



## Endogenous estradiol levels are associated with attachment avoidance and implicit intimacy motivation

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### ABSTRACT

Estradiol has been linked with attachment and caregiving processes in humans and other mammals; however, relations between estradiol and personality constructs relevant to intimate relationships have not yet been explored. In the present sample of 100 adult participants (52 men, 48 women), we examined endogenous estradiol levels in relation to two personality constructs that predict comfort with and desire for close, intimate relationships—attachment style and implicit intimacy motivation. In both men and women, estradiol levels were predicted by an interaction between a dimension of attachment style—attachment avoidance—and implicit intimacy motivation. Specifically, the highest estradiol levels were observed among participants whose explicit traits support the expression of their implicit motives, that is, those characterized by both low avoidance and high intimacy motivation. Our findings provide novel evidence that endogenous estradiol levels are associated with relationship-relevant personality constructs in theoretically meaningful ways. These findings also highlight the importance of considering interactions between implicit and explicit personality constructs in the study of the biological bases of personality.

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### Introduction

Estradiol has been associated with the regulation of attachment and caregiving processes in humans and other mammals (Dwyer, 2008; Lévy and Fleming, 2006). Levels of this steroid hormone are highest in females just prior to ovulation (Johnson and Everitt, 2000), when sexual motivation also tends to peak (e.g., Adams et al., 1978). Estradiol rises during pregnancy, peaks around parturition, and then declines following birth (e.g., Storey et al., 2000). The rise of estradiol prior to delivery is thought to be critical for the onset of maternal behavior (Wynne-Edwards and Reburn, 2000). During this period, for instance, pregnant female macaques demonstrate heightened caregiving behavior toward other females' infants, and such behavior is correlated with rising estradiol levels (Maestripieri and Zehr, 1998). Higher prepartum estradiol levels also predict more effective caregiving toward neonates among red-bellied tamarin monkeys (Pryce et al., 1988). In humans, mothers who maintain high levels of estradiol before and after childbirth report feeling more attached to their infants after birth compared to postpartum women with lower levels of estradiol (Fleming et al., 1997).

Although research with males is more limited, estradiol has also been linked with paternal caregiving behavior (Wynne-Edwards, 2001). For instance, following an estradiol inhibitor during adoles-

cence, male hamsters are less attentive to pups during and after birth (Timonin and Wynne-Edwards, 2008). In humans and nonhuman primates, estradiol levels are higher among expectant fathers compared to non-fathers (Berg and Wynne-Edwards, 2001), particularly among those with prior parental experience (Ziegler et al., 2004).

These findings suggest that state levels of estradiol fluctuate in response to both biological processes (e.g., pregnancy) and social contexts (e.g., parental experience). However, many steroid hormones also exhibit some trait-like properties (e.g., testosterone, Sellers et al., 2007), including those that vary over the course of the menstrual cycle in women (e.g., progesterone, Liening et al., 2010). For instance, Chatterton et al. (2004) obtained several estradiol samples from women over a 15-month period and found that correlations among estradiol levels at the same point of the menstrual cycle ranged from .88 to .96. These results indicate considerable rank-order stability of estradiol over time. That is, individuals who had high estradiol levels (relative to the overall sample) at one assessment also tended to have relatively high levels at later assessments. Estradiol also appears to be relatively stable over time in male subjects (Kaneda and Ohmori, 2005).

Thus, differences in estradiol levels may reflect not only state fluctuations, but also more stable trait-like differences. Such findings raise the intriguing possibility that estradiol is associated with other similarly stable constructs, such as human personality traits. Specifically, the links between estradiol and attachment processes described earlier suggest that estradiol may be particularly relevant for

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personality constructs that are associated with interpersonal relationships. Yet, relatively few studies have examined associations between endogenous estradiol levels and personality traits and, to our knowledge, none have investigated associations between estradiol and personality constructs with direct relevance for close relationships. With respect to personality more generally, there is some evidence that estradiol is positively associated with aspects of reward-seeking, risk-taking, and sensation-seeking (Daitzman and Zuckerman, 1980; Vermeersch et al., 2008, 2009). Although these constructs may have some indirect implications for close relationships, they are not measures of interpersonal processes per se.

In sum, despite the established links between estradiol and attachment processes, it is not yet known whether estradiol is associated with more stable relationship-relevant personality variables in humans. In the present study, we examined endogenous estradiol levels in relation to two personality constructs that predict comfort with and desire for close, intimate relationships: attachment style (Shaver and Mikulincer, 2006) and implicit intimacy motivation (McAdams, 1980). These constructs represent two aspects of personality—the first more explicit or conscious and the second more implicit or nonconscious—that play an important role in human attachment processes and may therefore be associated with endogenous estradiol levels. Although extensive research has documented the role of these personality constructs in relationship processes (e.g., Feeney, 2008; McAdams and Constantian, 1983), to our knowledge our study is the first to examine their association with estradiol levels. In addition, previous work demonstrates that explicit and implicit personality constructs interact to predict important life outcomes, such as satisfaction with work and relationships (Winter et al., 1998). By including both implicit and explicit personality measures in the current study, we had the opportunity to further investigate such interactions in relation to biological processes.

Individual differences in adult attachment are generally represented by two independent, continuous dimensions, attachment-related avoidance and anxiety (Shaver and Mikulincer, 2006). Attachment orientations tend to be relatively stable over time (e.g., Fraley, 2002; Kirkpatrick and Hazan, 1994), although, like many personality traits, they can also show some variability across situations (La Guardia et al., 2000). Individuals with high scores on the avoidance dimension report discomfort with close relationships, including both romantic relationships and parent–child relationships (e.g., Edelstein and Shaver, 2004; Rholes et al., 2006). They dislike physical and emotional intimacy (e.g., Brennan et al., 1998b) and report feeling less close to their children (Rholes et al., 1995). As caregivers, avoidant adults maintain distance from relationship partners (Kunce and Shaver, 1994) and report more self-serving motives for helping others (Feeney and Collins, 2003). Observer ratings of behavior further indicate that avoidant individuals are particularly unsupportive when relationship partners are highly distressed (e.g., Edelstein et al., 2004; Fraley and Shaver, 1998). These findings, linking avoidance with impoverished attachment relationships and poor quality caregiving behavior, led us to predict that higher levels of avoidance would be associated with lower estradiol levels.

The anxiety dimension reflects fears of being alone and preoccupation with intimacy and relationship partners (e.g., Davis et al., 2003). Individuals with high scores on the anxiety dimension are hypervigilant to attachment-related concerns (Mikulincer et al., 2002) and easily distressed by even brief separations from relationship partners (e.g., Fraley and Shaver, 1998). Anxious individuals also tend to be insensitive caregivers, although they are likely to be overly involved or intrusive rather than distant (Kunce and Shaver, 1994), and their motivations for caregiving include trying to keep relationship partners from leaving (Feeney and Collins, 2003). Predictions for anxiety in relation to estradiol levels are less clear than those for avoidance. On the one hand, anxious adults are highly attuned to

relationships and often overly involved with their partners, which could be associated with higher estradiol levels. On the other hand, anxious individuals show deficits in caregiving—albeit of a different nature than those of avoidant individuals—which could instead be associated with lower estradiol levels. In the present study, we therefore considered the investigation of attachment anxiety in relation to estradiol levels more exploratory.

Assessments of attachment style are based on people's explicit, self-reported orientations toward close relationships. Implicit motives, in contrast, are thought to be inaccessible to conscious awareness and are assessed via indirect rather than self-report measures (Schultheiss and Pang, 2007). In general, implicit motives are defined as driving forces that shape, organize, and energize behavior toward desired goal states (Murray, 1938). Motives are more fluid than traits and therefore tend to be somewhat less stable over time (e.g., Schultheiss et al., 2008); nevertheless, motives measured at one point in time have been shown to predict more distal life outcomes, such as the likelihood of marriage (Winter et al., 1998). Implicit intimacy motivation is specifically characterized by the goal state of warm, close, and communicative exchange with another person (McAdams, 1980). Individuals with high levels of intimacy motivation are thought to be concerned with the quality of specific close relationships, particularly the deepening and broadening of important relationships, as opposed to the quantity of interpersonal relationships or more superficial aspects of relationships in general (McAdams, 1992).

Numerous studies document the significance of implicit intimacy motivation for close relationship processes. For instance, intimacy motivation is positively associated with self-disclosure (Craig et al., 1994; McAdams et al., 1984), an important component of the development of interpersonal intimacy (Reis and Shaver, 1988). People with high levels of intimacy motivation are perceived by others as warmer, more loving, and more sincere than those with lower levels of intimacy motivation (McAdams, 1980). They think more often about close relationships (McAdams and Constantian, 1983), express greater concern with friends' well-being (McAdams et al., 1984), and spend more time interacting with others (McAdams and Constantian, 1983), particularly in dyads (Craig et al., 1994). When asked to recall significant life experiences, individuals with high levels of intimacy motivation are more likely to focus on memories that emphasize relationships and closeness (King and Noelle, 2005; McAdams, 1982). Given that implicit intimacy motivation is linked with a desire for and a focus on close, intimate relationships, in the present study we expected that higher levels of intimacy motivation would be associated with higher estradiol levels.

However, it is also important to note the importance of interactions between implicit and explicit personality constructs (McClelland et al., 1989; Winter et al., 1998). Winter et al. proposed that the behavioral expression of implicit motives is channeled by more explicit traits. That is, whether and how an implicit motive is expressed depends on the extent to which explicit traits support or hinder such expression. In support of this idea, Brunstein et al. (2005) found that implicit and explicit achievement motivation interacted to predict students' performance on a laboratory achievement task: Students characterized by high levels of both implicit and explicit achievement motivation showed the most improvement on a task in which they believed they were doing poorly. For students with low levels of explicit achievement motivation, implicit achievement motivation had little effect on performance. Brunstein et al. interpret these findings as reflecting the ability of explicit desires for achievement to recruit and focus implicit achievement motives in the service of task performance.

Winter et al. (1998) similarly found that implicit motives and explicit traits operated in a synergistic manner to predict important life outcomes. For instance, implicit power motivation interacted with the explicit trait of extraversion (characterized by talkativeness,

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