



Original Article

Hormones and social monitoring: Menstrual cycle shifts in progesterone underlie women's sensitivity to social information[☆]

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ABSTRACT

During the luteal phase of the menstrual cycle, women's bodies prepare themselves for possible pregnancy and this preparation includes a dramatic increase in progesterone. This increase in progesterone may underlie a variety of functionally relevant psychological changes designed to help women overcome challenges historically encountered during pregnancy (e.g., warding off social threats and recruiting allies). This paper reports data supporting the hypothesis that increases in progesterone during the luteal phase underlie heightened levels of social monitoring—that is, heightened sensitivity to social cues indicating the presence of social opportunity or threat. Increases in progesterone during the luteal phase were associated with increased accuracy in decoding facial expressions (Study 1) and increased attention to social stimuli (Study 2). Findings suggest that increases in progesterone during the luteal phase may be linked functionally with low-level perceptual attunements that help women effectively navigate their social world.

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To navigate the challenges of everyday social life, people must be keenly aware of the opportunities and threats afforded by other people. Indeed, people are profoundly sensitive to information indicating the presence of others who might help or harm them (Ackerman et al., 2009; Delton et al., 2012; DeWall, Maner, & Rouby, 2009; Öhman & Mineka, 2001). Although an emerging literature has revealed a number of factors that affect people's sensitivity to social information, less is known about how this sensitivity is guided by evolved physiological processes. In this paper we use an adaptationist framework to investigate a relatively covert yet powerful physiological determinant of women's sensitivity to social information. In two studies, we test the hypothesis that increases in progesterone during the luteal phase of the menstrual cycle promote heightened sensitivity to social cues.

1. Luteal phase increases in progesterone prepare the body for pregnancy

The luteal phase of a woman's menstrual cycle (the period immediately following ovulation and lasting until the onset of menstruation) is marked by her body's preparation for possible pregnancy. During this time, the dominant follicle turns into the

corpus luteum, the endometrium thickens, and body temperature increases—all to promote the growth of a fertilized egg (Gilbert, 2000). Notably, these changes occur regardless of whether conception has actually occurred. This is consistent with the logic of error management theory (Haselton & Buss, 2000; Haselton & Nettle, 2006): the energetic costs of preparing for possible pregnancy in the absence of conception are outweighed by the reproductive costs of failing to generate the necessary environment for the growth of a fertilized egg. Thus, during the luteal phase of each menstrual cycle, a woman's body prepares itself for possible pregnancy whether or not an egg has actually been fertilized.

From an adaptationist perspective, the physiological changes initiated during the luteal phase should underlie relevant psychological processes designed to overcome challenges historically associated with pregnancy (Conway et al., 2007; Fessler, 2002; Jones et al., 2005; Navarrete, Fessler, & Eng, 2007). For example, to prevent their bodies from rejecting a growing fetus, women experience suppressed immune system functioning during the luteal phase, and this immunosuppression increases their vulnerability to forms of contagious illness (Robinson & Klein, 2012). Consequently, immunosuppression during the luteal phase is accompanied by corresponding psychological processes aimed at helping women avoid potential disease: During the luteal phase (and into the first trimester of pregnancy), women display high sensitivity to disgusting stimuli and they avoid sources of potential disease such as public restrooms and undercooked meat (Fessler, 2002; Fleischman & Fessler, 2011).

Moreover, many of the physiological and behavioral processes that occur during the luteal phase are mediated by increases in

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progesterone. The luteal phase is associated with dramatic increases in progesterone: women experience increases in progesterone from the follicular phase to luteal phase that can range up to 1000% (Schultheiss, Dargel, & Rohde, 2003). During the luteal phase, the corpus luteum generates progesterone which, in turn, helps build and maintain the endometrial lining. If an egg is fertilized, progesterone levels continue to rise throughout pregnancy. Increased levels of progesterone during the luteal phase may serve as a catalyst not only for physiological changes that facilitate the growth of a fertilized egg, but also for adaptive psychological changes that could help women face challenges during pregnancy. Women's tendency to avoid potential sources of disease during the luteal phase, for example, appears to be mediated by increases in progesterone (Fleischman & Fessler, 2011).

In addition to challenges associated with immunosuppression, pregnancy also increases women's need to vigilantly avoid social threats and to recruit social allies. In many species, pregnancy hinders females' ability to locomote and the energetic costs of incubating unborn offspring reduces their capacity to pursue other goals (Ghalambor, Reznick & Walker, 2004; Kullberg, Houston, & Metcalfe, 2002; Shine, 2003). Consequently pregnant females experience reduced ability to forage for food and flee from predators and physical aggressors (Lee, Witter, Cuthill, & Goldsmith, 1996; Schwarzkopf & Shine, 1992). Indeed, throughout evolutionary history, pregnancy has involved heightened susceptibility to social threats and, as a result, it also increased women's reliance on allies who could provide resources and protection (Taylor, Klein, Lewis, Gruenewald, Gurung, & Updegraff, 2000). Consequently, psychological processes designed to avoid social threats and to nurture social alliances may arise from the increase in progesterone that occurs during the luteal phase.

2. Progesterone and social monitoring

Avoiding social threats and nurturing social alliances require a high degree of sensitivity to the social cues displayed by other people. Accordingly, heightened levels of progesterone during the luteal phase may promote early-stage perceptual attunements to a range of social cues. In line with this reasoning, we tested the hypothesis that progesterone may be a physiological catalyst for the activation of what Gardner and colleagues have termed the social monitoring system (Gardner, Pickett, & Brewer, 2000; Gardner, Pickett, Jefferis, & Knowles, 2005; Pickett, Gardner, & Knowles, 2004).

The social monitoring system is a psychological system that increases people's awareness of social cues signaling the presence of others who might help or harm them (Gardner et al., 2000; Pickett et al., 2004). When people are susceptible to threats or in need of allies, activation of the social monitoring system is up-regulated in order to quickly identify other people's interpersonal intentions. Activation of the social monitoring system is associated with heightened encoding of cues signaling possible social acceptance or social threat, such as those communicated in other people's facial expressions and vocal tones (Gardner et al., 2000, 2005; Pickett et al., 2004). By increasing sensitivity to such social cues, the social monitoring system helps people react appropriately to potential social allies or threats.

Pregnancy historically heightened women's susceptibility to social threats and increased their need for social support. Therefore, increases in progesterone during the luteal phase—a physiological process that prepares the women's bodies and minds for possible pregnancy—may cause an increase in social monitoring. Increases in social monitoring would help women adaptively navigate their social world during a time in which social interactions have especially significant consequences.

A handful of studies suggest that increases in progesterone might mediate increased processing of social cues, particularly the negative emotional signals displayed by others (Sakaki & Mather, 2012). For example, late in pregnancy when progesterone levels are especially

high, women sometimes display heightened encoding of threat faces and sad faces (Pearson et al., 2009). Similarly, administration of progesterone has been shown to increase amygdala responses to angry and fearful faces (van Wingen et al., 2008; cf. Derntl, Windischberger et al., 2008b). In another study, women in the luteal phase judged disgust and fear expressions as more intense than women in the follicular phase did (Conway et al., 2007). Heightened judgments of anger and disgust in other people's faces have also been linked directly to high levels of progesterone (Derntl, Kryspin-Exner, Fernbach, Moser and Habel, 2008; Derntl, Windischberger et al., 2008). “Seeing” strong displays of anger or hostility in the faces of others could help women avoid potential sources of threat (Maner et al., 2005), a pattern that would be particularly functional when women are pregnant and especially vulnerable to danger (Taylor et al., 2000).

Thus, several studies suggest that women in the luteal phase tend to over-perceive negative emotions such as anger and disgust (Derntl, Kryspin-Exner, Fernbach, Moser and Habel, 2008; Derntl, Windischberger et al., 2008; Guapo et al., 2009). The implications of such over-perceptions for accurately detecting and decoding emotional displays are unclear. On one hand, over-perceiving negative emotions may prompt lower accuracy, as women mistake other expressions for ones signaling anger and contempt (Derntl et al., 2013). On the other hand, heightened social monitoring could result in both biased judgments (e.g., in over-interpreting expressions of anger) and increased accuracy (e.g., in initially detecting and decoding the emotions of others). Indeed, results pertaining to accuracy have been somewhat mixed. For example, one study showed that high progesterone levels biased women toward over-perceiving negative facial expressions in others, but at the same time were associated with greater accuracy in decoding the emotions experienced by other people in emotionally arousing scenarios (Derntl et al., 2013).

3. Overview of the current research

The current research extends this literature in a number of ways. First, some previous studies are limited by the fact that they did not examine the role of progesterone, instead focusing on effects of pregnancy or on differences between women in the luteal versus follicular phases. The current studies directly examined the role of progesterone using actuarial hormone estimates (Study 1) and direct salivary assays (Study 2). Second, the current studies focused on quick, initial perceptions of emotional stimuli. Many of the previous investigations described earlier assessed relatively overt social judgments. For example, some previous investigations presented participants with facial stimuli for several seconds, which could allow elaborative processing to occur (e.g., Derntl et al., 2013); thus previous findings could reflect higher-order inferences about emotions, in addition to participants' initial decoding of facial emotion. In the current studies, we assessed responses to emotional faces that were presented more quickly for 1 second (Study 1) or 500 ms (Study 2). Third, in addition to assessing the way people decode emotional displays, we examined rapid attention to emotional stimuli (Study 2). Finally, we included positive emotional expressions in Study 2 to assess the link between progesterone and attention to signs of affiliation. Although some previous studies included positive emotional expressions, processing of those stimuli sometimes demonstrated ceiling effects, making interpretation of the findings difficult (e.g., Pearson et al., 2009).

Indeed, in addition to heightening women's sensitivity to signs of pathogen avoidance and physical threat, luteal phase increases in progesterone may also be linked with psychological processes that facilitate the creation and maintenance of social alliances. Taylor and colleagues (2000) reviewed evidence that females from many species are highly motivated to “tend and befriend” social allies, especially when they are pregnant and susceptible to danger. Moreover, Taylor

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