Women's Fertility Status Alters Other Women's Jealousy and Mate Guarding

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Abstract

Across three studies, we tested the hypothesis that women exhibit greater jealousy and mate guarding toward women who are in the high (vs. low) fertility phase of their cycle. Women who imagined their partner with a woman pictured at high fertility reported more jealousy than women who imagined their partner with a woman pictured at low fertility (Studies 1 and 2). A meta-analysis across studies manipulating fertility status of the pictured woman found a significant effect of fertility status on both jealousy and mate guarding. Women with attractive partners viewed fertile-phase women as less trustworthy, which led to increased mate guarding (Study 2). In Study 3, the closer women were to peak fertility, the more instances they reported of other women acting jealously and mate guarding toward them. These studies provide evidence that women selectively exhibit jealousy and mate guarding toward women who are near peak fertility.

Keywords

jealousy, mate guarding, competition, fertility, ovulation, evolution, emotion

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A few years ago, actor Mel Gibson's mistress became pregnant with their child. His marriage ended, and he eventually married his mistress. It had been rumored for some time that Gibson had engaged in extra-marital affairs, but it seemed to be the mistress' pregnancy that prompted his wife to end their 31-year marriage (Sacks, 2011). Infidelity can lead to several negative outcomes, including relationship dissolution (Amato & Previti, 2003; Buunk, 1995). The costs of infidelity may be particularly high if the infidelity occurs with a woman who is near the fertile phase of her ovulatory cycle. If the mistress becomes pregnant, the emotional and psychological costs of infidelity would be compounded by the threat of the man's time, money, and other resources being diverted away from his primary partner to the mistress and child. The present studies tested the hypothesis that women demonstrate more mate guarding and jealousy toward other women who are in the fertile phase of their ovulatory cycle than toward women who are not in the fertile phase of their cycle.

Selective Jealousy and Mate Guarding

Mate guarding refers to behaviors people use to prevent others from stealing their partner (Buss, 1988a). For example, a woman might hold her partner's hand when a rival approaches, or she might ask her partner to stay home instead of going to a party (Buss, 2002). Jealousy, the emotional response to a relationship threat, has been hypothesized to be a psychological mechanism that motivates mate guarding (Buss, Larsen, Westen, & Semmelroth, 1992; Daly, Wilson, & Weghorst, 1982; Symons, 1979). Jealousy and mate guarding may help someone keep a partner, but they have costs. Jealousy and mate guarding require a person's time and energy, and they may cause relationship conflict if a partner is perceived as overly suspicious and competitive. Therefore, it would be adaptive for people to focus their jealousy and mate guarding on situations in which their competitors pose significant threats (Fink, Klappauf, Brewer, & Shackelford, 2014).

Previous research has shown that men selectively exhibit jealousy and mate guarding in situations that could pose high relationship threats. Men selectively mate guard when their partners possess characteristics that other men may find desirable. Evidence suggests that men engage in more mate guarding when they perceive their partners to be highly attractive (Buss & Shackelford, 1997). Men also selectively mate guard when the potential consequences of their partner's infidelity are more severe. Studies have found that men guard their partners more when their partners are near (vs. far from) peak fertility (Gangestad, Thornhill, & Garver, 2002;

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Haselton & Gangestad, 2006). If a man's partner cheated on him during the fertile phase of her cycle and became pregnant, then the man faces the risk of unknowingly expending his time, energy, and other resources on another man's child. Previous research has found that fertile-phase women exhibit heightened attraction to dominant men (Gangestad, Simpson, Cousins, Garver-Apgar, & Christensen, 2004). Consequently, dominant males pose greater relationship threats to men with fertile-phase partners than men with non-fertile-phase partners. Men have been found to be more sensitive to cues of male dominance when their partners are near peak fertility (Burriss & Little, 2006). Men's sensitivity to dominant males—specifically when their partners are highly fertile—might allow men to guard their partners from rivals who pose substantial relationship threats.

Women also selectively exhibit jealousy and mate guarding when they perceive substantial threats to their relationship. Studies have found that women who possesses features that men find highly desirable (e.g., feminine voice, feminine face) are judged by other women as more likely to be a competitor and elicit greater jealousy from other women (Dijkstra & Buunk, 2001; Fink et al., 2014; Puts, Barndt, Welling, Dawood, & Burriss, 2011). Previous research has also found that women are less likely to let their partners talk to another woman who is dressed in revealing clothing (a potential cue to sexual availability) than a woman dressed in conservative clothing (Vaillancourt & Sharma, 2011).

Women Are Bigger Threats When They Are Fertile

Another factor that may increase a woman's likelihood of experiencing jealousy and engaging in mate guarding is the fertility status of the rival woman. Women who are in the fertile phase of their cycle are potentially threatening to a relationship for a few reasons. First, women are more desirable when they are near peak fertility. Compared with non-fertile-phase women, fertile-phase women engage in more behaviors to make themselves desirable to men. Research has found that they wear more reds and pinks (Beall & Tracy, 2013), which some evidence suggests are colors that men find highly desirable on women (Elliot & Niesta, 2008). Evidence suggests that women also flirt more with men possessing genetic-fitness markers when they are near (vs. far from) peak fertility (Cantú et al., 2014). Studies have found that fertile-phase women wear more attractive and sexier clothing than non-fertile-phase women (Durante, Li, & Haselton, 2008; Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007), especially when primed with potential rivals (Durante, Griskevicius, Hill, Perilloux, & Li, 2011).

Not only do fertile-phase women perform more actions to make themselves desirable to men than non-fertile-phase women, but evidence suggests that women's interest in sex also increases when they are near peak fertility (Bullivant et al., 2004; Dawson, Suschinsky, & Lalumière, 2012; Roney & Simmons, 2013). As women approach peak fertility, they report an increased desire to go out to meet men (Haselton & Gangestad, 2006). They are also particularly drawn to men with putative markers of genetic quality (Cantú et al., 2014; Feinberg et al., 2006; Gangestad, Garver-Apgar, Simpson, & Cousins, 2007; Gangestad et al., 2004; Garver-Apgar, Gangestad, & Thornhill, 2008; Little, Jones, & Burriss, 2007; Little, Jones, & DeBruine, 2008; Lukaszewski & Roney, 2009; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999; Provost, Troje, & Quinsey, 2008; Puts, 2005; Roney & Simmons, 2008; Roney, Simmons, & Gray, 2011). Past research has found that fertile-phase women even report a heightened desire for men outside of their current relationship if their current partner is low in attractiveness (Pillsworth & Haselton, 2006). Because fertile-phase rivals may be willing to cheat on their partner (they at least express interest in men other than their partner) with attractive men, women partnered to attractive men may have reason to question the trustworthiness of fertile-phase rivals. Indeed, a previous study found that women socially distances themselves from fertile-phase women when their partners were evaluated as highly desirable (Krems, Neel, Neuberg, Puts, & Kenrick, 2016). This effect occurred because women with desirable partners rated ovulating women low in trustworthiness.

Men also tend to find women more desirable when they are closer to peak fertility. Studies have found that women earn more tips as exotic dancers (G. Miller, Tybur, & Jordan, 2007), and their faces (Bobst & Lobmaier, 2012; Law Smith et al., 2006; Puts et al., 2013; Roberts et al., 2004; Samson, Fink, & Matts, 2011), voices (Pipitone & Gallup, 2008; Puts et al., 2013), and odors (Gildersleeve, Haselton, Larson, & Pillsworth, 2012; Kuukasjärvi et al., 2004; Singh & Bronstad, 2001; Thornhill et al., 2003) are judged to be more attractive when they are at high fertility than when they are at low fertility. Previous research suggests that men think more about mating when exposed to women's fertility cues (S. L. Miller & Maner, 2011). Because women at peak fertility are more desirable than women at low fertility, women might increase their jealousy and mate guarding toward fertile rivals.

Women may also experience more jealousy and engage in more mate guarding toward women who are at high (vs. low) fertility because a partner's sexual relationship with them could lead to a pregnancy. Women are sensitive to the threat of losing their partner's resources (e.g., protection, money), especially if those resources are given to another woman (Buss, 1988a; Buss & Shackelford, 1997). An (*im*)perfectly timed short-term sexual affair could lead to a long-term diversion of resources. If a man cheats on his partner with a woman who is in the fertile phase of her ovulatory cycle, then that woman could become pregnant. The pregnancy could lead to the demise of the relationship. If the relationship survived, then the pregnancy could impose long-term costs because a woman may have to share her partner's time, money, and other resources with a rival woman and her offspring.

Women Are Sensitive to Other Women's Fertility Cues

Females in other mammalian species are vigilant toward other females who are near peak fertility. Researchers have found that when conception likelihood is high, subdominant female yellow baboons and African elephants are attacked more by other females (Dublin, 1983; Wasser, 1983; Wasser & Starling, 1988). Studies have also found that female yellow baboons attempt to monopolize males when other females are near peak fertility (Wasser, 1983).

Despite women's fertility being less conspicuous than in many other mammals (e.g., fertile-phase women lack obvious genital swellings), women are sensitive to other women's fertility cues. Studies have found that women view other women photographed in the fertile phase of their ovulatory cycle as more attractive than the same women photographed not in the fertile phase (Law Smith et al., 2006; Roberts et al., 2004). Women are also sensitive to cyclical changes in other women's voices, faces, and odor (Necka, Puts, Dimitroff, & Norman, 2016; Pipitone & Gallup, 2008; Puts et al., 2013; Woodward, Thompson, & Gangestad, 2015). In one study, both women and men rated women's voices as more attractive when the voices were recorded during the fertile phase of their cycle than at other times in their cycles (Pipitone & Gallup, 2008). Another study found that women evaluated the faces and voices of women near peak fertility as more attractive to men than the faces and voices of the same women far from peak fertility (Puts et al., 2013).

Research suggests that women even have higher levels of testosterone after exposure to the scent of fertile-phase women than after exposure to the scent of non-fertile-phase women (Maner & McNulty, 2013). This effect is especially pronounced when the women making the judgments have hormone levels indicating that they are also near peak fertility (i.e., high estradiol and low progesterone; Woodward et al., 2015). Testosterone is associated with competition in women (e.g., Bateup, Booth, Shirtcliff, & Granger, 2002), which is an appropriate response to a mate-poacher—especially if the poacher is highly likely to conceive should one's partner cheat with her. Recent work also found that women who played an economics game when they were near peak fertility gave less money to other women who were near peak fertility (Necka et al., 2016). Women's detection of, and hormonal response to, fertility in other women suggest that women may react differently toward fertile-phase women than non-fertile-phase women. Recent evidence supports this idea. Four studies found that women with desirable partners were more likely to socially distance themselves and their partners from women who were in the fertile phase of their ovulatory cycle than women who were not in the fertile phase of their cycle (Krems et al., 2016). Specifically, women with desirable partners evaluated fertile-phase women low in trustworthiness, which lead to increased social distancing from the fertile-phase women compared with the non-fertile-phase women.

We hypothesized that women would experience more jealousy and engage in more mate guarding in response to a woman who is near (vs. far from) peak fertility. In Studies 1 and 2, we tested the hypothesis that women would report more jealousy and more mate guarding toward a woman photographed at high fertility than a woman photographed at low fertility. In Study 3, we tested the hypothesis that women who were near peak fertility would report that other women engaged in more mate guarding behaviors toward them that day than women who were far from peak fertility.

Study 1

We predicted that women would report greater jealousy and mate guarding after imagining their partner with a pictured woman who was at high fertility than after imagining their partner with a pictured woman who was at low fertility. Because previous research has found that people's self-perceived attractiveness is related to feelings of jealousy (Bush, Bush, & Jennings, 1988; Dijkstra & Buunk, 1998), we controlled for participants' self-reported attractiveness.

To explore potential mediators, we also included a measure of participants' perception of the woman's attractiveness to test if perceived attractiveness mediated the relationship between fertility status of the pictured woman and participants' jealousy and mate guarding.

Method

Participants. Using G*Power 3 software (Faul, Erdfelder, Lang, & Buchner, 2007) we determined that we needed a sample of at least 90 participants to detect a medium-sized effect ($f = .30$, $\alpha = .05$, $1 - \beta = .8$). We requested 100 participants from Texas Tech University. Three participants did not rate their own physical attractiveness, so our final sample included 97 participants (age: $M = 19.01$, $SD = 1.26$).

Procedure. This study was administered online, so participants did not interact with an experimenter who may have influenced their responses. Participants were randomly presented with one of four photographs (one of two women pictured at either high or low fertility). Underneath the photograph was a vignette which instructed participants to imagine their partner working late, alone with the photographed woman. After reading the vignette, participants reported their level of jealousy and their likelihood of engaging in a variety of mate guarding behaviors. They then provided ratings of the attractiveness of the photographed woman and ratings of their own attractiveness.

Materials

Pictured woman's fertility status. Participants saw one of four headshots used in previous research (Roberts et al., 2004). In one headshot, the pictured woman was wearing a red shirt. To eliminate the possibility of the red shirt

influencing participants' judgments of the pictured woman (Beall & Tracy, 2013; Elliot & Niesta, 2008), we changed the shirt color from red to gray. The headshots were of two different women. For each woman, one photograph was taken when she was at peak fertility (cycle days 8-14), and the other was taken when she was at low fertility (cycle days 17-25). Participants saw a headshot of one of the two women at either high or low fertility.

Vignette about partner and woman. The vignette instructed participants to imagine that their partner and the woman in the photograph were coworkers and were alone together working late at the office (see Supplemental Materials). Single participants were instructed to imagine that they had a partner when imagining the described scenario. Participants were asked to type a description of the situation they imagined, including what they imagined their partner and the woman were doing.

Jealousy. Participants reported, "How jealous did the scenario about your partner working late, alone with that woman, make you feel?" on a scale from 0 (*not at all*) to 7 (*extremely*).

Mate guarding. We selected and adapted questions from the Mate Retention Inventory (Shackelford, Goetz, & Buss, 2005) to gauge women's likelihood of engaging in various mate guarding behaviors such as dropping by their partner's office unexpectedly (see Supplemental Materials). Participants rated their likelihood of engaging in each behavior on a scale from 0 (*definitely would not*) to 7 (*definitely would*).

Picture attractiveness. Participants reported, "How attractive is the pictured woman?" on a scale from 0 (*not at all*) to 7 (*extremely*).

Participant attractiveness. Participants reported, "How attractive are you?" on a scale from 0 (*not at all*) to 7 (*extremely*).

Results

Jealousy. Controlling for participants' ratings of their own attractiveness, we found a significant main effect of fertility status on jealousy, $F(1, 92) = 4.21$, $p = .043$, $d = .42$, 95% confidence interval (CI) = [0.01, 0.82].[1] Participants who saw a woman pictured at high fertility reported feeling significantly more jealous ($M = 3.04$, $SD = 2.15$) than participants who saw a woman pictured at low fertility ($M = 2.25$, $SD = 1.67$).

There was also a significant main effect of the target woman on jealousy, $F(1, 92) = 10.20$, $p = .002$, $d = .65$, 95% CI = [0.24, 1.06]. Participants who saw Woman A ($M = 3.27$, $SD = 2.30$) were significantly more jealous than participants who saw Woman B ($M = 2.04$, $SD = 1.32$). There was not a significant fertility by target woman interaction, $F(1, 92) = 0.73$, $p = .394$, $d = .17$, 95% CI = [–0.23, 0.57]. The difference in jealousy between the two pictured women may have been due to differences in attractiveness between the women. Participants rated Woman A ($M = 3.23$, $SD = 1.28$) as significantly more attractive than Woman B ($M = 2.51$, $SD = 1.12$), $F(1, 94) = 8.48$, $p = .004$, $d = .59$, 95% CI = [0.18, 1.00].

Mate guarding. Controlling for participants' reported attractiveness, we found that participants who saw a woman pictured at high fertility reported more mate guarding ($M = 2.75$, $SD = 1.43$) than participants who saw a woman pictured at low fertility ($M = 2.49$, $SD = 1.36$), but the effect was not significant, $F(1, 92) = 1.01$, $p = .351$, $d = .20$, 95% CI = [–0.20, 0.60]. There was a significant main effect of the target woman on mate guarding, $F(1, 92) = 7.38$, $p = .008$, $d = .55$, 95% CI = [0.14, 0.95]. Women who viewed Woman A ($M = 2.99$, $SD = 1.35$) reported higher levels of mate guarding than women who viewed Woman B ($M = 2.25$, $SD = 1.35$). There was not a significant fertility status by target woman interaction, $F(1, 92) = 0.98$, $p = .466$, $d = .20$, 95% CI = [–0.20, 0.60].

Attractiveness. We tested whether the target woman's attractiveness mediated the relationship between fertility status and jealousy. The target's fertility status did not significantly predict participants' ratings of the target's attractiveness, $F(1, 92) = 3.55$, $p = .063$, $d = .38$, 95% CI = [–0.02, 0.78]. Nevertheless, mediation can still occur in the absence of a significant direct effect between a predictor and a proposed mediator (Hayes, 2009). We used bootstrapping to test if the effect of fertility status on jealousy of the pictured woman was mediated by the attractiveness of the pictured woman. Five thousand bootstrap resamples were performed. There was a significant indirect effect of fertility status on jealousy through the ratings of the pictured woman's attractiveness, $b = 0.19$, 95% CI = [0.005, 0.58].

We also used bootstrapping to test if the non-significant effect of fertility status on mate guarding toward the pictured woman was mediated by the attractiveness of the pictured woman. Five thousand bootstrap resamples were performed. There was a significant indirect effect of fertility status on mate guarding through the ratings of the pictured woman's attractiveness, $b = 0.12$, 95% CI = [0.002, 0.37].

Discussion

As predicted, women reported feeling significantly more jealous after imagining their partner with a woman photographed during the fertile phase of her ovulatory cycle than after imagining their partner with a woman photographed during the non-fertile phase of her cycle. Participants who imagined their partner with a fertile-phase woman also tended to report greater intentions to mate guard than participants who imagined their partner with a non-fertile-phase

woman, but the effect was not significant. The attractiveness of the pictured woman mediated the relationships between fertility and jealousy and fertility and mate guarding. This suggests that attractiveness may partially explain the effects of fertility on jealousy and mate guarding.

There are a few potential reasons why we did not detect a direct effect of fertility on mate guarding. Women reported very low mate guarding. The mode for five of the six mate guarding items was 0, and the mode for the other mate guarding item was 1, on a 0 to 7 scale. Although participants reported feeling jealous after reading the vignette, the vignette may not have been threatening enough to warrant action for most participants. Jealousy is a low cost response to relationship threats that could be used under a wide range of circumstances with minimal risk of social repercussions. In contrast, mate guarding is a high cost response that should be reserved for specific situations in which the target woman is likely to be a threat to the relationship. It is also possible that our measure of mate guarding primarily measured behaviors that were more extreme than behaviors that women would typically exhibit (e.g., showing up at the partner's work unannounced). To avoid conflict, women may be particularly selective about the types of mate guarding they exercise and the situations in which they choose to exercise them.

Study 2

Study 2 tested the hypothesis that women would report greater jealousy and mate guarding after imagining their partner talking to a flirtatious woman who was photographed at high (vs. low) fertility. We increased the number of target women from 2 to 22 to increase the generalizability of our results. We also used a more threatening vignette and added additional items to our mate guarding measure assessing a wider variety of mate guarding behaviors.

We also explored potential mediators that could contribute to the effect of fertility on jealousy and mate guarding. Based on another study we conducted on this hypothesis (see Supplemental Materials), we had reason to expect that attractiveness might not always mediate the relationship between fertility and jealousy. Rival women who are near peak fertility may be threatening to a relationship for a variety of reasons, but one reason why they are threatening is because they can become pregnant if they have sex. Fertility cues that are unrelated to attractiveness, such as changes in personality or facial redness, may still warrant vigilance on the part of partnered women. We included measures of other potential mediators that have been found to shift across the ovulatory cycle, such as the shape, texture, and color of women's faces and perceptions of personality traits (Law Smith et al., 2006; Oberzaucher, Katina, Schemehl, Holzleitner, & Grammer, 2012).

We also included measures of partner attractiveness and participants' perception of the pictured woman's trustworthiness to test a moderated mediation model previously shown to predict women's social distancing from other women (Krems et al., 2016). Previous research has found that among women with attractive partners, women perceive fertile-phase women as less trustworthy, which leads them to distance themselves from those women. Study 2 tested whether this model extended to additional forms of mate guarding, such as providing positive inducements for the partner, displaying public signals of possession, directly guarding the partner, derogating the rival, or directly aggressing against the rival.

Method

Participants. We adjusted our sample size to account for the greater variability in our stimulus faces (i.e., 44 pictures vs. four pictures in Study 1) by tripling our sample size from the sample size collected for Study 1. From Amazon's Mechanical Turk, we recruited 300 participants who were in a serious, romantic relationship. Out of the 300 recruited, 293 participants completed all questions and were in relationships with men (age: $M = 30.77$, $SD = 10.99$).

Procedure. Participants were shown one of 44 pictures and imagined that the woman pictured was flirting with their partner at a party. Then, participants reported their level of jealousy and their likelihood of engaging in 21 different mate guarding behaviors toward the pictured woman. Finally, participants gave responses about a variety of potential mediators.

Materials

Pictured woman's fertility status. Participants saw one of 22 different women pictured at either high fertility or low fertility. Pictures were taken as part of a previously published study (Puts et al., 2013). We used photographs of women who reported "White" ethnicity and did not have unusual cycle data or cycle lengths greater than 34 or less than 27 days. The fertility status of the pictured women was estimated using a backward-counting method and self-reported average menstrual cycle length and first day of most recent menses. The onset of their next menses was estimated by adding one average cycle length to the first day of their last menses. Ovulation typically occurs 15 days prior to menstruation. Thus, the pictured women's likelihood of conception was estimated by comparing their expected date of ovulation (i.e., 15 days prior to their next menses) with the dates when they were photographed. Conception risk estimates were validated using estradiol and progesterone levels assayed from saliva collected during each testing session. Specifically, pictured women were retained if they demonstrated agreement between changes in their estimated conception risk and changes in their estradiol and progesterone (i.e., when estimated conception risk increased, estradiol increased, and progesterone decreased), and for whom the change in progesterone levels across sessions was greater than 49 pg/ml.

Vignette about partner and woman. Participants read a paragraph asking them to imagine that they, their partner,

and Sara, the photographed woman (name from Krems et al., 2016), were at a party (adapted from Huelsnitz, Farrell, Simpson, & Griskevicius, 2015). The vignette described Sara talking to and flirting with the participants' partner.

Jealousy. Participants reported, "How jealous did this situation involving Sara make you feel?" on a scale from 0 (*not at all*) to 7 (*extremely*).

Mate guarding. We selected and adapted a greater number of items from the Mate Retention Inventory (Shackelford et al., 2005) for Study 2 than Study 1. Based on Buss's (1988b) mate retention taxonomy, we categorized the types of mate guarding included in our scale as positive inducements for partner (three items, α = .74), direct guarding of partner (five items, α = .70), public signals of possession (seven items, α = .90), derogation of rival (three items, α = .80), or direct aggression toward rival (three items, α = .75; see Supplemental Materials). Participants indicated their likelihood of engaging in each behavior on a scale from 0 (*definitely would not*) to 7 (*definitely would*).

Potential mediators. Participants reported, "How attractive is Sara?" and "How trustworthy is Sara?" on a scale from 0 (*not at all*) to 7 (*extremely*). Participants also judged other traits that Sara may have possessed. We created composites from those individual items. Ratings of attractiveness, health, sexiness, and youthfulness were averaged to create a "general attractiveness" dimension (α = .83). Ratings of sociability, trustworthiness, and likability were averaged to create a "personality trait" dimension (α = .60). Ratings of the homogeneity and attractiveness of Sara's skin texture, femininity and attractiveness of her face shape, fullness of her lips, and redness of her face were averaged to create a "facial features" dimension (α = .73).

Participant and partner attractiveness. Participants reported, "How attractive are you?" and "How attractive is your partner?" on a scale from 0 (*not at all*) to 7 (*extremely*).

Results

Jealousy. Controlling for participants' self-rated attractiveness, we found a significant main effect of fertility on jealousy, $F(1, 290) = 4.24$, $p = .040$, $d = .24$, 95% CI = [0.0003, 0.05].[2] Participants who saw a woman pictured at high fertility reported feeling significantly more jealous ($M = 5.57$, $SD = 2.22$) than participants who saw a woman pictured at low fertility ($M = 5.06$, $SD = 2.09$).

Mate guarding. Controlling for participants' self-rated attractiveness, we found that participants who saw a woman pictured at high fertility tended to report more mate guarding ($M = 4.93$, $SD = 1.40$) than participants who saw a woman pictured at low fertility ($M = 4.70$, $SD = 1.45$) but the difference was not significant, $F(1, 290) = 1.92$, $p = .167$, $d = .17$, 95% CI = [–0.57, 0.09]. Next, we analyzed the mate guarding subscales separately. All of the subscales were in the predicted direction, but none were significant (all ps > .08).

Attractiveness and other mediators. The target women were not rated significantly more attractive when they were pictured at high fertility ($M = 4.36$, $SD = 1.53$) than when they were pictured at low fertility ($M = 4.32$, $SD = 1.70$), $F(1, 290) = 0.06$, $p = .800$, $d = .02$, 95% CI = [–0.33, 0.41]. Using the same bootstrapping procedure described in Study 1, we tested if participant-rated attractiveness of the target woman mediated the effects of target fertility on jealousy and target fertility on mate guarding. Target attractiveness did not mediate either effect (jealousy: $b = 0.01$, 95% CI = [–0.09, 0.15]; mate guarding: $b = -0.004$, 95% CI = [–0.06, 0.03]). None of the other potential mediators were significant (general attractiveness: $b = -.04$, 95% CI = [–0.18, 0.06]; personality traits: $b = -.02$, 95% CI = [–0.13, 0.02]; facial features: $b = -.01$, 95% CI = [–0.11, 0.07]).

Moderated mediation of trustworthiness. We tested Krems and colleagues' (2016) moderated mediation model of trustworthiness and partner attractiveness with mate guarding and jealousy. According to this model, partner attractiveness (the moderator) interacts with target fertility (predictor) to affect perceptions of the target's trustworthiness (the mediator). Consequently, trustworthiness (the mediator) affects mate guarding and jealousy. Moderated mediation can occur in the absence of a significant interaction between the moderator and the predictor on the mediator (Preacher, Rucker, & Hayes, 2007). However, we observed a significant interaction between partner attractiveness and target fertility on trustworthiness controlling for participants' self-rated attractiveness, $t(1, 288) = -2.62$, $p = .009$, $b = -.38$, $SE = .14$, 95% CI = [–0.66, –0.10], $r_p = -.15$. We also observed a significant effect of trustworthiness on mate guarding controlling for participants' self-rated attractiveness, $F(2, 290) = 8.73$, $p < .001$, $R^2 = .06$, 95% CI = [0.01, 0.11]. Trustworthiness did not significantly predict jealousy controlling for participants' self-rated attractiveness, $F(2, 290) = 1.11$, $p = .332$, $R^2 = .008$, 95% CI = [–0.01, 0.03].

Mate guarding. Following Preacher and Hayes (2008), we estimated the indirect effect of the target woman's fertility status on overall mate guarding at 1 *SD* above and below the mean of participants' partners' attractiveness for 5,000 bootstrapped samples. The indirect effect of the Target Fertility × Partner Attractiveness interaction was significant, $b = .04$, 95% CI = [0.001, 0.11]. Because zero was not included in the CI, this analysis demonstrated significant moderated mediation. At 1 *SD* above the mean (high partner attractiveness), the indirect effect was significant, $b = .08$, 95% CI = [0.004, 0.25]. At 1 *SD* below the mean (low partner attractiveness), the indirect effect was non-significant, $b = -.02$, 95% CI =

[–0.12, 0.03]. When participants had a highly attractive partner, they evaluated fertile-phase targets low in trustworthiness, which lead to participants' mate guarding the target.

We ran the same moderated mediation model separately for the five different mate guarding subscales. We found significant moderated mediation for direct guarding of partner (b = .24, 95% CI = [0.02, 0.67]), public signals of possession (b = .30, 95% CI = [0.01, 0.88]), and direct aggression toward rival (b = .15, 95% CI = [0.004, 0.46]). The model was not significant for derogation of rival and positive inducements for partner.

Jealousy. We tested the same moderated mediation model as described above with jealousy as the outcome measure. The indirect effect of the Target Fertility × Partner Attractiveness interaction was not significant, b = –.004, 95% CI = [–0.07, 0.05].

Discussion

Consistent with our predictions and the results of Study 1, women reported more jealousy after imagining a fertile-phase woman flirting with their partner than after imagining a non-fertile-phase woman flirting with their partner. As in Study 1, women tended to report more mate guarding in response to a fertile-phase woman than a non-fertile-phase woman, but the effect was not significant. These results provide additional evidence that women feel more jealous in response to women who are near peak fertility than women who are not near peak fertility.

As in Krems et al. (2016), we found moderated mediation for trustworthiness on the relationship between fertility status and mate guarding. For women who had highly attractive partners, rivals who were in the fertile phase of their ovulatory cycle were perceived as less trustworthy than rivals who were not in the fertile phase of their cycle, which predicted women's intentions to mate guard against the rival. This replicates the model found by Krems and colleagues predicting women's social distancing from fertile-phase women. We note that two of the images used in the present study overlap those used by Krems et al. and hence the replication is not completely independent. Nevertheless, the present study shows that this model also extends to additional forms of mate guarding, such as direct guarding of one's partner, public displays that one's partner is taken, and verbally or physically threatening rivals. Women with attractive partners mate guard fertile-phase women because those women seem less trustworthy than non-fertile-phase women.

Only the main effect of fertility predicted jealousy. The moderated mediation model was not significant with jealousy as the outcome measure. One reason for the disparity in findings between jealousy and mate guarding may be related to the risks associated with jealousy and mate guarding. Because jealousy can be hidden more easily than mate guarding, there are fewer potential costs to jealousy than mate guarding. Jealousy may be a signal to "watch out" without necessarily engaging in behaviors that might compromise one's romantic relationship or same-sex friendships. Because of this, jealousy may be experienced across a greater number of situations than mate guarding. There is no harm in being jealous in the most non-threatening circumstances (e.g., a woman's partner is not particularly attractive and she trusts the rival), but it is potentially unwise to mate guard in those non-threatening circumstances.

Contrary to Study 1, participant-rated attractiveness of the pictured woman did not mediate the relationship between fertility status and jealousy or fertility status and mate guarding. Although changes in attractiveness that co-occur with changes in fertility status sometimes increase jealousy (Study 1), Study 2 suggests that women are jealous of fertile-phase women even in the absence of perceived changes in physical attractiveness.

The primary findings of Study 2 were consistent with the findings of Study 1. Participants who imagined their partner with a woman pictured at high fertility were significantly more jealous than participants who imagined their partner with a woman pictured at low fertility. We also found that participants who had attractive partners tended to view the high-fertility women as untrustworthy, which led to significant increases in mate guarding among participants who imagined their partner with a high-fertility woman versus a low-fertility woman.

Meta-Analysis

To assess the overall size and reliability of the effect of a target woman's fertility status on jealousy and mate guarding, we performed a meta-analysis (weighting each study by its df) across Studies 1 and 2, and another study that we conducted using only one target woman (see Supplemental Material). The effect of the target woman's fertility predicting jealousy was small (d = .28) but reliable, Z = 3.32, p < .001. The effect of the target woman's fertility predicting mate guarding was also small (d = .22) but reliable, Z = 2.35, p = .019. Combining the results of these studies suggests that the overall effects of fertility on jealousy and mate guarding were significant. These effect sizes are also consistent with a meta-analysis on a variety of different ovulatory effects on behavior (Gildersleeve, Haselton, & Fales, 2014).

Study 3

In Study 3, we approached mate guarding from a different perspective. Women reported instances of other women acting jealously and mate guarding toward them. This gave us the opportunity to measure everyday instances of mate guarding toward many different women. We predicted that, as women's conception likelihood increased, women would report more instances of other women acting jealously and mate guarding toward them that day.

Method

Participants. Using G*Power 3 software (Faul et al., 2007), we determined that we needed a sample of at least 84 participants to detect a medium-sized effect ($r = .30$, $\alpha = .05$, $1 - \beta = .80$). We requested 150 participants from mTurk, based on previous research suggesting that retention rates for studies of fertility using mTurk range from 48% to 56% (Durante & Arsena, 2015). One hundred forty-four participants completed the entire questionnaire. We requested women who were naturally cycling (i.e., not on any type of hormonal medication such as birth control), who identified as heterosexual, were pre-menopausal, ages 18 to 40 ($M = 24.67$, $SD = 4.50$), and were not pregnant. Participants who did not meet the inclusion criteria were excluded from analyses. We also excluded participants whose estimated cycle lengths were less than 25 days and greater than 35 days (Gangestad et al., 2004). Of the women originally recruited, 69 met all requirements and were retained for analyses.

Procedures. This study was administered online. Participants thought about other women's behavior toward them that day and described up to five instances of other women acting jealously and mate guarding toward them. Next, participants reported the date of their last menses, as well as information about their use of hormonal medication.

Materials

Jealousy and mate guarding measurement. Participants thought about their day, focusing only on the day they participated in the study, and recalled instances of other women acting jealously and mate guarding toward them (see Supplemental Materials). Participants described up to five instances of other women behaving jealously and mate guarding toward them that day.

Participants frequently described situations in which they received dirty looks and eye rolls from other women. They also reported that other women were particularly affectionate toward their partners while in the presence of the participants (e.g., holding his hand or kissing him). Another common behavior that participants reported was concealing and distancing their partner from the participant (e.g., grabbing their partner's hand and pulling him away from the participant). These behaviors are consistent with previous research on women's mate retention tactics (Krems et al., 2016; Vaillancourt & Sharma, 2011).

Two independent coders blind to participants' fertility status reviewed every instance that participants listed of other women behaving jealously and mate guarding toward them. Coders judged the following things about every instance: (a) Is this an instance of a woman behaving jealously/mate guarding toward the participant (yes/no)? (b) Is this particular instance different from all other instances the participant previously listed (yes/no)? (c) Did the description include information (e.g., key words such as "last week") that made it clear that this instance did not happen today (yes/no)? This was done to ensure that each instance was counted only once, and that only instances that corresponded with our hypothesis (actions by women that could have happened that day) were counted. Cohen's κ was utilized to determine if there was agreement between the two coders' judgments. There was very good agreement between the coders' judgments, $\kappa = .83$, $p < .001$, so we used the average of the two coders' responses. For each participant, we calculated the total number of unique instances she listed of other women behaving jealously and mate guarding toward her that could have happened that day.

Fertility measurement. After all participants' data had been collected, research assistants calculated conception likelihood for each participant. They used actuarial data (Wilcox, Dunson, Weinberg, Trussell, & Baird, 2001), which provided probability estimates of the likelihood of conception from a single act of unprotected sex on each day of the ovulatory cycle. Every day of the ovulatory cycle is associated with a number ranging from 0 (*no chance to conceive*) to .1 (*a 10% chance of conceiving*). Participants reported the start date of their last menses, as well as the date they predicted their next menses to start.

Research assistants first counted forward from the first day of each participant's last menses to the date she participated in the study. That number was the first estimate of participants' cycle day. Research assistants then took into account the estimated start date of participants' next period and adjusted their follicular phase using procedures described in Puts (2006). Research assistants placed all participants on a normalized, 28-day cycle, counted backward 15 days, and assumed that was the date of ovulation. Then, research assistants counted the number of days from the study date to the date of ovulation. For example, if the study date was 2 days after the ovulation date, research assistants calculated her cycle day to be 15 + 2 = 17. That number was the second estimate of participants' cycle day. Research assistants then used the actuarial data to estimate every woman's likelihood of conception based on the estimate from the forward-counting method and the estimate from the backward-counting method on normalized cycles. These two estimates were highly correlated ($r = .79$, $p < .001$), so we used their average as our measure of conception likelihood (method described in Gangestad et al., 2004).[3] Because recent work on ovulatory effects demonstrates the superiority of continuous estimates of fertility to dichotomous estimates, we did not dichotomize conception likelihood (Gangestad et al., 2016; Gildersleeve et al., 2014).

Results

Women's conception likelihood significantly predicted the number of jealous, mate guarding instances listed, $F(1, 67) = 8.20$, $p = .006$, $R^2 = .11$, 95% CI = [0.01, 0.26].

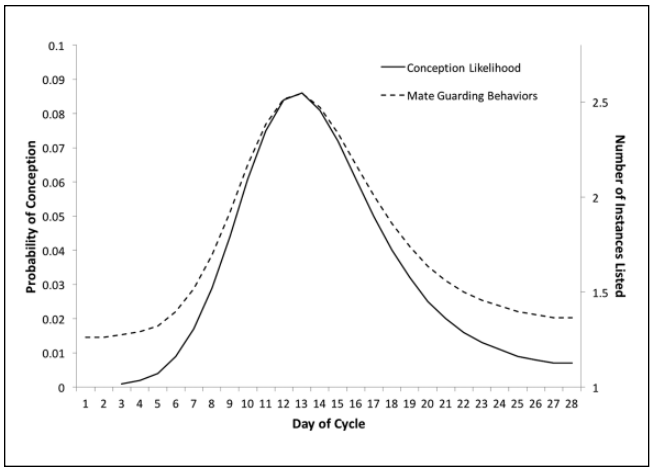

Figure 1. Estimated number of mate guarding behaviors across the ovulatory cycle.
Note. The dotted line was created from the estimated number of mate guarding instances from the regression equation (Study 3).

As participants' conception likelihood increased, they listed significantly more instances of other women acting jealously and mate guarding toward them. Figure 1 displays the estimated number of instances of jealous, mate guarding behaviors toward women depending on their cycle day.

Discussion

As women's conception likelihood increased, women reported more jealous, mate guarding behaviors directed at them. This suggests that other women selectively mate guard women who are near peak fertility. We acknowledge that we had a relatively small sample size, especially given error measuring conception likelihood (Gangestad et al., 2016). The present research provides evidence that among this sample of women, greater conception likelihood is associated with increased reports of mate guarding.

General Discussion

Primary Prediction

Across three studies and a meta-analysis, we found evidence that women are more vigilant toward women whose conception risk is higher within their ovulatory cycles. Across three studies measuring jealousy (including one in Supplemental Materials), women reported greater jealousy toward women pictured within the fertile phase of their ovulatory cycle than toward women pictured outside of the fertile phase of their ovulatory cycle. Although the effect of fertility status on mate guarding was not significant in some individual studies, a meta-analysis provided evidence that women report both greater jealousy and greater mate guarding in response to women photographed at times during the ovulatory cycle when conception risk is higher. Women at higher conception risk days of their ovulatory cycle also reported more mate guarding occurring against them than women not in the fertile phase of their ovulatory cycle.

This research demonstrates that women's sensitivity to other women's fertility status (e.g., Pipitone & Gallup, 2008; Puts et al., 2013; Roberts et al., 2004) is used to selectively mate guard against fertile-phase women. Previous research found that women experience hormonal changes associated with competitive behavior after exposure to a woman who is near peak fertility (Maner & McNulty, 2013; Woodward et al., 2015), and that women socially distance themselves and their partners from fertile-phase rivals (Krems et al., 2016). The present research builds on this research by demonstrating that exposure to a fertile-phase woman also increases feelings of jealousy (Studies 1 and 2, meta-analysis) and behaviors that may protect a partner from competitors, such as showing affection to and directly guarding their partners (Study 3, meta-analysis).

Exploration of Mechanisms

We tested a variety of potential mechanisms that may contribute to the effect of fertility on jealousy and mate guarding. We replicated and extended work by Krems and colleagues (2016), finding that one reason why women directly mate guard against fertile-phase rivals is because fertile rivals are perceived as less trustworthy when women have highly attractive partners. Our results suggest that women with attractive partners are likely to distrust fertile-phase rivals, which leads to a greater likelihood that they will directly guard their partner, publicly signal that their partner is taken, and verbally or physically threaten fertile-phase rivals than non-fertile-phase rivals.

This model was not significant with jealousy as the outcome measure. It is not surprising that jealousy emerges under a variety of conditions, whereas mate guarding only emerges under highly selective conditions. Women can experience jealousy with minimal risks, but women risk social repercussions if their jealousy leads them to action (i.e., mate guarding).

Participant-rated attractiveness of the target woman mediated only the relationships between fertility and jealousy and fertility and mate guarding in Study 1. There are a variety of reasons why women should be threatened by rival women who are in the fertile phase of their cycle, and increased attractiveness is only one of those reasons. Previous research has found that fertile-phase women are more interested in short-term sex with men possessing putative cues to heritable fitness (Cantú et al., 2014; Feinberg et al., 2006; Gangestad et al., 2007; Gangestad et al., 2004; Garver-Apgar et al., 2008; Little et al., 2007; Lukaszewski & Roney, 2009; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999; Provost et al., 2008; Puts, 2005; Roney & Simmons, 2008; Roney et al., 2011) and may be more likely to pursue an attractive man outside of their primary relationship than non-fertile-phase women (Pillsworth

& Haselton, 2006). Women in the fertile phase of their ovulatory cycle are also a greater threat because they could become pregnant. Women have reason to be vigilant of other women who display fertility cues, even if those cues are unrelated to a woman's physical attractiveness. Future research may help determine what about fertile women makes them the target of jealousy and makes them seem untrustworthy to women with attractive partners.

Alternative Interpretation

It is possible that the results from Study 3 may be due to fertile-phase women over-perceiving jealousy from others. Research has found that women who are near peak fertility report more jealousy than women who are not near peak fertility (Cobey et al., 2012). Although feeling jealous is distinct from perceiving others as jealous, women's experience of jealousy may prompt them to project jealousy onto other women. Studies have found that women who are closer to peak fertility are also more competitive toward female rivals than women who are far from peak fertility (e.g., Durante, Griskevicius, Cantú, & Simpson, 2014; Durante et al., 2011), especially when both competitors are near peak fertility (Necka et al., 2016). Thus, as women approach the fertile window, other women's behavior may become more salient and they may be more likely to view other women as jealous.

In addition to potential cycle-based changes in perceptions of mate guarding, there is evidence (in this article and others) that women do respond differently to women in the fertile phase of their ovulatory cycle than women not in the fertile phase of their cycle. Research has found that women report more jealousy (Studies 1 and 2), have higher testosterone (Maner & McNulty, 2013; Woodward et al., 2015), and intend to socially distance themselves (Krems et al., 2016) in response to fertile-phase women. Thus, it seems plausible that women actually mate guard more against fertile-phase women than non-fertile-phase women. It may be that both processes—those coming from within the participants and those coming from outside of the participants—contributed to the results of Study 3.

Future Directions

One avenue for future research is the effect of another woman's ovulatory cycle on women's direct aggression. If fertility cues alter women's jealousy and mate guarding behavior, then these cues might also lead women to engage in more direct aggression toward women who are at high fertility than women who are at low fertility. Studies have found that other female mammals directly aggress against fertile rivals (Dublin, 1983; Wasser, 1983) and it is plausible that women do so, as well. In Study 2, we found that participants with attractive partners evaluated fertile-phase women low in trustworthiness, which led to greater intentions to directly aggress against fertile-phase women than non-fertile-phase women. Previous research using smell as the cue for fertility did not find that participants report greater intentions to aggress against women who were near peak fertility (Woodward et al., 2015). It may be that women aggress against fertile rivals only under specific conditions. In addition to having an attractive partner and distrusting ovulating women, economic scarcity may be another factor that motivates women to aggress against rivals who are in the fertile phase of their ovulatory cycle. Studies have found that when women are motivated to compete for economic resources, their use of direct aggression increases (Campbell, Muncer, & Bibel, 1998; Griskevicius et al., 2009). If a man got his mistress pregnant, then his partner may lose the man's economic resources to the mistress and the child. Women may be more likely to aggress directly against fertile-phase women than non-fertile-phase women when economic resources are scarce.

The evolutionary success of a heritable trait depends on reproduction, but humans are not simply motivated to find a partner and reproduce; they are motivated to keep those partners (Daly et al., 1982). Jealousy and mate guarding help people achieve that goal. However, the costs of jealousy and mate guarding should lead people to reserve those feelings and behaviors for situations with particularly high relationship threats (Fink et al., 2014). Mate guarding should be selective. Studies have found that men selectively mate guarded their female partners when their partners were near peak fertility, presumably because, ancestrally, the threat of a partner's infidelity at that time was more severe than when she was at low fertility (Haselton & Gangestad, 2006). The present research demonstrates that women also selectively mate guard in situations where relationship threats are particularly severe.

When female rivals are more likely to conceive, they can pose severe threats to a relationship. One way to prevent the loss of a relationship and resources is to be vigilant of highly fertile rivals. Women's ability to detect fertility in other women may be an adaptation that promotes selective mate guarding. Because women are sensitive to other women's fertility status, they can (and apparently do) selectively guard their relationships from fertile women.

Declaration of Conflicting Interests

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Notes

1. Without the covariate, the effect was in the same direction but non-significant, $F(1, 98) = 3.20$, $p = .077$, $d = .36$, 95% CI = [–1.50, 0.08].

2. Without the covariate, the effect remained significant, $F(1, 291) = 4.10$, $p = .044$, $d = .24$, 95% CI = [0.0002, 0.04].
3. The effect remains significant for both of the estimation methods if we do not average them—Method 1: $F(1, 67) = 9.52$, $p = .003$, $R^2 = .12$, 95% CI = [0.02, 0.27]); Method 2: $F(1, 66) = 5.86$, $p = .018$, $R^2 = .08$, 95% CI = [0.002, 0.22].

Supplemental Material

The online supplemental material is available at http://pspb.sagepub.com/supplemental.

References

Amato, P. R., & Previti, D. (2003). People's reasons for divorcing: Gender, social class, the life course and adjustment. *Journal of Family Issues*, *24*, 602-626. doi:10.1177/0192513X03254507

Bateup, H. S., Booth, A., Shirtcliff, E. A., & Granger, D. A. (2002). Testosterone, cortisol, and women's competition. *Evolution and Human Behavior*, *23*, 181-192. doi:10.1016/S1090-5138(01)00100-3

Beall, A. T., & Tracy, J. L. (2013). Women are more likely to wear red or pink at peak fertility. *Psychological Science*, *24*, 1837-1841. doi:10.1177/0956797613476045

Bobst, C., & Lobmaier, J. S. (2012). Men's preference for the ovulating female is triggered by subtle face shape differences. *Hormones and Behavior*, *62*, 413-417. doi:10.1016/j.yhbeh.2012.07.008

Bullivant, S. B., Sellergren, S. A., Stern, K., Spencer, N. A., Jacob, S., Mennella, J. A., & McClintock, M. K. (2004). Women's sexual experience during the menstrual cycle: Identification of the sexual phase by noninvasive measurement of luteinizing hormone. *Journal of Sex Research*, *41*, 82-93. doi:10.1080/00224490409552216

Burriss, R. P., & Little, A. C. (2006). Effects of partner conception risk phase on male perception of dominance in faces. *Evolution and Human Behavior*, *27*, 297-305. doi:10.1016/j.evolhumbehav.2006.01.002

Bush, C. R., Bush, J. P., & Jennings, J. (1988). Effects of jealousy threats on relationship perceptions and emotions. *Journal of Social and Personal Relationships*, *5*, 285-303. doi:10.1177/0265407588053002

Buss, D. M. (1988a). The evolution of human intrasexual competition: Tactics of mate attraction. *Journal of Personality and Social Psychology*, *54*, 616-628. doi:10.1037/0022-3514.54.4.616

Buss, D. M. (1988b). From vigilance to violence: Tactics of mate retention in American undergraduates. *Ethology and Sociobiology*, *9*, 291-317. doi:10.1016/0162-3095(88)90010-6

Buss, D. M. (2002). Human mate guarding [Special issue]. *Neuroendocrinology Letters*, *23*(S4), 23-29.

Buss, D. M., Larsen, R. J., Westen, D., & Semmelroth, J. (1992). Sex differences in jealousy: Evolution, physiology, and psychology. *Psychological Science*, *3*, 251-255. doi:10.1111/j.1467-9280.1992.tb00038.x

Buss, D. M., & Shackelford, T. K. (1997). From vigilance to violence: Mate retention tactics in married couples. *Journal of Personality and Social Psychology*, *72*, 346-361. doi:10.1037/0022-3514.72.2.346

Buunk, B. P. (1995). Sex, self-esteem, dependency and extradyadic sexual experience as related to jealousy responses. *Journal of Social and Personal Relationships*, *12*, 147-153. doi:10.1177/0265407595121011

Campbell, A., Muncer, S., & Bibel, D. (1998). Female-female criminal assault: An evolutionary perspective. *Journal of Research in Crime and Delinquency*, *35*, 413-428.

Cantú, S. M., Simpson, J. A., Griskevicius, V., Weisberg, Y. J., Durante, K. M., & Beal, D. J. (2014). Fertile and selectively flirty: Women's behavior toward men changes across the ovulatory cycle. *Psychological Science*, *25*, 431-438. doi:10.1177/0956797613508413

Cobey, K. D., Buunk, A. P., Roberts, S. C., Klipping, C., Appels, N., Zimmerman, Y.,... Pollet, T. V. (2012). Reported jealousy differs as a function of menstrual cycle stage and contraceptive pill use: A within-subjects investigation. *Evolution and Human Behavior*, *33*, 395-401.

Daly, M., Wilson, M., & Weghorst, S. J. (1982). Male sexual jealousy. *Ethology and Sociobiology*, *3*, 11-27. doi:10.1016/0162-3095(82)90027-9

Dawson, S. J., Suschinsky, K. D., & Lalumière, M. L. (2012). Sexual fantasies and viewing times across the menstrual cycle: A diary study. *Archives of Sexual Behavior*, *41*, 173-183. doi:10.1007/s10508-012-9939-1

Dijkstra, P., & Buunk, B. P. (1998). Jealousy as a function of rival charactsteristics: An evolutionary perspective. *Personality and Social Psychology Bulletin*, *24*, 1158-1166.

Dijkstra, P., & Buunk, B. P. (2001). Sex differences in the jealousy-evoking nature of a rival's body build. *Evolution and Human Behavior*, *22*, 335-341. doi:10.1016/S1090-5138(01)00070-8

Dublin, H. T. (1983). Cooperation and reproductive competition among female African elephants. In S. K. Wasser (Ed.), *Social behavior of female vertebrates* (pp. 291-313). New York, NY: Academic Press.

Durante, K. M., & Arsena, A. R. (2015). Playing the field: The effect of fertility on women's desire for variety. *Journal of Consumer Research*, *41*, 1372-1391. doi:10.1086/679652

Durante, K. M., Griskevicius, V., Cantú, S. M., & Simpson, J. A. (2014). Money, status, and the ovulatory cycle. *Journal of Marketing Research*, *51*, 27-39. doi:10.1509/jmr.11.0327

Durante, K. M., Griskevicius, V., Hill, S. E., Perilloux, C., & Li, N. P. (2011). Ovulation, female competition, and product choice: Hormonal influences on consumer behavior. *Journal of Consumer Research*, *37*, 921-934. doi:10.1086/656575

Durante, K. M., Li, N. P., & Haselton, M. G. (2008). Changes in women's choice of dress across the ovulatory cycle: Naturalistic and laboratory task-based evidence. *Personality and Social Psychology Bulletin*, *34*, 1451-1460. doi:10.1177/0146167208323103

Elliot, A. J., & Niesta, D. (2008). Romantic red: Red enhances men's attraction to women. *Journal of Personality and Social Psychology*, *95*, 1150-1164. doi:10.1037/0022-3514.95.5.1150

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*, 175-191. doi:10.3758/BF03193146

Feinberg, D. R., Jones, B. C., Law Smith, M. J., Moore, F. R., DeBruine, L. M., Cornwell, R. E., . . . Perrett, D. I. (2006). Menstrual cycle, trait estrogen level, and masculinity preferences in the human voice. *Hormones and Behavior*, *49*, 215-222. doi:10.1016/j.yhbeh.2005.07.004

Fink, B., Klappauf, D., Brewer, G., & Shackelford, T. K. (2014). Female physical characteristics and intra-sexual competition in women. *Personality and Individual Differences*, *58*, 138-141. doi:10.1016/j.paid.2013.10.015

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. doi:10.1037/0022-3514.92.1.151

Gangestad, S. W., Haselton, M. G., Welling, L. L. M., Gildersleeve, K., Pillsworh, E. G., Burriss, R. P., . . . Puts, D. A. (2016). How valid are assessments of conception probability in ovulatory cycle research? Evaluations, recommendations and theoretical implications. *Evolution and Human Behavior*, *37*, 85-96.

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. doi:10.1111/j.0956-7976.2004.01503010.x

Gangestad, S. W., Thornhill, R., & Garver, C. E. (2002). Changes in women's sexual interests and their partners' mate-retention tactics across the menstrual cycle: Evidence for shifting conflicts of interest. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, *269*, 975-982. doi:10.1098/rspb.2001.1952

Garver-Apgar, C. E., Gangestad, S. W., & Thornhill, R. (2008). Hormonal correlates of women's mid-cycle preference for the scent of symmetry. *Evolution and Human Behavior*, *29*, 223-232. doi:10.1016/j.evolhumbehav.2007.12.007

Gildersleeve, K. A., Haselton, M. G., & Fales, M. R. (2014). Do women's mate preferences change across the ovulatory cycle? A meta-analytic review. *Psychological Bulletin*, *140*, 1205-1259. doi:10.1037/a0035438

Gildersleeve, K. A., Haselton, M. G., Larson, C. M., & Pillsworth, E. G. (2012). Body odor attractiveness as a cue of impending ovulation in women: Evidence from a study using hormone-confirmed ovulation. *Hormones and Behavior*, *61*, 157-166. doi:10.1016/j.yhbeh.2011.11.005

Griskevicius, V., Tybur, J. M., Gangestad, S. W., Perea, E. F., Shapiro, J. R., & Kenrick, D. T. (2009). Aggress to impress: Hostility as an evolved context-dependent strategy. *Journal of Personality & Social Psychology*, *96*, 980-995.

Haselton, M. G., & Gangestad, S. W. (2006). Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Hormones and Behavior*, *49*, 509-518. doi:10.1016/j.yhbeh.2005.10.006

Haselton, M. G., Mortezaie, M., Pillsworth, E. G., Bleske-Rechek, A., & Frederick, D. A. (2007). Ovulatory shifts in human female ornamentation: Near ovulation, women dress to impress. *Hormones and Behavior*, *51*, 41-45. doi:10.1016/j.yhbeh.2006.07.007

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, *76*, 408-420.

Huelsnitz, C. O., Farrell, A. K., Simpson, J. A., & Griskevicius, V. (2015, February). *The green-eyed monster: Responses to mate-poaching attempts as a function of attachment orientation*. Poster presented at the 12th annual meeting of the Society for Personality and Social Psychology Evolutionary Preconference, Long Beach, CA.

Krems, J. A., Neel, R., Neuberg, S. L., Puts, D. A., & Kenrick, D. T. (2016). Women selectively guard their (desirable) mates from ovulating women. *Journal of Personality and Social Psychology*, *110*, 551-573. doi:10.1037/pspi0000044

Kuukasjärvi, S., Eriksson, C. P., Koskela, E., Mappes, T., Nissinen, K., & Rantala, M. J. (2004). Attractiveness of women's body odors over the menstrual cycle: The role of oral contraceptives and receiver sex. *Behavioral Ecology*, *15*, 579-584. doi:10.1093/beheco/arh050

Law Smith, M. J., Perrett, D. I., Jones, B. C., Cornwell, R. E., Moore, F. R., Feinberg, D. R., . . . Hillier, S. G. (2006). Facial appearance is a cue to oestrogen levels in women. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, *273*, 135-140. doi:10.1098/rspb.2005.3296

Little, A. C., Jones, B. C., & Burriss, R. P. (2007). Preferences for masculinity in male bodies change across the menstrual cycle. *Hormones and Behavior*, *51*, 633-639. doi:10.1016/j.yhbeh.2007.03.006

Little, A. C., Jones, B. C., & DeBruine, L. M. (2008). Preferences for variation in masculinity in real male faces change across the menstrual cycle: Women prefer more masculine faces when they are more fertile. *Personality and Individual Differences*, *45*, 478-482. doi:10.1016/j.paid.2008.05.024

Lukaszewski, A. W., & Roney, J. R. (2009). Estimated hormones predict women's mate preferences for dominant personality traits. *Personality and Individual Differences*, *47*, 191-196. doi:10.1016/j.paid.2009.02.019

Maner, J. K., & McNulty, J. K. (2013). Attunement to the fertility status of same-sex rivals: Women's testosterone responses to olfactory ovulation cues. *Evolution and Human Behavior*, *34*, 412-418. doi:10.1016/j.evolhumbehav.2013.07.005

Miller, G., Tybur, J. M., & Jordan, B. D. (2007). Ovulatory cycle effects on tip earnings by lap dancers: Economic evidence for human estrus? *Evolution and Human Behavior*, *28*, 375-381. doi:10.1016/j.evolhumbehav.2007.06.002

Miller, S. L., & Maner, J. K. (2011). Ovulation as a male mating prime: Subtle signs of women's fertility influence men's mating cognition and behavior. *Journal of Personality and Social Psychology*, *100*, 295-308. doi:10.1037/a0020930

Necka, E. A., Puts, D. A., Dimitroff, S. J., & Norman, G. J. (2016). Other women's fertility moderates female resource distribution across the menstrual cycle. *Evolution and Human Behavior*, *37*, 387-391.

Oberzaucher, E., Katina, S., Schemehl, S. F., Holzleitner, I. J., & Grammer, K. (2012). The myth of hidden ovulation: Shape and texture changes in the face during the menstrual cycle. *Journal of Evolutionary Psychology*, *10*, 163-175.

Penton-Voak, I. S., & Perrett, D. I. (2000). Female preference for male faces changes cyclically: Further evidence. *Hormones and Behavior*, *21*, 39-48. doi:10.1016/S1090-5138(99)00033-1

Penton-Voak, I. S., Perrett, D. I., Castles, D. L., Kobayashi, T., Burt, D. M., Murray, K., & Minamisawa, R. (1999). Menstrual cycle alters face preference. *Nature*, *399*, 741-742. doi:10.1038/21557

Pillsworth, E. G., & Haselton, M. G. (2006). Male sexual attractiveness predicts differential ovulatory shifts in female extra-pair attraction and male mate retention. *Evolution and Human Behavior*, *27*, 247-258. doi:10.1016/j.evolhumbehav.2005.10.002

Pipitone, R. N., & Gallup, G. G. (2008). Women's voice attractiveness varies across the menstrual cycle. *Evolution and Human Behavior*, *29*, 268-274. doi:10.1016/j.evolhumbehav.2008.02.001

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*, 879-891. doi:10.3758/BRM.40.3.879

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research*, *42*, 185-227. doi:10.1080/00273170701341316

Provost, M. P., Troje, N. F., & Quinsey, V. L. (2008). Short-term mating strategies and attraction to masculinity in point-light walkers. *Evolution and Human Behavior*, *29*, 65-69. doi:10.1016/j.evolhumbehav.2007.07.007

Puts, D. A. (2005). Mating context and menstrual phase affect women's preferences for male voice pitch. *Evolution and Human Behavior*, *26*, 388-397. doi:10.1016/j.evolhumbehav.2005.03.001

Puts, D. A. (2006). Cyclic variation in women's preferences for masculine traits: Potential hormonal causes. *Human Nature*, *17*, 114-127. doi:10.1007/s12110-006-1023-x

Puts, D. A., Bailey, D. H., Cárdenas, R. A., Burriss, R. P., Welling, L. L. M., Wheatley, J. R., & Dawood, K. (2013). Women's attractiveness changes with estradiol and progesterone across the ovulatory cycle. *Hormones and Behavior*, *63*, 13-19. doi:10.1016/j.yhbeh.2012.11.007

Puts, D. A., Barndt, J. L., Welling, L. L. M., Dawood, K., & Burriss, R. P. (2011). Intrasexual competition among women: Vocal femininity affects perceptions of attractiveness and flirtatiousness. *Personality and Individual Differences*, *50*, 111-115. doi:10.1016/j.paid.2010.09.011

Roberts, S. C., Havlicek, J., Flegr, J., Hruskova, M., Little, A. C., Jones, B. C., . . . Petrie, M. (2004). Female facial attractiveness increases during the fertile phase of the menstrual cycle. *Proceedings of the Royal Society of London, Series B: Biological Sciences*, *27*, S270-S272. doi:10.1098/rsbl.2004.0174

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. doi:10.1016/j.yhbeh.2007.09.008

Roney, J. R., & Simmons, Z. L. (2013). Hormonal predictors of sexual motivation in natural menstrual cycles. *Hormones and Behavior*, *63*, 636-645. doi:10.1016/j.yhbeh.2013.02.013

Roney, J. R., Simmons, Z. L., & Gray, P. B. (2011). Changes in estradiol predict within-women shifts in attraction to facial cues of men's testosterone. *Psychoneuroendocrinology*, *36*, 742-749. doi:10.1016/j.psyneuen.2010.10.010

Sacks, E. (2011, December 24). Mel Gibson's divorce with wife of 31 years, Robyn Gibson, is now official. *New York Daily News*. Retrieved from http://www.nydailynews.com/entertainment/gossip/mel-gibson-divorce-wife-31-years-robyn-gibson-official-article-1.996318

Samson, N., Fink, B., & Matts, P. (2011). Does a woman's skin color indicate her fertility level? Preliminary findings. *Swiss Journal of Psychology*, *70*, 199-202. doi:10.1024/1421-0185/a000057

Shackelford, T. K., Goetz, A. T., & Buss, D. M. (2005). Mate retention in marriage: Further evidence of the reliability of the Mate Retention Inventory. *Personality and Individual Differences*, *39*, 415-425. doi:10.1016/j.paid.2005.01.018

Singh, D., & Bronstad, P. M. (2001). Female body odour is a potential cue to ovulation. *Proceedings of the Royal Society London, Series B: Biological Sciences*, *268*, 797-801. doi:10.1098/rspb.2001.1589

Symons, D. (1979). *The evolution of human sexuality*. New York, NY: Oxford University Press.

Thornhill, R., Gangestad, S. W., Miller, R., Scheyd, G., McCollough, J. K., & Franklin, M. (2003). Major histocompatibility complex genes, symmetry, and body scent attractiveness in men and women. *Behavioral Ecology*, *14*, 668-678. doi:10.1093/beheco/arg043

Vaillancourt, T., & Sharma, A. (2011). Intolerance of sexy peers: Intrasexual competition among women. *Aggressive Behavior*, *37*, 569-577. doi:10.1002/ab.20413

Wasser, S. K. (1983). Reproductive competition and cooperation among female yellow baboons. In S. K. Wasser (Ed.), *Social behavior of female vertebrates* (pp. 349-390). New York, NY: Academic Press.

Wasser, S. K., & Starling, A. K. (1988). Proximate and ultimate causes of reproductive suppression among female yellow baboons at mikumi national park, Tanzania. *American Journal of Primatology*, *16*, 97-121. doi:10.1002/ajp.1350160202

Wilcox, A. J., Dunson, D. B., Weinberg, C. R., Trussell, J., & Baird, D. D. (2001). Likelihood of conception with a single act of intercourse: Providing benchmark rates for assessment of post-coital contraceptives. *Contraception*, *63*, 211-215. doi:10.1016/S0010-7824(01)00191-3

Woodward, S. L., Thompson, M. E., & Gangestad, S. W. (2015). Women exposed to the scents of fertile-phase and luteal-phase women: Evaluative, competitive, and endocrine responses. *Adaptive Human Behavior and Physiology*, *1*, 434-448. doi:10.1007/s40750-014-0019-8