their first session. All other procedures in the high- and low-fertility sessions were identical. All participants rated their relationship along various dimensions during both a high-fertility session and a low-fertility session. Women took a series of LH tests on the days surrounding their high-fertility session. At the final session, all participants were debriefed and paid.

Scheduling and LH testing

During the initial session for Sample 1 and the preliminary phone interview for Sample 2, women answered questions about their cycle regularity, cycle length, previous two dates of menstrual onset, and anticipated date of next menstrual onset. Following the methods of Gangestad et al. (2002), we used this information to schedule women for two sessions—one occurring during a high-fertility phase of the cycle and the other occurring during a low-fertility phase of the cycle. Fifty-seven women completed their high-fertility session first (53%) and the remaining 51 completed their low-fertility session first. Order of session was determined by women's cycle point during the initial session or the preliminary phone interview, and is controlled for in the analyses below.

Because ovulation typically occurs 14 to 15 days prior to menstrual onset (Wilcox et al., 1995), high-fertility sessions were scheduled to occur between 16 and 19 days prior to predicted next menstrual onset. This resulted in high-fertility sessions occurring, on average, 16.6 days before next menstrual onset ($SD = 1.7$, range = 13–20). Beginning two days before their high-fertility session, women took daily midstream urine LH tests for five days. Ovulation typically occurs 24 to 48 hours after an LH surge (Guermandi et al., 2001). An LH surge was observed, on average, 0.4 days after the high-fertility session ($SD = 1.4$). Low-fertility sessions were scheduled to occur in the luteal phase of the cycle, 3 to 10 days prior to predicted menstrual onset. This resulted in low-fertility sessions occurring, on average, 6.4 days before next menstrual onset ($SD = 2.8$, range = 0–12). The day of ovulation and the five days beforehand constitute the high-fertility phase of the cycle (Jöchle, 1973; Wilcox et al., 1995). Therefore, all women in our sample were in the high-fertility phase of their cycle at their high-fertility session, and none were in the high-fertility phase during their low-fertility session.

At their final session, participants were given postcards to return to the lab to report the date of their next menstrual onset. Participants also informed the lab of the date of menstrual onset between their low- and high-fertility sessions if they completed their low-fertility session first. The number of days prior to menstrual onset reported above is based on a confirmed date of menstrual onset for 77.7% of sessions. In all other cases, calculations are based on an estimate of the next menstrual onset calculated using menstrual cycle information provided by women at the initial session or the preliminary phone interview.

Partner ratings

Both samples of participants rated their partners along dimensions hypothesized to indicate high-fitness genes. For Sample 1 we assessed women's ratings of their partner's sexual attractiveness using a four-item measure (e.g. "How desirable do you think women find your partner as a short-term mate or casual sex partner, compared to most men" and "How sexy would women say your partner is, compared to most men"). Because women find hypothesized indicators of high-fitness genes sexually attractive, previous research has used partner sexual attractiveness as a proxy for partner heritable fitness (Haselton and Gangestad, 2006; Larson et al., 2012; Pillsworth and Haselton, 2006a). For Sample 2 we assessed women's ratings of their partner's desirability as a mate using a nineteen-item measure (e.g. "Members of the opposite sex are attracted to him" and "He can have as many sexual partners as he wants"; adapted from Lalumiere et al., 1996). This questionnaire included women's ratings of their partner's sexual attractiveness and also included items assessing women's perceptions of their partner's ability to attract women and obtain multiple dating and sex partners.

For Sample 1 we also assessed women's ratings of their partner's investment attractiveness using a five-item measure (e.g. "How desirable do you think women find your partner as a long-term mate or marriage partner, compared to most men" and "Compared with most men, what is your partner's present financial status").

The full sets of items used for Samples 1 and 2 can be found in the supplemental materials.

High- and low-fertility relationship ratings

At both their high- and low-fertility sessions, participants in both samples rated their current feelings about their romantic relationship. Several scales were added to the questionnaire after some women in Sample 2 had completed participation; therefore, only 43 participants from Sample 2 completed these items. The full scales used for Samples 1 and 2 can be found in the supplemental materials.

Inclusion of other in self

Participants in both samples completed the Inclusion of Other in Self (IOS) scale to assess feelings of interconnectedness and interpersonal closeness between a woman and her partner (Aron et al., 1992). The IOS is a series of seven pairs of circles corresponding to self and other. The self and other circles range from barely touching to almost completely overlapping. Participants in Sample 1 were asked to think about how they felt about their relationship with their partner over the last 48 hours before choosing the pair of circles that best represented their relationship with their partner. Participants in Sample 2 were not asked to refer to any specific time frame when completing this item.

[2] We originally recruited 191 women to participate, but later excluded 83 women from analyses (32 from Sample 1, 51 from Sample 2). Women were excluded because they failed to complete all study sessions ($n = 25$), they showed no evidence of an LH surge ($n = 12$), or their high- or low-fertility sessions did not occur during predetermined high- or low-fertility windows as defined in the *Scheduling and LH testing* section ($n = 46$). Sessions did not occur during predetermined scheduling windows either because participants were unavailable on those days or because predicted high- and low-fertility windows differed from actual high- and low-fertility windows as determined using the date of next menstrual onset following participation (see the *Scheduling and LH testing* section). Of the women who completed all parts of the study, 65.1% were eligible for inclusion in the analyses, a retention rate that is comparable to previous studies using similar inclusion criteria (e.g., 74.1% in Pillsworth and Haselton, 2006a; 61.4% in Gangestad et al., 2002). Age, ethnicity, and relationship length did not significantly differ between women excluded from the analyses and women retained in the sample (p's > .10).

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Satisfaction

Participants in both samples completed measures of relationship satisfaction over the past 48 hours, relative to other days. Items were rated on a scale from −4 (*far less than usual*) to 4 (*far more than usual*). In Sample 1, participants completed a four-item satisfaction measure we created for use in this study. In Sample 2, participants completed three items from the Rusbult Investment Model Scale (Rusbult et al., 1998), a well-validated measure common in the relationships literature.

Partner faults and virtues

Participants in Sample 2 rated their partners' faults and virtues. Using items from the Interpersonal Qualities Scale (Murray et al., 1996), women rated how well a series of traits described their partner on a scale from 1 (*not at all characteristic*) to 9 (*completely characteristic*). Ten traits were classified as faults, and ten traits were classified as virtues.

Commitment

Participants in both samples completed measures of relationship commitment over the past 48 hours, relative to other days. Items were rated on a scale from −4 (*far less than usual*) to 4 (*far more than usual*). In Sample 1, participants completed a two-item measure we created for use in this study. In Sample 2, participants completed three items from the Rusbult Investment Model Scale (Rusbult et al., 1998).

Quality of alternatives

Participants in Sample 2 completed measures of their perceptions of the quality of their alternative dating partners over the past 48 hours, relative to other days. Items were rated on a scale from −4 (*far less than usual*) to 4 (*far more than usual*). In Sample 2, participants completed two items from the Rusbult Investment Model Scale (Rusbult et al., 1998).

Predictions

Women's preferences for men's sexually desirable characteristics increase as ovulation approaches within the cycle. Therefore, we predicted that women's ratings of partner sexual desirability would be a key moderator of fertility-contingent changes in relationship feelings, such that women's feelings about their relationship would be more negative at high than low fertility if they rated their partner as relatively low in sexual desirability. We expected this pattern for several measures of relationship quality: relationship closeness (as measured by the IOS), relationship satisfaction, and ratings of partner faults and virtues. We included women's ratings of partner faults and virtues as assessments of relationship quality because individuals who are highly satisfied with their relationships tend to view their partners in an idealized manner, reporting that their partners possess many of these virtues and few of these faults (Murray et al., 1996).

To show that changes across the cycle in ratings of relationship quality depended specifically on the extent to which a woman finds her partner sexually desirable, in Sample 1 we also included ratings of partner investment attractiveness. Previous work has shown that women's preferences for characteristics associated with investment attractiveness do not change across the ovulatory cycle (Gangestad et al., 2007). Therefore, we predicted that ratings of partner investment attractiveness would not moderate changes in women's relationship feelings across the cycle.

We did not advance firm predictions about whether women's feelings of commitment to their relationship would change across the cycle. Because relationship satisfaction is one factor that influences relationship commitment (Rusbult et al., 1998), one could predict that women's feelings of commitment would change across the cycle if their assessments of relationship quality change. However, a primary tenet of the dual mating hypothesis is that ancestral women attempted to maintain their primary relationship to ensure continued investment, even if they pursued short-term sexual affairs with men other than their partner near ovulation. One could therefore predict that women would remain committed to their long-term relationship across the cycle.

We also did not advance firm predictions about whether women's assessments of the quality of alternative dating partners would shift across the cycle. Relationships researchers conceptualize the quality of alternatives to a relationship as the "extent to which [an] individual's most important needs could effectively be fulfilled outside of the current relationship" (Rusbult et al., 1998, p. 359). If the criteria women use to evaluate men's attractiveness change across the ovulation cycle, then their perceptions of the availability of potential relationship partners might also change. Therefore, although we did not make predictions about perceptions of the quality of alternative relationship partners across the cycle, we included it as an exploratory variable.

Statistical analyses

Using repeated measures analysis of variance (ANOVA; SPSS 17.0), we analyzed changes in the dependent measures across the cycle. For all analyses, fertility status (high or low fertility) was a within-subjects repeated measure. Order of sessions (high or low first) was entered as a between-subjects factor. Partner ratings were included as covariates to investigate whether changes across the ovulatory cycle were moderated by partner ratings. Partner ratings were zero centered so that the main effect of fertility would be estimated at the mean levels of partner ratings. When the interactions between fertility and partner ratings were significant, simple effects analogs were run re-centering partner ratings at one standard deviation below the mean and one standard deviation above the mean. This allows for an estimation of the effects of fertility among women with low levels of partner attractiveness and among women with high levels of partner attractiveness. For Sample 1, sexual attractiveness and investment attractiveness were entered simultaneously in order to assess the unique contribution of each type of attractiveness to changes across the cycle.

For analyses in which we had an a priori hypothesis about the direction of the effect, we used directed tests as recommended by Rice and Gaines (1994). Directed tests allocate a probability of 0.04 (of a total α of 0.05) to the predicted direction and 0.01 to the unpredicted direction, thereby increasing the power to find anticipated effects without eliminating the possibility of finding an effect in the unpredicted direction (in contrast to a one-tailed test). All other analyses are traditional two-tailed tests, which allocate a probability of 0.025 to both tails. When directed p values are reported, they are noted. Because of straightforward directional predictions and the challenging nature of collecting large samples of women who are followed throughout the cycle, previous studies documenting changes across the cycle have used directed tests for predicted effects (e.g. Gangestad et al., 2002, 2007; Garver-Apgar et al., 2006; Gildersleeve et al., 2012; Haselton and Gangestad, 2006; Thornhill and Gangestad, 1999).

The supplementary materials contain reports of additional control variables initially entered and later removed from the analyses, additional analyses of effects involving order of participation, main effects of partner ratings on relationship assessments, descriptive statistics, and correlations between all relationship quality and partner rating variables.

Results

Inclusion of other in self

Sample 1

There was no main effect of fertility on women's feelings of self-other overlap, F (1, 37) = 0.42, p_{dir} = .32, partial η^2 = .01. As

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predicted, the key interaction between fertility and partner sexual attractiveness was significant, F (1, 37) = 17.04, p_{dir} < .001, partial η^2 = .32. As Fig. 1 shows, the less sexually attractive women rated their partner, the less self-other overlap they felt at high compared to low fertility (partial r = .56, p_{dir} < .001). Follow-up analyses revealed that when ratings of partner sexual attractiveness were one standard deviation below the mean, women reported significantly less self-other overlap at high than low fertility, F (1, 37) = 12.85, p_{dir} < .001, partial η^2 = .26 (marginal mean at high fertility = 4.55, SD = 0.38; marginal mean at low fertility = 5.52, SD = 0.38). However, when ratings of partner sexual attractiveness were one standard deviation above the mean, women reported significantly more self-other overlap at high than low fertility, F (1, 37) = 6.09, p = .02, partial η^2 = .14 (marginal mean at high fertility = 5.36, SD = 0.42; marginal mean at low fertility = 4.64, SD = 0.40). This pattern indicates that changes in feelings of closeness were driven by both decreased closeness at high fertility among women with less sexually attractive partners and increased closeness at high fertility among women with more sexually attractive partners.

The parallel interaction between fertility and partner investment attractiveness was marginally significant, F (1, 37) = 3.93, p = .06, partial η^2 = .10. As Fig. 2 shows, the *more* attractive as an investment partner women rated their partner, the less self-other overlap they felt at high compared to low fertility (partial r = −.31, p = .06). Follow-up analyses revealed that when ratings of partner investment attractiveness were one standard deviation below the mean, women's reports of self-other overlap did not differ significantly between high and low fertility, F (1, 37) = 0.93, p = .34, partial η^2 = .02 (marginal mean at high fertility = 4.87, SD = 0.41; marginal mean at low fertility = 4.59, SD = 0.40). However, when ratings of partner investment attractiveness were one standard deviation above the mean, women reported marginally significantly less self-other overlap at high than low fertility, F (1, 37) = 3.75, p = .06, partial η^2 = .09 (marginal mean at high fertility = 5.04, SD = 0.39; marginal mean at low fertility = 5.57, SD = 0.38). This pattern indicates that changes in feelings of closeness were driven by decreased closeness at high fertility among women with partners who were higher in investment attractiveness.

Sample 2

There was no main effect of fertility on women's feelings of self-other overlap, F (1, 40) = 0.33, p_{dir} = .36, partial η^2 = .01. As in Sample 1, and as predicted, the key interaction between fertility and partner mating desirability was significant, F (1, 40) = 3.73, p_{dir} = .04, partial η^2 = .09. As shown in Fig. 3, the less desirable women rated their partner, the less self-other overlap they felt at high compared to low fertility (partial r = .29, p_{dir} = .04). Similar to Sample 1, follow-up analyses revealed that when ratings of partner mating desirability were one standard deviation below the mean, women reported marginally significantly less self-other overlap at high than low fertility, F (1, 40) = 3.03, p_{dir} = .06, partial η^2 = .07 (marginal mean at high fertility = 4.84, SD = 0.32; marginal mean at low fertility = 5.14, SD = 0.28). However, when ratings of partner mating desirability were one standard deviation above the mean, women's reports of self-other overlap did not differ significantly between high and low fertility, F (1, 40) = 0.86, p = .36, partial η^2 = .02 (marginal mean at high fertility = 5.19, SD = 0.31; marginal mean at low fertility = 5.03, SD = 0.28). This pattern indicates that changes in feelings of closeness were driven by decreased closeness at high fertility among women with less desirable partners.

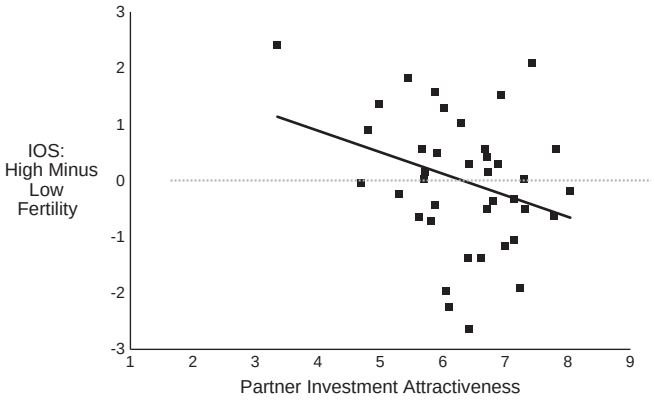

Fig. 2. Relationship between changes across the ovulatory cycle in ratings of inclusion of other in self and ratings of partner investment attractiveness. Points represent residual scores controlling for order of sessions and partner sexual attractiveness. N = 41, partial r = −.31, p = .06.

Satisfaction

Sample 1

There was no main effect of fertility, F (1, 37) = 0.09, p_{dir} = .48, partial η^2 = .002, no interaction between fertility and partner sexual attractiveness, F (1, 37) = 0.90, p_{dir} = .22, partial η^2 = .02, and no interaction between fertility and partner investment attractiveness, F (1, 37) = 0.64, p = .43, partial η^2 = .02, on women's satisfaction with their relationship.

Sample 2

There was no main effect of fertility on women's satisfaction with their relationship, F (1, 40) = 1.78, p_{dir} = .12, partial η^2 = .04. In

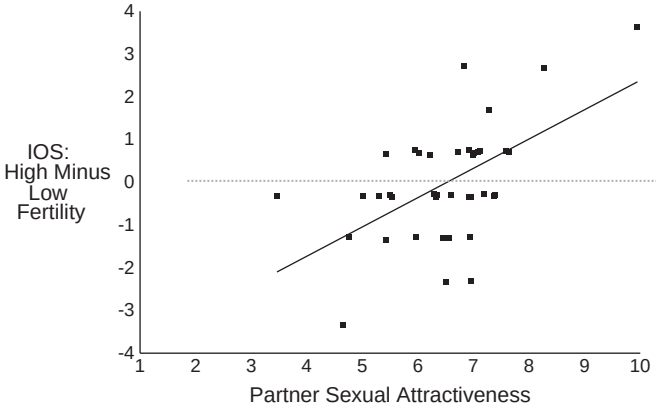

Fig. 1. Relationship between changes across the ovulatory cycle in ratings of inclusion of other in self and ratings of partner sexual attractiveness. Points represent residual scores controlling for order of sessions and partner investment attractiveness. N = 41, partial r = .56, p_{dir} < .001.

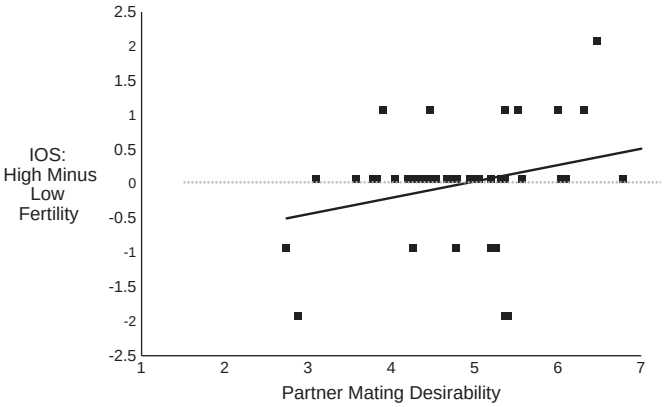

Fig. 3. Relationship between changes across the ovulatory cycle in ratings of inclusion of other in self and ratings of partner mating desirability. Points represent residual scores controlling for order of sessions. N = 43, partial r = .29, p_{dir} = .04.

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contrast to Sample 1, in Sample 2 using a measure of satisfaction typically used in the relationships literature, the key interaction between fertility and partner mating desirability was significant, F (1, 40) = 7.76, p_{dir} = .005, partial η^2 = .16. As shown in Fig. 4, the more desirable women rated their partner, the more satisfied they were at high compared to low fertility (partial r = .40, p_{dir} = .005). Follow-up analyses revealed that when ratings of partner mating desirability were one standard deviation below the mean, women's levels of satisfaction did not differ significantly between high and low fertility, F (1, 40) = 0.93, p_{dir} = .21, partial η^2 = .02 (marginal mean at high fertility = 0.71, SD = 0.35; marginal mean at low fertility = 1.09, SD = 0.40). However, when ratings of partner mating desirability were one standard deviation above the mean, women reported significantly higher levels of satisfaction at high than low fertility, F (1, 40) = 8.45, p = .006, partial η^2 = .17 (marginal mean at high fertility = 1.38, SD = 0.35; marginal mean at low fertility = 0.23, SD = 0.40). This pattern indicates that changes in feelings of satisfaction were driven by increased satisfaction at high fertility among women with more desirable partners.

Partner faults and virtues

Sample 2

There was a marginally significant main effect of fertility on women's assessments of their partner's faults, F (1, 64) = 2.93, p_{dir} = .06, partial η^2 = .04 (marginal mean at high fertility = 3.78, SD = 0.15; marginal mean at low fertility = 3.64, SD = 0.15), and the interaction between fertility and partner mating desirability was significant, F (1, 64) = 12.36, p_{dir} < .001, partial η^2 = .16. As shown in Fig. 5, the less desirable women rated their partner, the more faults they said their partner had at high compared to low fertility (partial r = −.40, p_{dir} < .001). Follow-up analyses revealed that when ratings of partner mating desirability were one standard deviation below the mean, women's ratings of partner faults were significantly higher at high than low fertility, F (1, 64) = 13.34, p_{dir} < .001, partial η^2 = .17 (marginal mean at high fertility = 3.97, SD = 0.22; marginal mean at low fertility = 3.54, SD = 0.22). However, when ratings of partner mating desirability were one standard deviation above the mean, women's ratings of partner faults did not differ significantly between high and low fertility, F (1, 64) = 1.82, p = .18, partial η^2 = .03 (marginal mean at high fertility = 3.58, SD = 0.21; marginal mean at low fertility = 3.74, SD = 0.22). This pattern indicates that changes in ratings of partner faults were driven by increased faults at high fertility among women with less desirable partners.

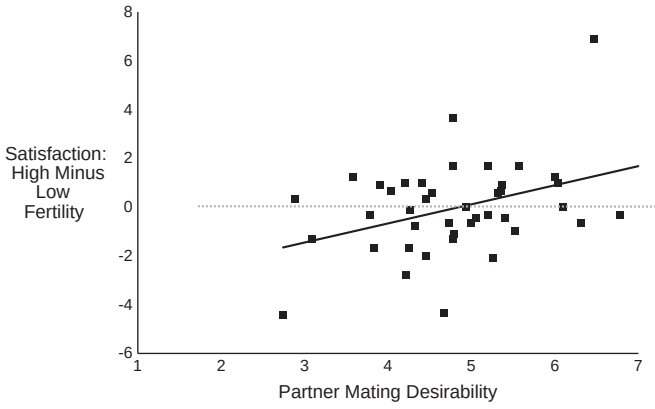

Fig. 4. Relationship between changes across the ovulatory cycle in ratings of satisfaction and ratings of partner mating desirability. Points represent residual scores controlling for order of sessions. N = 43, partial r = .40, p_{dir} < .01. One participant was an apparent outlier (top right corner). With her data point removed, the association between changes in ratings of satisfaction and ratings of partner mating desirability remained statistically significant (N = 42, partial r = .30, p_{dir} = .03).

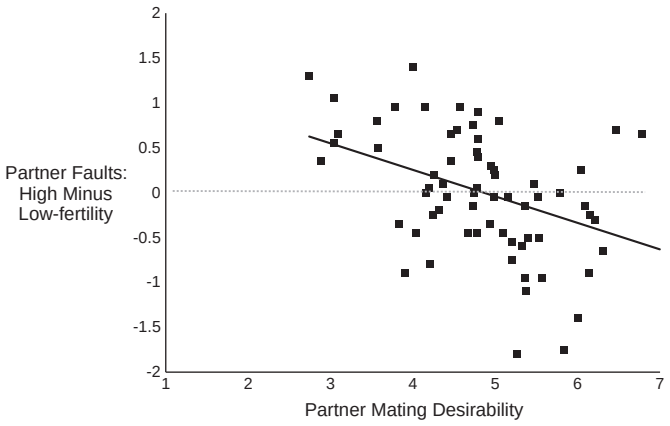

Fig. 5. Relationship between changes across the ovulatory cycle in ratings of partner faults and ratings of partner mating desirability. Points represent residual scores controlling for order of sessions. N = 67, partial r = −.40, p_{dir} < .001.

There was no main effect of fertility, F (1, 64) = 0.26, p_{dir} = .38, partial η^2 = .004, and no interaction between fertility and partner mating desirability, F (1, 64) = 0.04, p_{dir} = .53, partial η^2 = .001, on women's assessments of their partner's virtues.

Commitment

Sample 1

There was no main effect of fertility, F (1, 37) = .02, p = .90, partial η^2 < .001, no interaction between fertility and partner sexual attractiveness, F (1, 37) = 1.35, p = .25, partial η^2 = .04, and no interaction between fertility and partner investment attractiveness, F (1, 37) = .64, p = .43, partial η^2 = .02, on women's feelings of commitment to their relationship.

Sample 2

As in Sample 1, there was no main effect of fertility, F (1, 40) = 0.20, p = .89, partial η^2 = .001, and no interaction between fertility and partner mating desirability, F (1, 40) = 0.09, p = .77, partial η^2 = .002, on women's feelings of commitment to their relationship.

Quality of alternatives

Sample 2

Similar to the results for commitment, there was no main effect of fertility, F (1, 40) = 0.24, p = .63, partial η^2 = .006, and no interaction between fertility and partner mating desirability, F (1, 40) = 0.01, p = .97, partial η^2 = .001, on women's perceptions of the quality of alternative relationship partners.

Discussion

Many studies have documented systematic shifts in women's mate preferences across the ovulation cycle (reviewed in Gangestad and Thornhill, 2008). The present work provides some of the first evidence that these changes have implications for women's relationships with their romantic partner. Across two studies, we found evidence that women's feelings about their relationship changed across the ovulation cycle and depended on their assessment of their partner's sexual desirability. Women who rated their partner as relatively low in sexual desirability felt less close to their partner and more critical of their partner on high- relative to low-fertility days of the cycle. Women who rated their partner as relatively high in sexual desirability felt closer to their partner and more satisfied with their relationship on high- relative to low-fertility days of the cycle. In contrast to these findings, women's feelings of relationship commitment and their perceptions of the

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quality of alternative relationship partners did not change across the cycle. This suggests that, in addition to previously documented shifts across the cycle in women's sexual attractions, there are also shifts across the cycle in women's perceptions of relationship quality.

In Sample 1, as predicted, women who rated their partner as relatively low in sexual attractiveness experienced declines in feelings of closeness at high fertility, whereas women who rated their partner as relatively low in investment attractiveness did not. This finding is similar to a finding in earlier research showing that the extent to which women experienced changes across the cycle in their attraction to men other than their partner depended on their ratings of their partner's sexual attractiveness but not on their ratings of their partner's investment attractiveness (Pillsworth and Haselton, 2006a). These differential moderating effects are consistent with research documenting that at high fertility, women's preferences for characteristics associated with sexual attractiveness increase, but their preferences for characteristics associated with investment attractiveness do not (Gangestad et al., 2007). In sum, although women evaluate their partners in many ways, their partner's sexual desirability may be a primary factor affecting changes in women's evaluations of their relationship across the cycle.

A primary tenet of the dual mating hypothesis is that, among women whose partners lack hypothesized indicators of high-fitness genes, shifts in attractions across the ovulation cycle lead women to consider alternative short-term sex partners at high fertility while simultaneously maintaining their investing partnership with their long-term mate. In line with this notion, the studies reported here showed evidence that women who rated their partner as relatively low in sexual desirability felt less close to and more critical of their partner at high relative to low fertility, but their commitment to remain in their relationship did not change across the cycle. In addition, in Sample 2 we found that women's perceptions of the quality of alternative relationship partners did not change across the cycle. Although we did not advance a prediction about whether perceptions of relationship alternatives would change, the lack of change for this variable could reflect the fact that women are not seeking to find a new long-term partner when fertile within the cycle.

Recently, Eastwick and Finkel (2012) proposed that attachment bonds suppress shifts in women's attractions to men other than their long-term partner across the cycle. The model proposes that phylogenetically recent attachment bonds evolved to suppress more evolutionarily ancient ovulatory shifts in attraction, thereby protecting women's relationships with their partner and facilitating biparental care of children. The logic of this model leads to several expectations about patterns we could have observed in the current research. First, given that women with low sexual desirability partners are most at risk of experiencing attraction to other men at high fertility, one might expect these women to feel particularly close to their partners at high fertility (thereby helping to protect their relationship from those attractions to other men). Second, one might expect that women with highly investing partners, who presumably make particularly good coparents, would experience an increase in positive assessments of relationship quality at high fertility. In fact, we found the opposite of these patterns, which would seem to challenge the Eastwick and Finkel model (also see Larson et al., 2012). Instead, as a collective, studies documenting women's cycle shifts appear to be more consistent with a dual mating model in which ancestral women enhanced their reproductive success through experiencing and sometimes acting on shifts in attractions to other men at high fertility, while simultaneously maintaining their primary relationship to receive continued investments.

There were noteworthy differences in the findings across the two samples in the current research. Among women in Sample 2 (but not Sample 1) we found the predicted interaction of partner desirability and fertility on women's relationship satisfaction. For relationship closeness (IOS), we found that the association between ratings of partner sexual desirability and changes in feelings of closeness was stronger in Sample 1 than in Sample 2. It is possible that these differences were caused by differences in methods across the two samples. For example, we assessed satisfaction using a well-validated questionnaire typical in relationship research in Sample 2 but not Sample 1. Likewise, whereas women in Sample 1 were asked to consider only their recent feelings when completing the IOS scale, we did not impose this constraint on women in Sample 2. It is possible that women in Sample 2 therefore reported on how they close they feel to their partner *in general*, leading to somewhat weaker changes in feelings of closeness among women in Sample 2 compared with Sample 1. Consistent with this possibility, more women in Sample 2 than Sample 1 did not change their responses on the IOS scale between high and low fertility (seen in Figs. 1 and 3). Nonetheless, the IOS results are of note. That changes in closeness across the cycle appeared even when women were not explicitly asked to consider only their recent relationship feelings indicates that these changes are robust. In addition, these results suggest that women's position within the ovulatory cycle may be an important source of variation in responses to the IOS as it is typically administered in studies (i.e., when researchers do not ask participants to focus on a delimited time frame).

The simple effects analog results showed that the predicted interactions were typically driven by *downward* shifts in assessments of relationship quality at high fertility among women whose partners were low on sexual desirability. In addition, in several instances these interactions were driven by *upward* shifts in assessments of relationship quality at high fertility among women whose partners were high on sexual desirability. Specifically, in Sample 2 (but not Sample 1), changes in women's relationship satisfaction were driven by upward shifts among women who rated their partner as relatively high in sexual desirability, and in Sample 1 (but not Sample 2), changes in feelings of closeness were driven by both upward shifts among women who rated their partner as relatively high in sexual desirability and downward shifts among women who rated their partner as relatively low in sexual desirability. It is possible that upward shifts in perceptions of relationship quality among women with sexually desirable partners are less robust than the downward shifts among women with less sexually desirable partners. In support of this notion, research documenting changes in women's attractions across the cycle consistently finds that women experience heightened attraction to men other than their partners if their partners lack hypothesized indicators of high-fitness genes. However, the parallel finding that women experience heightened attraction to their own partners if their partners are high on indicators of high-fitness genes is often not found in studies examining shifts in attraction (reviewed in Larson et al., 2012).

Previous work has found associations between changes in estimated or measured hormones and changes in women's preferences for sexually desirable characteristics across the cycle (Garver-Apgar et al., 2008; Lukaszewski and Roney, 2009; Puts, 2006; Roney and Simmons, 2008; Roney et al., 2011; Welling et al., 2007). For example, studies that have assayed women's estradiol levels throughout the cycle have found that estradiol is positively associated with preferences for facial cues of men's testosterone, both within and outside of the fertile phase of the cycle (Roney and Simmons, 2008; Roney et al., 2011). The phylogenetic record also supports a role for estradiol in women's cycle shifts. Shifts in estrus sexual behavior evolved at a time when functional estradiol receptors first became sexually dimorphic, suggesting that estradiol is involved in cycle shifts in a wide variety of species, including humans (Thornhill and Gangestad, 2008). Other hormone mechanisms are also possible. For example, preferences for the scent of symmetry and vocal masculinity are negatively associated with progesterone (Garver-Apgar et al., 2008; Puts, 2006), and preferences for dominance in a short-term sexual partner are positively associated with luteinizing hormone and follicle stimulating hormone (Lukaszewski and Roney, 2009). It is possible that

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changes in one or more of these hormones (or several in interaction) are responsible for cycle shifts in women's assessments of relationship quality.

The rigorous methods used in the studies we report reinforce our confidence in the findings. Within-subjects designs, in which women serve as their own controls, provide a statistically powerful method for testing predictions about cycle effects by controlling for individual differences between women along various dimensions that might also impact assessments of relationship quality. In addition, our use of hormone tests allowed for a more precise estimation of cycle effects than would otherwise be possible. By following women over time and using luteinizing hormone tests, we can be confident that we have captured data in high- and low-fertility windows.

Conclusion

Women in relationships know that their feelings about their partner can vary from day to day. However, most women probably do not realize that fertility-related hormone processes operating outside of their awareness might contribute to these changes. As we have shown here, on the crucial few days on which conception can occur, women evaluate their partners differently, apparently raising their standards for sexual desirability. This leads some women to feel more distant and critical of their partner and other women to feel closer and more satisfied with their partner, though these shifts might only persist for a few days a month. These findings demonstrate a basic link between variation in hormones and variation in women's daily experiences in their relationships. They also provide support for the idea that women's relationship experiences are linked to reproductive functions with a deep evolutionary history.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.yhbeh.2012.10.005.

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