


# The Endocrinology of Exclusion: Rejection Elicits Motivationally Tuned Changes in Progesterone

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Psychological Science  
21(4) 581–588  
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sagepub.com/journalsPermissions.nav  
DOI: 10.1177/0956797610362676  
<http://pss.sagepub.com>  


## Abstract

Social exclusion can have profound effects on a vast array of motivated psychological processes, from social withdrawal and aggression to prosocial behavior and social affiliation. The current studies examined motivationally tuned endocrinological consequences of exclusion by measuring the release of progesterone, a hormone that reflects an individual's level of social-affiliative motivation. Results from two experiments indicate that release of progesterone following social exclusion depends on people's levels of social anxiety and rejection sensitivity. Individuals high in social anxiety displayed a drop in progesterone in response to exclusion, a pattern consistent with a lack of affiliative motivation. In contrast, individuals high in rejection sensitivity displayed an increase in progesterone when given an opportunity to reaffiliate, a change consistent with a desire for compensatory social contact. These findings provide new insight into the immediate biological changes precipitated by social exclusion—changes that could initiate a range of motivated social responses.

## Keywords

hormones, rejection, social exclusion, rejection sensitivity, social anxiety, motivation

Received 6/22/09; Revision accepted 8/7/09

The desire for positive social relationships reflects a fundamental human need rooted deeply in human evolutionary biology (Baumeister & Leary, 1995; Taylor et al., 2000). Social exclusion and rejection thwart this need for social belonging and, consequently, have profound effects on a vast array of psychological and interpersonal processes (Baumeister, DeWall, Ciarocco, & Twenge, 2005; Leary, 1990; Williams, Cheung, & Choi, 2000).

The current research contributes to the social-exclusion literature in two ways. First, we investigated effects of exclusion on the release of progesterone, a hormone that reflects one's level of affiliative motivation. Through this investigation, we created new links between research on social exclusion and a large literature on behavioral endocrinology. Second, we examined personality factors (social anxiety and rejection sensitivity) expected to moderate the effects of social exclusion on progesterone. Identifying such moderating variables provides important clues as to who might respond to exclusion with a desire for compensatory social affiliation or a desire for social withdrawal.

state resembling physical pain (Eisenberger, Lieberman, & Williams, 2003; MacDonald & Leary, 2005). How do people respond to the pain of social exclusion? On one hand, some studies suggest that people respond by withdrawing from others, as a way of protecting themselves from further rejection in the short term and shoring up resources to strengthen the self (Allen & Badcock, 2003; Molden, Lucas, Gardner, Dean, & Knowles, 2009). Moreover, several studies indicate that exclusion can promote aggression and interpersonal contempt (Buckley, Winkel, & Leary, 2004; Leary, Twenge, & Quinlivan, 2006; Twenge, Baumeister, Tice, & Stucke, 2001), possibly as a means of trying to regain control over the situation (Warburton, Williams, & Cairns, 2006). Thus, antisocial responses to social exclusion are well documented.

On the other hand, studies suggest that people sometimes respond to exclusion with a heightened desire to affiliate and reconnect with other people. When feeling ostracized, for example, people sometimes respond by conforming to the

## Responses to Social Exclusion

Rejection, ostracism, and other forms of social exclusion can be highly aversive and can precipitate a neuropsychological

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opinions of others, possibly as a way of trying to regain social acceptance (Williams et al., 2000). People also respond to rejection by attending carefully to others who display positive social cues signaling acceptance (DeWall, Maner, & Rouby, 2009; see also Gardner, Pickett, & Brewer, 2000; Pickett, Gardner, & Knowles, 2004) and by behaving generously toward others who represent good prospects for friendship (Maner, DeWall, Baumeister, & Schaller, 2007). Thus, although people sometimes respond to exclusion with social withdrawal and contempt, they sometimes instead respond with a strong desire to reconnect with the social world.

## The Role of Progesterone

In humans and other species, the neuroendocrine system provides a foundation for a broad range of motivated social processes (e.g., Josephs, Sellers, Newman, & Mehta, 2006; Maner, Miller, Schmidt, & Eckel, 2008). Some work has documented heightened cortisol levels in response to rejection, suggesting that exclusion is at some level experienced as a stressful event (Blackhart, Eckel, & Tice, 2007). However, evidence for other endocrinological responses to exclusion is limited.

One of the most intriguing questions raised by the social-exclusion literature is whether exclusion motivates social withdrawal or social affiliation. Thus, we investigated the effects of exclusion on a hormone closely tied to the presence (or absence) of social affiliative motivation: progesterone. Most studies of exclusion have tended to infer the presence of affiliative or antisocial motives by observing cognitively “downstream” consequences of exclusion—overt social judgments, prosocial behavior, aggression, and the like. Insofar as progesterone levels reflect a basic biological underpinning of affiliative motivation, examination of progesterone responses provides a particularly direct window into the immediate motivational consequences of exclusion.

Strong evidence demonstrates that progesterone levels reflect an individual’s motivation to affiliate and bond with others. In female rats, for example, affiliative behavior is greatest during proestrus, coincident with peak circulating levels of progesterone (Frye, Petralia, & Rhodes, 2000). Conversely, blocking allopregnanolone (a progesterone metabolite) reduces rats’ tendencies to seek social contact (Frye et al., 2006). Animal models indicate that release of progesterone works in concert with release of oxytocin, another hormone linked with social bonding, to promote social-affiliative behavior (Miyamoto & Schams, 1991).

In humans, basal progesterone levels are correlated with individual differences in implicit affiliative motivation, with higher progesterone levels reflecting a greater desire to affiliate with others (Wirth & Schultheiss, 2006). Natural fluctuations in progesterone occurring throughout women’s menstrual cycles are mirrored by fluctuations in social-affiliative motivation (Schultheiss, Dargel, & Rohde, 2003). Women on oral contraceptives (which typically contain a progesterone

derivative) display higher levels of affiliative motivation than do women not on birth control, who experience intervals of low progesterone secretion during the follicular phase (Schultheiss et al., 2003).

In a study relevant to the current work, Schultheiss, Wirth, and Stanton (2004) found that watching a movie intended to elicit affiliative motivation (compared with a control movie) led both male and female participants to display heightened levels of progesterone. Similarly, engaging in an interpersonal-closeness task with a partner (compared with a control task) led participants to display increased progesterone; increases in progesterone during a second session in the same study 1 week later predicted participants’ altruistic motivations toward their partner (Brown et al., 2009).

Indeed, both the human and the nonhuman animal literatures indicate that release of progesterone regulates behaviors aimed at bringing individuals into close proximity with one another, thus facilitating the formation of close social bonds (Taylor, 2006; Taylor et al., 2000). It should be noted that although women have higher endogenous levels of progesterone than men do, both men and women exhibit the link between fluctuations in progesterone and changes in affiliation seeking (Schultheiss et al., 2004; Wirth & Schultheiss, 2006).

One recent study provides suggestive evidence pertaining to the link between social exclusion and progesterone. Wirth and Schultheiss (2006) had participants watch a movie clip in which a young child is rejected by his mother. Male and female participants who watched this movie clip subsequently displayed higher progesterone levels than did participants who watched a control movie clip. This finding is consistent with the possibility that being primed with feelings of exclusion promotes endocrinological processes reflecting social-affiliative motivation.

## Moderating Variables

In addition to examining changes in progesterone following social exclusion, we examined individual difference variables expected to moderate progesterone responses. We included two individual differences that have been highlighted in the social-exclusion literature: social anxiety and rejection sensitivity. Social anxiety reflects a tendency to experience anxiety and worry in the context of social interactions. Highly socially anxious people tend to display hypervigilance to possible embarrassment or rejection and thus tend to avoid social interactions (Barlow, 2002). The negative effects of exclusion are especially pronounced among highly socially anxious individuals (Oaten, Williams, Jones, & Zadro, 2008). Socially anxious individuals tend to generalize from a single instance of rejection to other potential partners, leading them to view even novel partners as sources of further rejection, rather than as sources of potential affiliation (Maner et al., 2007). In response to rejection, highly socially anxious individuals display interpersonal deficits, such as a lack of eye contact, that reflect a

tendency toward social withdrawal (Mallott, Maner, DeWall, & Schmidt, 2009). Thus, we expected a person's degree of social anxiety to moderate his or her progesterone reactivity in response to exclusion. Relative to nonanxious people, highly anxious individuals were expected to respond to exclusion with greater drops in their levels of progesterone (a pattern consistent with a desire for social withdrawal). Moderating effects of social anxiety were examined in Study 1.

The second individual difference variable we examined was rejection sensitivity, which refers to the tendency to anxiously expect, readily perceive, and respond strongly to instances of rejection (Downey & Feldman, 1996). We expected that individuals low in rejection sensitivity would not be especially reactive to a rejection manipulation, whereas individuals high in rejection sensitivity would display a greater change in hormonal levels (i.e., heightened reactivity).

What was the expected direction of this reactivity? Highly rejection-sensitive individuals often respond to perceived rejection with hostility and contempt (Ayduk, Gyurak, & Luerssen, 2008; Downey, Bonica, & Rincon, 1999). Yet rejection-sensitive individuals also go to excessive lengths to seek nurturance and support, even using coercion and ingratiation to maintain exaggerated closeness with other people (e.g., Downey et al., 1999). Given a promising opportunity to reaffiliate, rejection-sensitive individuals are quick to seek out compensatory social closeness; when faced with rejection cues, such individuals present themselves to other people in ways that increase the likelihood of social acceptance (e.g., Romero-Canyas, Downey, Pelayo, & Bashan, 2004) and behave prosocially toward new sources of potential friendship (Romero-Canyas & Downey, 2005). Indeed, whereas socially anxious people can best be described as socially avoidant, a more apt description of many individuals high in rejection sensitivity would be that they are excessively clingy or dependent. At the extreme end of the continuum, rejection sensitivity may be linked with a tendency for people to urgently seek compensatory relationships for support when a close relationship ends (Downey et al., 1999). Thus, we hypothesized that given an opportunity to reaffiliate, individuals high in rejection sensitivity would display increases in progesterone (a pattern consistent with a desire for social reconnection). We created an opportunity for reaffiliation in Study 2 and examined moderating effects of rejection sensitivity.

## Study 1

In Study 1, participants wrote about either a personal experience of exclusion (exclusion condition) or a control experience (control condition). We measured levels of progesterone secretion before and after the manipulation. We expected that social anxiety would moderate progesterone reactivity to social exclusion, such that participants high in social anxiety would display decreases in progesterone in response to exclusion, but that participants low in social anxiety would not.

## Method

**Participants.** Fifty-three undergraduates participated in Study 1 for course credit. Five failed to complete the social anxiety measure. Thus, 48 participants remained (35 men and 13 women; age range: 18–26 years). To prepare for the experiment, participants refrained from activities known to affect hormone levels: ingesting food, caffeine, or alcohol for 2 hr prior to testing; exercising for 12 hr prior to testing; and smoking for 6 hr prior to testing. Because hormonal birth control can dampen fluctuations in progesterone, we screened out women using hormonal contraceptives.

**Design and procedure.** To reduce diurnal hormone variability, we asked all participants to arrive between noon and 4:30 p.m. Participants were told that the study was an investigation of hormones and social interactions. Participants completed the Social Phobia Scale (SPS; Mattick & Clarke, 1998), a well-validated measure of social anxiety, which includes 20 items assessing anxiety in social settings (e.g., "I get tense when I speak in front of other people"). Responses are made on a 5-point scale from 1, *not at all*, to 5, *extremely*. We averaged responses across items ( $\alpha = .92$ ).

Participants next provided a baseline saliva sample (approximately 4 ml) and underwent a procedure used in previous studies to manipulate social exclusion (e.g., DeWall et al., 2009). Participants in the exclusion condition wrote about a personal experience in which they felt excluded or rejected. Studies have shown that visualizing a previously experienced instance of rejection evokes responses similar to those found when interpersonal methods are used to create rejection (e.g., Gardner et al., 2000; Pickett et al., 2004). Participants in the control condition wrote about an experience in which they felt strong physical pain (e.g., suffered a broken bone). We chose this control condition so that both conditions would involve an aversive and painful memory.

Participants completed filler questionnaires while they waited to finish the experiment and then provided a saliva sample approximately 15 min after the manipulation. The time delay was included because initial changes in progesterone typically require 15 min before they are detectable in saliva. After this saliva sample was collected, participants were debriefed.

**Progesterone measurement.** We used a conventional approach for assaying salivary progesterone. Saliva samples were frozen at  $-20^{\circ}\text{C}$ . To precipitate mucins, samples were thawed and centrifuged at 3,000 rpm for 10 min. Supernatant was stored in 250- $\mu\text{l}$  aliquots at  $-20^{\circ}\text{C}$  until assayed. Solid-phase radioimmunoassay kits were used to measure concentrations of progesterone in nanograms per deciliter. These kits have minimal cross-reactivity to other steroid hormones. Samples were processed in duplicate using a high-throughput, automated gamma counter. The lower limit of sensitivity of the radioimmunoassay kits was 0.7 ng/dl. Measurements were highly reliable; coefficients of variation were below 6%.

## Results

Change in progesterone was calculated by subtracting baseline progesterone values from progesterone values 15 min after the manipulation. Raw-score variability in progesterone is known to be substantially greater in women than in men; thus, following previous research (Maner et al., 2008), we standardized change scores within gender.

As in previous research (Wirth & Schultheiss, 2006), no main effects or interactions involving gender approached significance, and we collapsed the data across gender for subsequent analyses. We used multiple regression to evaluate the interactive effects of exclusion and social anxiety (SPS scores) on change in progesterone. As predicted, we observed a significant interaction,  $\beta = -0.28$ ,  $p = .05$ ,  $pr = -.28$ .

To interpret this interaction, we evaluated the simple effect of exclusion (compared with the control condition) on change in progesterone among participants high versus low in social anxiety (i.e., 1 *SD* above and below the mean; see Fig. 1). Among participants high in social anxiety, exclusion led to significantly larger decreases in progesterone than did the control condition,  $\beta = -0.43$ ,  $p = .04$ ,  $pr = -.30$ . Among individuals low in social anxiety, exclusion produced nonsignificantly greater increases in progesterone levels than did the control condition,  $\beta = 0.13$ ,  $p = .51$ ,  $pr = .10$ .

We also examined change in progesterone from baseline to postmanipulation by testing the regression intercepts for the progesterone difference score at 1 standard deviation above and 1 standard deviation below the mean of social anxiety. In

the exclusion condition, highly anxious individuals displayed a significant decrease in progesterone from baseline to posttest, intercept =  $-0.62$ ,  $p = .04$ , and participants low in social anxiety exhibited a nonsignificant increase, intercept =  $0.34$ ,  $p = .25$ . In the control condition, neither participants high in social anxiety, intercept =  $0.22$ ,  $p = .43$ , nor those low in social anxiety, intercept =  $0.07$ ,  $p = .78$ , displayed changes in progesterone.

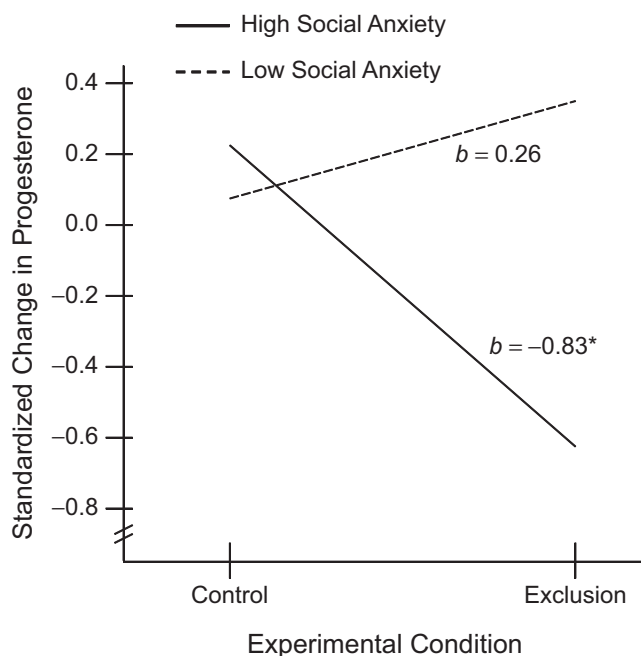
## Study 2

Study 2 extended Study 1 in a number of ways. First, rather than reliving a past exclusion experience, participants experienced a more immediate form of peer rejection. Participants interacted with another person (a confederate), who, after an initial meeting, declined the opportunity for further interaction. We manipulated whether this decision was allegedly due to external causes or to a negative reaction to the participant. Second, after the manipulation, we led participants to believe that they would have an opportunity for renewed social affiliation; participants expected to interact with a new group of people, which would provide a potential source of compensatory social contact. This design provided a strong framework for testing hypothesized increases in progesterone (consistent with a desire for affiliation) in response to social opportunities following rejection cues. Third, we evaluated moderating effects of rejection sensitivity. We hypothesized that participants high in rejection sensitivity would be more likely than those low in rejection sensitivity to respond to rejection with increases in progesterone, reflecting a desire for social contact.

## Method

**Participants.** Sixty-two undergraduates participated for course credit. Two failed to complete the rejection-sensitivity measure. Because of a screening error, 10 women were taking hormonal contraceptives, which can dampen fluctuations in progesterone; these women were excluded from analysis. Thus, 50 participants remained (31 men and 19 women; age range: 18–25 years). To prepare for the experiment, participants refrained from activities that affect hormone levels, as described in Study 1.

**Design and procedure.** As in Study 1, participants arrived between noon and 4:30 p.m. They were told that the study was an investigation of hormones and social interactions. Participants first completed the Rejection Sensitivity scale (RS; Downey & Feldman, 1996), which included 18 short scenarios involving the possibility of rejection (e.g., “You ask your boyfriend/girlfriend to move in with you”). For each scenario, participants indicated their concern over possible rejection (“How concerned or anxious would you be over whether or not the person would want to move in with you?”) on a 6-point scale (from 1, *very unconcerned*, to 6, *very concerned*) and their perceived



**Fig. 1.** Change in progesterone in the control and social-exclusion conditions in Study 1. Change in progesterone is shown separately for individuals high (1 *SD* above the mean) and low (1 *SD* below the mean) in social anxiety. Regression coefficients are shown for both levels of social anxiety (\* $p < .05$ ).



likelihood of rejection (“I would expect that he/she would want to move in with me”) on a 6-point scale (from 1, *very unlikely*, to 6, *very likely*). RS scores were calculated by multiplying the scores on the two measures (after reverse-scoring the likelihood measure) and averaging across scenarios ( $\alpha = .86$ ).

Participants next provided a baseline saliva sample and underwent a procedure used in previous studies to manipulate rejection (e.g., Vorauer, Cameron, Holmes, & Pearce, 2003). Participants were told that they would interact with a partner, first via video messaging and then face-to-face. They watched a videotaped message made by their ostensible partner, which depicted a friendly, same-sex confederate answering questions about personal and career goals. Next, participants made a video reply by responding to the same questions. When participants finished, the experimenter took the video and ostensibly showed it to the partner.

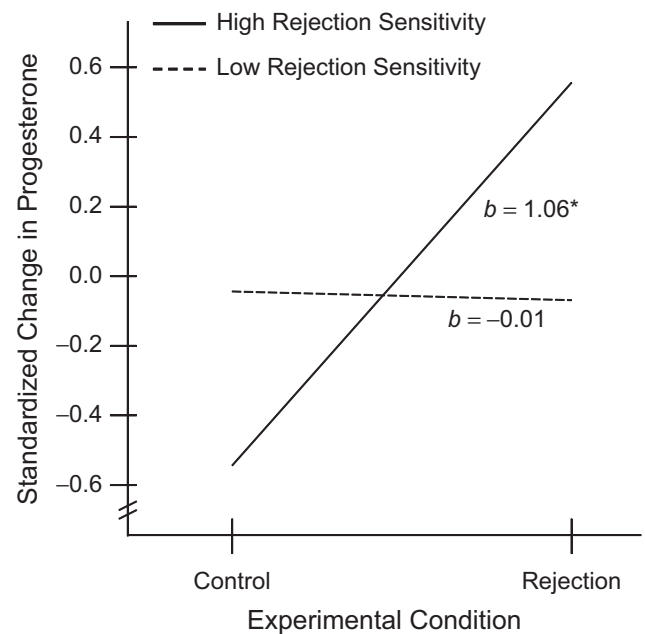
After 5 min, the experimenter returned and delivered the rejection manipulation. Participants in the control condition were told that, after watching the video, their partner had to leave suddenly because he or she had forgotten to do something. Participants in the rejection condition were told that, after watching the video, their partner left suddenly because he or she did not want to meet with the participant. Thus, in both cases, the confederate declined the opportunity for further interaction. However, in the control condition this decision was allegedly due to external causes, whereas in the rejection condition it was due to a negative reaction to the participant. Consequently, only the rejection condition was likely to create the psychological experience of rejection.

The experimenter then told participants that, although their partner had left, they could complete the experiment with a different group of participants down the hall, thus providing an immediate source of possible affiliation. Participants completed filler questionnaires while they waited to finish the experiment, and then provided a saliva sample approximately 15 min after the manipulation. After this saliva sample was collected, they were debriefed.

## Results

As in Study 1, change in progesterone was calculated by subtracting baseline progesterone values from posttest progesterone values, and change scores were standardized within gender. No effects associated with gender were found, and subsequent analyses were collapsed across gender.

We observed a main effect of the manipulation such that rejection led to greater increases in progesterone than did the control condition,  $\beta = 0.27$ ,  $p = .05$ ,  $pr = .28$ . We also observed the predicted interaction between rejection and RS score,  $\beta = 0.27$ ,  $p = .05$ ,  $pr = .28$  (see Fig. 2). Among participants high in rejection sensitivity (1 SD above the mean), rejection led to higher increases in progesterone than did the control condition,  $\beta = 0.54$ ,  $p = .008$ ,  $pr = .38$ . In contrast, no effect of rejection was observed among individuals low in rejection sensitivity (1 SD below the mean),  $\beta = -0.01$ ,  $p = .98$ ,  $pr = -.01$ .



**Fig. 2.** Change in progesterone in the control and peer-rejection conditions in Study 2. Change in progesterone is shown for individuals high (1 SD above the mean) and low (1 SD below the mean) in rejection sensitivity. Regression coefficients are shown for both levels of rejection sensitivity (\* $p < .05$ ).

We also examined change in progesterone from baseline to postmanipulation by testing the regression intercepts for the progesterone difference score at 1 standard deviation above and below the mean RS score. High-RS individuals in the rejection condition displayed significant increases in progesterone from baseline to posttest, intercept = 0.53,  $p = .04$ , whereas rejection elicited no change among low-RS individuals, intercept =  $-0.07$ ,  $p = .80$ . In the control condition, participants high in rejection sensitivity displayed a nonsignificant trend toward decreased progesterone, intercept =  $-0.53$ ,  $p < .10$ ; no change was observed among participants low in rejection sensitivity, intercept =  $-0.05$ ,  $p = .84$ .

## General Discussion

The present research is one of the first experimental investigations into motivationally tuned endocrinological processes elicited by social exclusion. Fluctuations in the secretion of progesterone—a hormone reflecting one’s level of affiliative motivation—were observed among individuals threatened by social exclusion.

The specific nature of those fluctuations, however, depended on individual differences in social anxiety and rejection sensitivity. Individuals high in social anxiety displayed a sizable decrease in progesterone following exclusion, a pattern consistent with a drop in affiliative motivation and perhaps a desire to withdraw from social contact. This finding fits with evidence that many socially anxious individuals become particularly avoidant following negative social experiences, such as rejection.

In contrast, individuals high in rejection sensitivity displayed a sizable increase in progesterone following rejection. This finding fits with evidence that rejection-sensitive individuals sometimes respond to rejection by seeking compensatory social closeness, particularly when the situation affords opportunities for positive social contact (as in Study 2). Indeed, in addition to providing evidence for moderation by individual differences, this research suggests the possibility that endocrinological responses to exclusion might be moderated by aspects of the social situation.

Although this research is limited because an affiliative opportunity was not available in Study 1, there are reasons to suspect that whether or not people display an inclination for social affiliation depends on the extent to which they perceive others as affording promising opportunities for positive social contact (Maner et al., 2007). For example, it is possible that, in the absence of promising new social opportunities, even people who might otherwise respond to social exclusion with signs of affiliation might instead respond with signs of social withdrawal or aggression. Future research would benefit from testing ways in which individual differences operate in concert with contextual factors to shape responses to exclusion. Moreover, future research should test more directly the hypothesis that appraisals of social opportunity (perceptions of others as providing promising opportunities for social bonding) or threat (perceptions of others as affording further rejection) serve as mechanisms through which exclusion affects motivationally tuned endocrinological responses.

The question remains whether patterns of progesterone release provide a biological underpinning for the social appraisals displayed by particular individuals, or whether patterns of progesterone release are caused by those appraisals. We suspect that appraisals and endocrinological processes have a dynamic and bicausal relationship, such that each feeds into the other. Yet there may also be reasons for thinking that patterns of endocrinological functioning emerge earlier in development than do patterns of conscious social appraisal, insofar as endocrinological processes are evolutionarily conserved and thus may precede the operation of higher-order cognitive appraisal processes.

The processes through which initial endocrinological changes translate into social behavior are likely to be complex, and future research should continue to explore the mechanisms through which initial hormonal responses promote overt psychological and behavioral signs of affiliation seeking or defensiveness. The activation of particular social motives, for example, can elicit evaluative readiness, such that people direct cognitive resources toward processing goal-relevant stimuli (Ferguson, 2008). Initial motives for affiliation or social avoidance could lead people to focus on particular individuals in the social environment, and appraisals of those individuals (as affording further rejection vs. opportunities for affiliation) may further shape people's inclinations toward social contact, seclusion, or aggression.

Indeed, there are likely to be many intervening processes that can interact with or interfere with initial endocrinological responses to shape downstream social behaviors aimed at seeking or avoiding social contact. For example, Brown and her colleagues (2009) found that initial increases in progesterone following a closeness-induction task did not increase immediate signs of affiliation; however, progesterone levels 1 week later did predict participants' affiliative tendencies toward their partner, perhaps because greater trust or felt closeness had developed in the interim.

Among individuals high in rejection sensitivity, who showed hormonal signs of affiliative motivation, a lack of self-efficacy or negative expectations about social interactions could down-regulate initial desires for social contact (Downey & Feldman, 1996). There is evidence that people high in rejection sensitivity sometimes respond to rejection cues with defensiveness and hostility (e.g., Ayduk, Mischel, & Downey, 2002). As other researchers have argued, aggressive responses to exclusion may reflect a desire to gain control over the situation (Williams et al., 2000). When coupled with the current findings, this body of research could imply that rejection-sensitive individuals respond to exclusion with an initial surge in affiliative motivation, but also with defensiveness and a desire for control and certainty. This interpretation would fit with recent theories suggesting that although excluded people may be eager to explore new relationships, they are also inclined to do so in a careful and self-protective manner (Maner et al., 2007).

The current studies provide a useful springboard from which to further investigate the operation of motivationally tuned endocrinological processes following exposure to social threats. Two important goals for future research will be to identify the links between initial endocrinological responses and motivated cognitive processes and to understand how these processes operate in concert to direct social behavior.

### 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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