Can Men Detect Ovulation?

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Abstract

In contrast to our closest cousin, the chimpanzee, humans appear at first to lack cues of impending ovulation that would mark the fertile period in which a female can become pregnant. Consequently, that ovulation is "concealed" in women has long been the consensus among scientists studying human mating. A recent series of studies shows, however, that there are discernible cues of fertility in women's social behaviors, body scents, voices, and, possibly, aspects of physical beauty. Some of these changes are subtle, but others are strikingly large (we report effect sizes ranging from small, $d = 0.12$ to large, $d = 1.20$). Moreover, emerging evidence suggests that women's male partners may adaptively shift their behavior in response to cues of approaching ovulation. These results have far-reaching implications for understanding fluctuations in attraction, conflict, and relationship dynamics.

Keywords

ovulation, fertility cues, attraction, evolutionary psychology, relationships

In 2007, Miller, Tybur, and Jordan conducted a bold study. They asked professional lap dancers to record their nightly tip earnings for 60 days and to keep records of their menstrual cycles—recording the days when menses began and ceased. They separated women into two groups, those not using the contraceptive pill (who regularly experience ovulation within their cycles) and those who use it (whose normal hormonal fluctuations are blocked). They found that regularly ovulating women received about $335 per 5-hour shift in tips on high-fertility days (close to ovulation) as compared to $260 per shift on low-fertility days outside of the menstrual phase ($d = 0.75$). The pill-taking women showed little change across the cycle (see Fig. 1). This result suggests that women are more attractive near ovulation—so much so, in fact, that the difference can incline men to part with precious financial resources.

The lap dancer study was small, with only 11 regularly ovulating women. Therefore, we need additional evidence before we can accept the potentially transformative idea that women's cycling fertility affects men's behavior. Moreover, the lap dance study raises, but does not answer, an intriguing question: What changes near ovulation make women more attractive to men? Do women simply behave differently at this time, or is it something more subtle—for example, how they look or even how they smell? In this paper, we highlight examples of evidence from an emerging literature on ovulation cues to begin addressing these fascinating questions.

The "Loss" of Ovulation Cues in Humans

In many mammalian species, the period of highest fertility just before ovulation is marked by dramatic increases in female sexual behavior and attractiveness. For example, rat females solicit males for sex exclusively within the fertile phase of the cycle (Erskine, 1989). In the chimpanzee, our closest primate cousin, females have sex throughout the cycle. However, they have pronounced genital swellings that generally coincide with the fertile period, enticing males to copulate with them much more frequently near ovulation. In contrast, humans are sexually active throughout the cycle and lack extreme changes generally accompanying the fertile period.

These cross-species comparisons have led to the widespread conclusion that cues of impending ovulation have been "lost" in humans over evolutionary time and that the behavioral changes accompanying the fertile period are absent. However, this conclusion may be premature. Like other mammals, women can only conceive by having intercourse on the day of ovulation, which usually occurs about two weeks before

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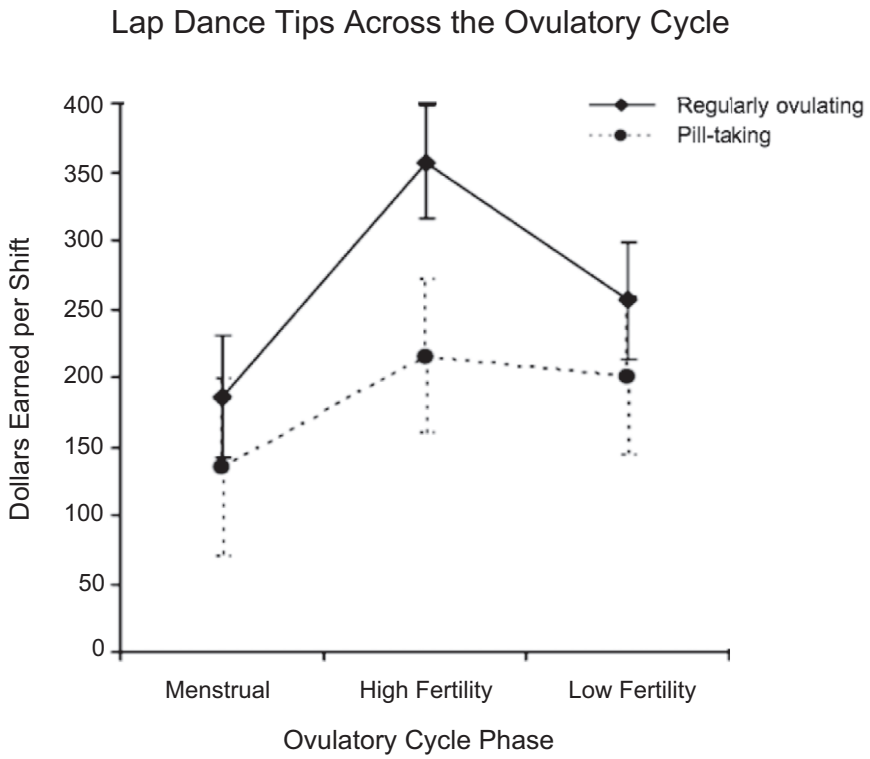

Fig. 1. Lap dancers' tip earnings (in dollars per shift) at different phases of the menstrual cycle (Miller, Tybur, & Jordan, 2007). Dancers in the regularly ovulating group were not using the contraceptive pill or any other form of hormonal contraception at the time of the study and are therefore presumed to have experienced ovulation in the high-fertility phase of the cycle. Dancers in the pill-taking group were using the contraceptive pill, which blocks normal hormonal fluctuations across the cycle. Error bars represent 95% confidence intervals.

menstrual onset, or on one of the few days before ovulation (Wilcox, Dunson, & Baird, 2000). Throughout evolutionary history, these were the crucial few days when women's sexual decisions had the greatest reproductive consequences and the only days when men could produce offspring by having sex. Two straightforward evolutionary hypotheses that follow are (a) women's psychological adaptations surrounding mating will take current ovulatory cycle position (and, hence, fertility) into account, and (b) men's psychological adaptations surrounding mating will take cues of impending ovulation in women into account, however subtle those cues may be. Thus, the fertile period should be accompanied by changes in both women's and men's social behavior. In this paper we primarily address the latter of these two hypotheses—namely, we evaluate a growing body of evidence suggesting that men can detect, are attracted to, and may adaptively shift their behaviors in response to fertility cues in women.

Evidence of Human Ovulation Cues

Overview

Recent studies show that there are many changes across the ovulatory cycle in women's sexuality and mate preferences. For example, near ovulation women show increased preferences for men with sexy traits like masculine faces and competitive behavior. Additionally, women report greater attraction to men *other than* their primary partners, particularly when their primary partners lack the sexy traits these women prefer most strongly near ovulation (reviewed in Thornhill & Gangestad, 2008).

This literature also shows that there are outward changes across the ovulatory cycle in women's social behaviors, body odors, voices, and, possibly, physical appearance. Figure 2 presents representative effect sizes from these studies. For within-subjects studies for which information about the correlation between high- and low-fertility scores was available, effect size (d) was calculated using the formula recommended by Borenstein, Hedges, Higgins, and Rothstein (2009). For within-subjects studies for which this information was not available (Doty, Ford, Preti, & Huggins, 1975; Gangestad, Thornhill, & Garver, 2002; and Pipitone & Gallup, 2008), d was calculated using the formula recommended by Morris and DeShon (2002). In all studies presented in the figure and discussed in the following sections, women are regularly ovulating (not using hormonal contraceptives such as the pill), and fertile days are compared with nonfertile days outside of the menstrual period and typically excluding premenstrual days (thereby setting aside effects driven by menstrual or premenstrual symptoms). Typically, the methodology involves estimations of cycle phases by counting days from the previous or next menstrual onset; however, we note cases in which

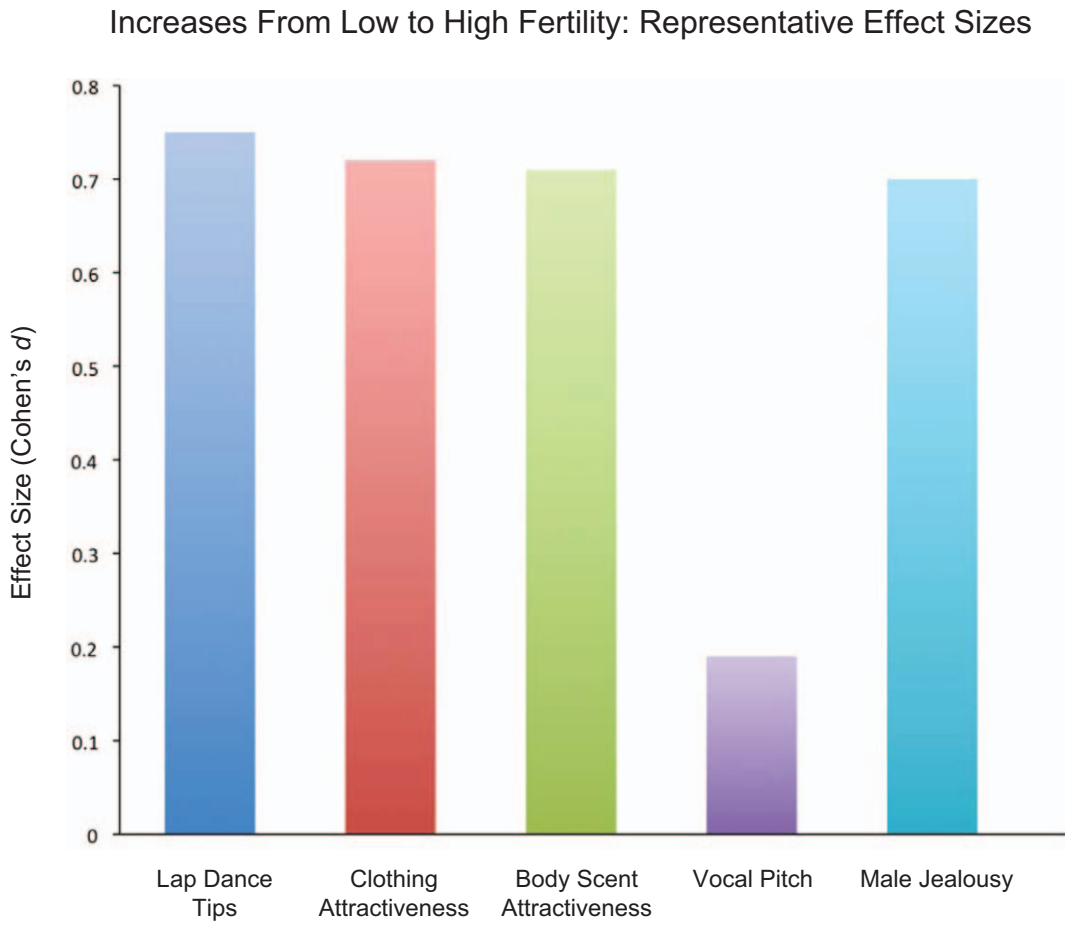

Fig. 2. Effect sizes representing the difference between high-fertility and low-fertility cycle phases (outside of menstrual and, typically, premenstrual days) in lap dancers' tip earnings (Miller, Tybur, & Jordan, 2007), women's clothing choices (Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007), women's body odor attractiveness (Thornhill et al., 2003), women's vocal pitch (Bryant & Haselton, 2009), and women's reports of their male partners' jealousy (Haselton & Gangestad, 2006) in terms of Cohen's *d*. Effect sizes of $d = 0.2$, 0.5, and 0.8 are generally considered small, medium, and large effects, respectively (Cohen, 1988). Although many of the effects presented in the graph are fairly large, parallel effects in nonhuman primates are often much larger. For example, the difference in percentage of chimpanzee females receiving genital inspection by males during genital swelling (high fertility) versus before swelling onset (low fertility) has an effect size (*d*) of 3.13 (Wallis, 1992). It is important to note that the effect sizes presented in this figure and elsewhere in the paper are representative only of the published literature and may not represent all studies—including unpublished but methodologically rigorous studies—of these effects.

researchers used more rigorous methods to confirm ovulation (e.g., hormone tests). Studies often use a within-group design in which a woman's behavior, appearance, or scent in one cycle phase is compared with that in another. This statistically powerful method has the advantage of requiring fewer research participants to detect reliable effects; thus sample sizes are often modest. As Figure 2 shows, the outward changes in women that accompany the fertile period and men's responses to these changes are often quite large.

Several studies show that, near ovulation, women respond more favorably to opportunities to flirt with attractive men and may actively seek such opportunities. In a study of 211 women in a French dance club, women in the fertile phase of their cycles were more likely than women outside of the fertile phase to say yes when asked to dance by an attractive male confederate ($d = 0.73$; Gueguen, 2009). Similarly, in a 40-day daily-report study of 38 women, women reported greater interest in going out to dance clubs and parties to meet men on fertile days than they did on nonfertile days ($d = 0.48$; Haselton & Gangestad, 2006).

Consistent with these findings, a separate line of evidence suggests that, near ovulation, women put more effort into appearing attractive. Haselton, Mortezaie, Pillsworth, Bleske-Rechek, and Frederick (2007) took full-body photographs of 30 women at high fertility (confirmed with hormone tests) and at low fertility. When presented with these photo pairs (with faces concealed), a mixed-sex group of judges chose the high-fertility photo as the one in which the woman was "trying to look more attractive" approximately 60% of the time ($d = 0.72$). Durante, Li, and Haselton (2008) conducted a study of 88 women using the same methods and replicated this result. They also asked women to imagine that they would be attending a large party that evening with many attractive others. Using colored pencils and an outline of a female body, participants sketched the outfit that they would wear to the

party. On average, judges rated high-fertility outfits as sexier ($d = 0.18$) and more revealing ($d = 0.12$) than low-fertility outfits. This effect was particularly pronounced among women ($n = 33$) tested on the highest fertility days of the cycle (the day before and the day of ovulation; $d = 0.42$ for sexiness, and $d = 0.45$ for revealingness). Some evidence also indicates that women's faces and bodies (see, e.g., Roberts et al., 2004) become slightly more attractive near ovulation; however, more research is needed to test this claim.

Changes in women's body odors

In many mammals, scent communication plays an important role in reproductive behavior (see Doty et al., 1975). Several studies suggest that scent may also be important in human reproduction, although perhaps in more subtle ways than in other mammals. In a pioneering study, researchers sampled vaginal secretions from four women every other day for several ovulatory cycles (using body temperature as a measure of ovulation; Doty et al., 1975). Male judges rated high-fertility samples as smelling more pleasant than low-fertility samples ($d = 1.20$). A recent set of studies also examined changes in women's underarm odor attractiveness across the ovulatory cycle. These studies used the "stinky T-shirt" paradigm in which women wear a T-shirt to bed on specific nights of the cycle while abstaining from practices that might alter their natural scent. Although men's ratings of odor attractiveness in these studies were not generally high, shirts worn at high fertility were rated as smelling sexier and more pleasant than T-shirts worn at low fertility (e.g., Thornhill et al., 2003, $N = 48$ female scent donors, $N = 77$ male scent raters, $d = 0.71$).

Changes in women's voices

Women's voices are affected by reproductive hormones (see Bryant & Haselton, 2009); therefore, fertility information could be found in the voice. In one study, 17 women counted from 1 to 10 on four occasions spaced equally across the cycle. Mixed-sex judges rated vocal recordings from the high-fertility phase as more attractive than recordings from other nonmenstrual days of the cycle ($d = 0.55$; Pipitone & Gallup, 2008). In a second study, Bryant and Haselton (2009) recorded 69 women at high fertility (confirmed by hormone tests) and at low fertility saying the simple sentence, "Hi, I'm a student at UCLA." Acoustical analyses revealed that pitch, a component of vocal femininity and attractiveness (see Bryant & Haselton, 2009), was higher at high fertility than at low fertility ($d = 0.19$). Furthermore, the difference between high and low fertility was larger for women who had their voices recorded closest to ovulation within the fertile window ($d = 0.70$).

Do Men Respond to Ovulation Cues?

In sum, judges in laboratory studies are able to differentiate between stimuli collected from women at high and low fertility across several sensory modalities. Moreover, the lap-dancer study provides naturalistic confirmation that men may respond differently to women depending on their cycle phase. However, the evidence reviewed thus far does not answer a crucial evolutionary question: Given the reproductive benefits to men of detecting ovulation (e.g., pursuing sex with women at peak fertility), do men respond to ovulation cues emitted by women with whom they regularly interact, such as their female romantic partners?

Although no published studies have directly assessed the impact of women's ovulation cues on their partners' behavior, several studies suggest that men may engage in more behaviors to dissuade their partners from pursuing other men precisely when the reproductive costs of partner infidelity would be highest—namely, near their partner's ovulation. These studies collected women's reports of their male partners' behaviors across the cycle. In one study of 27 women, male partners were reported to be more vigilant, monopolizing, and spoiling at high compared to low fertility (confirmed with hormone tests; $d = 0.87$; Gangestad et al., 2002). In a similar study of 38 women, partners were reported to be more jealous and possessive at high compared to low fertility ($d = 0.70$), and this was particularly true when women rated their partners as relatively low in sexual desirability (Haselton & Gangestad, 2006; see Pillsworth & Haselton, 2006, for converging results). A recent study provides evidence of a direct link between ovulation cues and men's mating behaviors: Miller and Maner (2010) exposed men to high- or low-fertility body odor samples of women who were otherwise unknown to those men. They found that men in the high-fertility odor condition had higher testosterone levels after the smell task than did men in the low-fertility condition ($d = 0.75$). Possibly, there is a parallel effect within established relationships, such that changes in men's testosterone in response to their partners' fertility cues lead to increased sexual interest in their partners and increased efforts to defend their partners against male rivals.

Conclusion and Future Directions

There is now good evidence of human ovulation cues—therefore, at some level, men may be able to detect ovulation. Nonetheless, many crucial questions remain. One question concerns how ovulation cues affect relationships. Women report that their male partners respond differently to them near ovulation, but we do not know with certainty whether these reports reflect changes in women's perceptions of their partners' behavior, changes in women's behaviors to which their partners respond (e.g., increased flirtatiousness, which leads to increased jealousy), or changes in men's behavior in direct response to fertility cues (e.g., body odor). Moreover, if ovulation cues are detectable outside of the laboratory, we do not yet know which categories of others detect them. It seems likely, however, that male partners, who can monitor subtle daily changes in their partners, such as shifts in odor, would have an advantage over other men at detecting and responding to these cues.

Another mystery to address is whether the changes accompanying ovulation are *signals* designed by selection to communicate a woman's fertile status. This hypothesis entails the notion that women benefit from actively advertising their fertility. Researchers have called this idea into question for several reasons, including the possibility that signaling ovulation could invite unwanted attention from men (including partners), thereby compromising women's ability to freely choose mates in the fertile phase of the cycle (e.g., Thornhill & Gangestad, 2008). There are several alternatives to the signaling hypothesis. One is that there has been selection on women to conceal ovulation in order to stretch male investment across the cycle or to preserve female choice (see Thornhill & Gangestad, 2008). According to this view, concealment is imperfect because there is a continued coevolutionary race in which women evolve to conceal cues but men evolve to detect them, however subtle they may be. Signs of impending ovulation are, in this view, merely "leaky cues." A related proposal, the female quality hypothesis, suggests that women have evolved to signal their overall quality so that they can compete with other women for male attention and investment (see Domb & Pagel, 2001, for this model as applied to baboons). One aspect of female quality may be her overall estrogen level and its correlates (attractive odors, voices, etc.), which could reflect her future reproductive potential. Estrogen levels vary between women, but they also vary across the ovulation cycle and peak near ovulation; thus, according to this hypothesis, the changes in attractiveness that accompany ovulation are not signals of ovulation, per se, but rather are incidentally related to ovulation because of estrogen variation across the cycle. The question of whether signs of ovulation are evolved signals, leaky cues, or other by-products of the evolutionary process is an exciting area for future study.

In conclusion, the existence of ovulation cues opens up many exciting avenues for discovery, particularly for understanding the extent to which these cues are detectable, by whom they are detectable, and what their effects are on others. The existence of detectable, attractive ovulation cues could revolutionize our understanding of day-to-day shifts in close relationship dynamics. More generally, because findings in this rapidly expanding literature link social behavior to reproductive factors outside of women's and men's explicit awareness, they are not easily explained as products of cultural norms or other uniquely social causes. Therefore, this work is powerful evidence of the footprints of evolution in modern social behavior.

Recommended Reading

Bryant, G.A., & Haselton, M.G. (2009). (See References). A representative study illustrating the rigorous methods that are increasingly used to confirm ovulation and examine changes in women's attractiveness across the ovulatory cycle.

Gangestad, S.W., Thornhill, R., & Garver-Apgar, C.E. (2005). Adaptations to ovulation: Implications for sexual and social behavior. *Current Directions in Psychological Science*, *14*, 312–316. A clearly written review for readers who wish to expand their knowledge on the topic of changes in women's mate preferences and sexual motivations across the ovulatory cycle.

Haselton, M.G., & Gangestad, S.W. (2006). (See References). A daily-report study documenting myriad changes in women's social behaviors across the ovulation cycle and providing some of the first evidence that the dynamics of women's relationships with their male partners may change near ovulation.

Miller, G., Tybur, J., & Jordan, B.D. (2007). (See References). An emerging "classic" study documenting changes in men's behavior in response to ovulation cues.

Thornhill, R., & Gangestad, S. (2008). (See References). This book provides a comprehensive discussion of theory and empirical work pertaining to the question of whether human females exhibit fertile phase sexuality (estrus).

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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