Title
Potential Evidence for Estrus in Humans: A Literature Review

Author
Lunge, Jenna

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Jenna Lunge

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Estrus, which is present across most mammalian species, has commonly been thought to have disappeared over the course of human evolution (Gangestad & Thornhill, 2008). According to Miller, Tybur, & Jordan (2007), estrus is categorized as increased sexual attractivity, proceptivity, and receptivity. It occurs when females are at their most fertile in order to acquire a mate with higher genetic quality. In this phase, ovarian follicles mature and estrogen spikes, which can cause various changes not only behaviorally, but physiologically as well. Gangestad and Thornhill (2008) noted that some researchers have predicted women display continuous sexuality instead of estrus, which would function to conceal ovulation. With continuous sexuality, a woman's sexuality would remain stable through her cycle and be unaffected by fertility. The literature discussed in this review, however, has been dedicated to demonstrating that estrus does exist in humans. Women instead display dual sexuality, where a phase of estrus is followed by a phase of non-fertile sexuality during the cycle. This paper provides a brief overview of key literature that suggests that women did not lose estrus during evolution. Measurable changes in mate-preference and observable differences in behavior at peak fertility demonstrate the existence of human estrus.

Numerous studies have noted that female mate-preference differs across the menstrual cycle in various measurable ways. For example, at peak fertility, women tend to find cues of health and high levels of testosterone more attractive than they do during infertile phases (Jones et al.,

2008). Using computer modified images of masculine and feminine male faces, Johnston, Hagel, Franklin, Fink, and Grammer (2001), found that women prefer a more masculine male face while they are ovulating. Male features such as a broader lower jaw and more prominent cheekbones are markers of higher testosterone levels and therefore, good health. Similar research conducted by Roney and Simmons (2008) measured hormone levels in the saliva of male and female participants on the days the studies were conducted. It was found that higher estradiol concentrations in female participants is positively correlated with preference for faces of males with higher testosterone concentrations. The association of higher estradiol concentrations in women and their preference for faces with cues of higher testosterone is a key indication that judgment of attraction not only varies as ovulation nears, but may also be a behavior signal of fertility.

In one so-called Sweaty T-shirt Study conducted by Gangestad and Thornhill (1998), women rated the natural body odors of men's t-shirts worn for two days for pleasantness, sexiness and intensity. The researchers measured the men's facial and body symmetry, and then compared them to the women's ratings of the t-shirt odors. It was found that women at the fertile stage in their cycle preferred the natural odors of the symmetrical men, while they showed no preference while in their non-fertile stage. Additionally, women taking the birth control pill did not show preferences for the odor of symmetrical or non-symmetrical men. Since the birth control pill prevents ovulation, these results sug-

gest that this behavioral change only occurs during ovulation. Given that symmetry is hypothesized to be an indicator of good health, it is thought that ovulating women prefer the odors of symmetrical men in order to increase the likelihood of a viable pregnancy and healthy offspring.

The aforementioned research are a few articles that discuss shifts in female mate-preferences across the menstrual cycle. These changes are typically described by the dual mating hypothesis, in which: 1) long-term partner choice is influenced by a man's resources and his likelihood to invest highly in children, called investment attractiveness, and 2) sexual partner choice is influenced by a man's high genetic quality, or sexual desirability (Larson, Haselton, Gildersleeve, & Pillsworth, 2013). In theory, a woman's preference for sexual desirability will be highest when she is ovulating given it is the only phase in which she can become pregnant. However, investment attractiveness will remain constant across her cycle because resources and benefits from her long-term partner will be consistently available. After describing the dual mating hypothesis, Larson, Haselton, Gildersleeve, and Pillsworth (2013) studied how ovulation may affect women's feelings towards their romantic partners. Interestingly, it was found that the participants' feelings of closeness to their partners at ovulation varied depending on the sexual desirability of the man. Women in relationships with men of high sexual desirability were more likely to feel closer to them at times of peak fertility, while women in relationships with low sexually desirable men reported feeling less close to their partners at peak fertility. This research supports the dual mating hypothesis in that women partnered with low sexually desirable men – hypothesized to indicate low genetic quality – are more likely to consider short-term affairs during ovulation while continuing their long-term relationship involving resources and benefits. Additionally, the authors comment that women who can secure mates with both investment attractiveness and sexual desirability feel closer to their partner at times of peak fertility and are less likely to consider short-term affairs because their mate has qualities of good genetics.

In addition to measurable changes in women's mate-preference across the menstrual cycle, it appears that women also experience distinct and measurable shifts in their behavior during ovulation. Research conducted by Haselton, Mortezaie, Pillsworth, Bleske-Rechek, and Frederick (2007) set out to test whether women attempted to appear more attractive during their phase of fertility. To do this, women were photographed in both their fertile and non-fertile stages, then anonymous judges were instructed to choose the photograph in which they thought the woman was attempting to look more attractive. With high levels of agreement between judges, photographs of women in their fertile phase were chosen more consistently, and the fertile photographs were chosen at higher rates when she was closer to ovulation. Most significantly, women wore 'more fashionable' and nicer clothing during their fertile phase. According to the authors, women may try to look more attractive at ovulation in order to stand out in comparison to other women and gain the attention of potential mates. This evidence supports the authors' theory that distinct behavioral cues of fertility exist, and therefore ovulation is not concealed in humans (Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007).

Not only do women attempt to look more attractive during ovulation, but they also seem to pay more attention to attractive things as well. According to Lens, Driasmans, Panderlaere, and Janssens (2012), women pay more attention to status products during their fertile phase than during their non-fertile phase. Using a visual attention recall test, researchers asked women at various stages of their menstrual

cycle to remember products – high status (expensive cars, electronics, etc.) or daily functional products (towel, bucket, etc.) – and recall their positions on a screen. It was found that ovulating women were more likely to recall the high status product first, as well as its position, as opposed to women who were not in the fertile phase or women taking the birth control pill. As discussed previously, one's attractiveness is suggestive of good genes. Therefore, there may be an evolutionary basis for interest in any cues of high quality at peak fertility. The authors suggest that this is indicative of short-term mating goals of seeking out genetic quality rather than a long-term goal of resource acquisition.

In another study that focused on overtly measurable behavioral changes at ovulation, it was found that women are more likely to wear pink or red during their fertile rather than non-fertile phase of the menstrual cycle (Beall & Tracy, 2013). Using data previously discussed about women attempting to appear more attractive at ovulation (Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007) to guide their research, Beall and Tracy (2013) hypothesized that women would be more likely to wear shades of red at ovulation given that many mammals signal estrus using this color. Women at high fertility were more than three times as likely to be wearing a shade of red as women at low fertility. Additionally, if a woman was wearing red or pink, she was three times more likely to be at high fertility than low fertility. Beall and Tracy (2013) use these data to suggest

that color preference in clothing is a behavioral indicator of fertility, and can be used to attract a mate with high quality genetics.

Until recently, many researchers believed that women had lost estrus through evolution which allowed them to conceal ovulation (Gangestad & Thornhill, 2008). Today, however, many studies have indicated that ovulation is not concealed in humans as once thought. Instead, females exhibit various changes throughout their menstrual cycle related to mate-preference and behavior. The research discussed here found that at times of peak fertility during the menstrual cycle, women find facial cues of testosterone (Jones et al., 2008) and the scent of symmetrical men more attractive than non-symmetrical men (Gangestad & Thornhill, 1998), while also trying to appear more attractive (Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007) and paying more attention to attractive objects (Lens, Driasmans, Panderlaere, & Janssens, 2012). As discussed, health and testosterone in men manifest through qualities deemed attractive, leading women to prefer these cues when they are most likely to become pregnant. Given the distinct and measurable changes in female mate-preference and behavior at times of ovulation, estrus in humans is a highly viable possibility as opposed to concealed ovulation. Future studies should be conducted to determine if these results remain consistent across cultures, and if these behavioral changes across ovulatory cycles are seen universally in women.

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Jenna Lunge

Jenna Lunge is a psychology major with a cognitive science minor at the University of California, Merced. She is from San Ramon, CA and became interested in studying psychology while attending California High School. Jenna is a member of Delta Gamma Fraternity and is also a UC Regents Scholar, one of the most prestigious scholarships awarded to UC students. She expects to graduate in the spring of 2015, take one year off, and then pursue a Ph.D. in evolutionary psychology. Jenna recently went skydiving and is currently planning a six week post-graduation cross country road trip.