

Oestradiol level and opportunistic mating in women

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The ovarian steroid hormone oestradiol plays a crucial role in female fertility, sexual motivation and behaviour. We investigated the relationship between oestradiol and the likelihood that women would engage in opportunistic mating. Two salivary samples were taken from normally cycling women within the peri-ovulatory and luteal phase of the menstrual cycle. At both testing sessions, participants also completed self-perceived desirability scales and provided subjective reports of sexual and social motivations, and satisfaction with their primary relationship partner. Oestradiol level was positively associated with a woman's self- and other-perceived physical attractiveness and with inclinations to mate outside her current relationship. Oestradiol was marginally negatively associated with a woman's satisfaction with her primary partner and relationship commitment. Results provide support for the relationship between physical beauty and fertility and suggest that physiological mechanisms play a major role in guiding a woman's mating strategies.

Keywords: hormones; oestradiol; fertility; attractiveness

1. INTRODUCTION

Oestradiol is an ovarian hormone underlying female reproductive viability. Throughout evolutionary history, only very healthy women were capable of sustaining hormone concentrations necessary for successful reproduction (Ellison 2001). Women may ovulate, but if oestradiol is low, mature follicles may not be fertilizable or the endometrial thickness of the uterine wall may be inadequate to sustain pregnancy (Yoshimura & Wallach 1987). Furthermore, high oestradiol levels are associated with high conception probability (Lipson & Ellison 1996).

Oestradiol may play a role in increasing female mating motivation. When oestradiol levels are high, females of many species become receptive to copulation solicitations (Beach 1948; Kendrick & Dixson 1985). Ovariectomized females treated with oestradiol become more sexually attractive to males (Herbert & Trimble 1967; Dixson 1983). Female songbirds treated with oestradiol selectively attune to male song and perform copulation displays (Manney *et al.* 2008). Oestradiol may also be associated with higher mating standards. For instance, the hormone testosterone is related to dominance behaviours and may signal

immunocompetence. Cycling female rodents prefer the odours of high-testosterone males (Litvinova *et al.* 2005), and during oestrus, female chimpanzees (*Pan troglodytes*) become proceptive only to high-ranking males (Pieta 2008). Recent findings suggest that human females with high oestradiol also prefer men with higher testosterone (Roney & Simmons 2008).

Because ancestral women probably varied in their ability to produce offspring, men may have evolved attraction towards fertility indicators. Indeed, high female oestradiol levels are associated with having low fluctuating asymmetry (Jasienska *et al.* 2006), high facial attractiveness (Law Smith *et al.* 2006), large breasts and a low waist-to-hip ratio (Jasienska *et al.* 2004)—features men consider attractive (e.g. Singh 1993). Physically attractive women receive more male attention (Buss & Barnes 1986) and, when in relationships, are more likely to be the targets of mate poaching (Schmitt & Buss 2001).

Attractive women also have especially high mating standards (Buss & Shackelford 2008). Because it is difficult to obtain a partner who is a good provider and also has good genes, women often have to trade off between having a long-term mate who provides continual material resources and more physically attractive, short-term sexual partners with good genetic resources (Gangestad & Simpson 2000). However, highly attractive women demand greater amounts of both types of resources in a male partner, in addition to good parenting and partner skills (Buss & Shackelford 2008). Thus, physically attractive women may not only have more alternatives but also high standards that are difficult to satisfy. Accordingly, they may have fewer reasons to be committed to any particular partner if higher quality potential mates are available.

If oestradiol underlies female fertility and physical attractiveness and is associated with increased mating motivation, better mating opportunities and higher mating standards, then women's mating strategies, in general, should be calibrated to their oestradiol levels. Specifically, we predicted that high oestradiol would be associated with (i) objective ratings of women's physical attractiveness, (ii) women's self-perceived attractiveness, (iii) decreased overall satisfaction and commitment to their current long-term partners, and (iv) greater inclinations towards mating opportunities outside the primary relationship. We did not expect high-oestradiol women to be more interested in short- or even long-term relationships *per se*, but if such women have more mating opportunities and are less easily satisfiable, they should (v) have a greater number of lifetime, long-term partners.

2. MATERIAL AND METHODS**(a) Participants**

Fifty-two female undergraduates, not taking contraception, participated. Ages ranged from 17 to 30 years ($M=19.37$, $s.d.=2.12$).

(b) Procedure

Because hormone levels vary across the ovulatory cycle, we collected data from two points during each woman's ovulatory cycle: the late follicular (peri-ovulatory) and luteal phase. Cycle day was precisely measured with over-the-counter urine tests (Clearblue Easy Ovulation Test Kit), which pinpoint the day of ovulation within the follicular phase by measuring luteinizing hormone (LH). Follicular phase testing sessions took place at $M=0.10$ days after the LH surge (0.90 days before the day of ovulation, $s.d.=1.72$).

Luteal phase testing took place 6 days or more after the LH surge and at least 3 days ($M=5.75$, $s.d.=3.22$) before the onset of menses. In both sessions, participants deposited saliva samples into plastic vials.

Participants also rated (1 = not at all, 9 = extremely) their self-perceived physical attractiveness: compared with most women, (i) 'how attractive is your body to men?', (ii) 'how attractive is your face to men?', and (iii) 'how sexy would men say you are?' (composite $\alpha=0.90$). Participants reported lifetime number of long-term partners and rated the degree to which they 'typically seek or have sought long-term relationships' and the same item for short-term relationships (1 = never, 7 = often). The Sociosexual Orientation Inventory (SOI; Simpson & Gangestad 1991) measured the willingness to engage in uncommitted sex.

Paired participants ($n=25$) also rated their relationship commitment and emotional, sexual and overall satisfaction with the current partner (composite $\alpha=0.90$), and the per cent likelihood they would flirt, kiss, date and have a one-night stand or serious affair with another man outside the primary relationship within the next year.

Finally, during each session, a full-body photograph was taken. Two male and seven female undergraduate assistants, blind to the research, rated the pictures on the same items used for self-perceived attractiveness judgements ($\alpha=0.92$).

(c) Hormonal analyses

Salivary samples were frozen (-20°C) and sent to the Endocrine Core Laboratory at Yerkes National Primate Research Center (Atlanta, GA) for salivary oestradiol assaying. Oestradiol concentrations were estimated using a commercial enzyme immunoassay kit (American Laboratory Products Company, Salem, NH). Hormone concentrations were obtained in duplicate and the intra-assay coefficients of variation (CV) were 10.5 per cent at 1.84 pg ml^{-1} and 12 per cent at 3.78 pg ml^{-1} , and inter-assay CV were 3.67 per cent at 3.95 pg ml^{-1} , 0.18 per cent at 14.71 pg ml^{-1} and 8.16 per cent at 30.43 pg ml^{-1} . Oestradiol was detectable in 45 participants' samples. Late follicular and luteal phase samples were highly intercorrelated ($r=0.57$), and there was no difference in salivary oestradiol concentration between the late follicular and luteal phase of the cycle ($p=0.42$). Therefore, the mean hormone concentration from both samples was used in the final analyses.

3. RESULTS

Oestradiol concentrations were not normally distributed (Shapiro–Wilk, $p=0.000$). Thus, oestradiol's association with the dependent measures was examined using non-parametric, rank-order correlations. All dependent measures were highly correlated between cycle phase (all $r_s > 0.43$ and $p_s < 0.04$). Thus, the data were collapsed along the luteal and follicular phase.

(a) Attractiveness, satisfaction and commitment

Oestradiol level was positively correlated with self-perceived ($r(45)=0.46$, $p=0.001$, $d=1.04$) and other-perceived attractiveness ($r(44)=0.41$, $p=0.005$, $d=0.90$). Oestradiol was not significantly correlated with women's relationship satisfaction ($r(25)=-0.33$, $p=0.095$, $d=0.70$) or commitment ($r(25)=-0.37$, $p=0.067$, $d=0.80$).

(b) Mating orientation and history

Oestradiol was positively correlated with lifetime number of long-term relationships ($r(45)=0.37$, $p=0.013$, $d=0.80$). However, oestradiol was not associated with preferences for long-term ($r(45)=0.08$, $p=0.62$) or short-term relationships ($r(45)=-0.05$, $p=0.75$) or with SOI score ($r(45)=0.17$, $p=0.29$). Furthermore, there was no relationship between oestradiol and the number of one-night stands ($r(45)=0.03$, $p=0.85$).

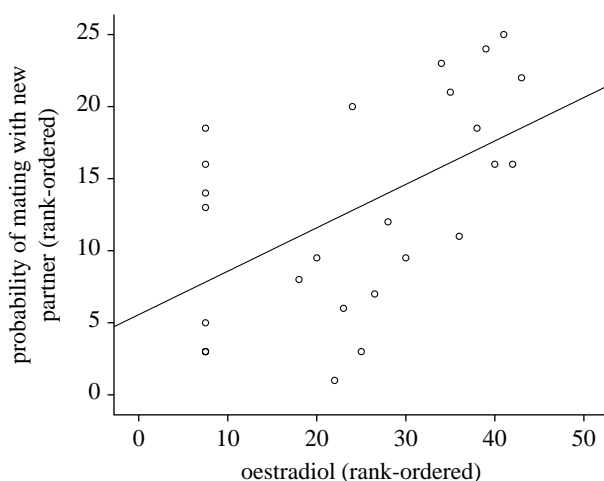


Figure 1. Rank-ordered composite of women's probability of mating with new partner (i.e. average of flirt, kiss, date, serious affair; $\alpha=0.84$) versus rank-ordered oestradiol concentrations.

(c) Mating with affair partner

Women with higher oestradiol reported a greater likelihood of flirting, kissing and having a serious affair (all $p_s < 0.041$ and $d_s > 0.89$) with someone other than their primary partner and were marginally more likely to date another man (figure 1). Oestradiol was not related to the likelihood of a one-night stand ($r(25)=0.21$, $p=0.31$; table 1).

(d) Does physical attractiveness mediate the relationship between oestradiol and mating behaviour?

It is possible that, while oestradiol influences fertility and physical attractiveness, women's mating behaviours and preferences could be based on the feedback they receive from their physical attractiveness. Accordingly, we considered the possibility that attractiveness mediates (Baron & Kenny 1986) the relationship between oestradiol and the mating variables. We separately regressed self- and other-perceived attractiveness onto oestradiol and obtained a residualized oestradiol score from each regression that effectively removed the influence of each attractiveness variable. Subsequent rank-order correlations using the residualized oestradiol scores determined that the relationship between oestradiol and the dependent mating measures remained robust after removing the influence of self-perceived attractiveness, though the relationship between oestradiol and the likelihood of flirting with another man became only marginally significant (table 2). A regression analysis revealed that self-perceived attractiveness positively predicted flirting with another man ($\beta=0.42$, $p=0.016$). However, a Sobel mediation test indicated that self-perceived attractiveness did not significantly mediate the relationship between oestradiol and flirting ($z=0.352$, $p=0.72$).¹

¹The mediation regression that forms the basis for the Sobel test met the assumption that the residuals are normally distributed (Shapiro–Wilk, $p=0.33$).

Table 1. Spearman's rank-order correlations between women's oestradiol and willingness to mate with affair partner. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.)

	flirt	kiss	date	one-night stand	serious affair
oestradiol (pg ml ⁻¹)	0.55*** $p=0.004$ $d=0.132$	0.44** $p=0.029$ $d=0.98$	0.35* $p=0.085$ $d=0.75$	0.21 $p=0.308$ $d=0.43$	0.41** $p=0.040$ $d=0.90$

Table 2. Spearman's rank-order correlations between residualized oestradiol and willingness to mate with affair partner. (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.)

	flirt	kiss	date	serious affair
residualized oestradiol (self-perceived attractiveness removed)	0.37* $p=0.065$ $d=0.80$	0.44** $p=0.026$ $d=0.98$	0.35* $p=0.084$ $d=0.75$	0.47** $p=0.018$ $d=1.06$
residualized oestradiol (other-perceived attractiveness removed)	0.55*** $p=0.005$ $d=1.32$	0.70*** $p=0.000$ $d=1.96$	0.56*** $p=0.004$ $d=1.35$	0.63*** $p=0.001$ $d=1.60$

4. DISCUSSION

High-oestradiol women were considered significantly more physically attractive by themselves and others. These women reported somewhat lower levels of satisfaction with and commitment to their primary partners, and a significantly greater likelihood along various dimensions of becoming acquainted with new potential mates. However, whereas high-oestradiol women reported being significantly more likely to have a serious affair, they did not indicate a greater likelihood of having brief sexual encounters. Furthermore, high-oestradiol women had significantly more long-term, but not short-term, relationships. Therefore, the results suggest that women with high oestradiol levels have higher mate value and are more likely to be aligned towards serial monogamy.

Fertility is variable not only between women but also within women, as cycle fecundity depends on oestradiol concentrations (Lipson & Ellison 1996). Our results are consistent with the possibility that highly fertile women are not easily satisfied by their long-term partners and are especially motivated to become acquainted with other, presumably more desirable, men. Importantly, such motivations do not seem to stem from a greater interest in casual sex, differences of sociosexuality or even preferences for long-term mating *per se*. The results suggest that although high-oestradiol women may not subjectively prefer long- over short-term relationships, they nonetheless adopt a strategy of serial monogamy. Without necessarily being consciously aware of their motives, highly attractive women are probably able to capitalize on their desirability and continually acquire valuable resources and a higher quality long-term mate by trading-up when the opportunity arises.

Although we hypothesized that oestradiol underlies a woman's mating strategy, we cannot be sure whether oestradiol directly controls the investigated variables. One possibility is that women who perceive their current partner to be of higher quality than other men may be less likely to move on to a new relationship and the influence of oestradiol on mating

behaviour may be attenuated. Another possibility is that high-oestradiol women, by being physically attractive, face better mating opportunities, which then influences how they adjust their mating behaviours and attitudes. However, mediation analyses generally did not support this possibility. Nevertheless, considering hormone (e.g. Roney & Simmons 2008) and extensive mating and relationship research (e.g. Buss & Shackelford 2008), we believe that links between oestradiol and mating strategy probably involve both direct causal paths and indirect feedback loops.

Taken together with other research (e.g. Jasienska *et al.* 2004; Law Smith *et al.* 2006), the current findings provide preliminary support for links between human oestradiol concentration, mate value and mating motivations. In particular, the study suggests that, despite characteristics of human fertility diverging from those of many other species, the mating behaviour of human females may be guided by homologous physiological mechanisms that regulate fertility. These results open the door to future research into the neuroendocrine components that underlie human mating attitudes and behaviour. More generally, deeper examinations of the relationship between hormones and human behaviour can shed light on the causal factors involved in decision-making processes.

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