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Dating Couples' Attachment Styles and Patterns of Cortisol Reactivity and Recovery in Response to a Relationship Conflict

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This study investigated theoretically predicted links between attachment style and a physiological indicator of stress, salivary cortisol levels, in 124 heterosexual dating couples. Cortisol was assessed at 7 points before and after an experimental conflict negotiation task, creating a trajectory of stress reactivity and recovery for each participant. Growth modeling of cortisol data tested hypotheses that (a) insecurely attached individuals show patterns of greater physiological stress reactions to interpersonal conflict than do securely attached individuals and (b) people with insecurely attached partners show patterns of greater stress in reaction to relationship conflict than those with securely attached partners. Hypothesis 1 was supported, but men and women differed in the type of insecure attachment that predicted stress trajectories. Hypothesis 2 was supported for men, but not for women. The discussion emphasizes the role of gender role norms and partner characteristics in understanding connections between adult attachment and patterns of cortisol responses to interpersonal stress.

A fundamental assumption of attachment theory is that attachment figures serve the function of helping individuals regulate feelings of distress in the face of a threat (Bowlby, 1969, 1973, 1979, 1980; Sroufe & Waters, 1977). Bowlby's original theory highlighted two ways in which the experience and regulation of affect are implicated in the infant–caregiver attachment bond. First, when infants experience distress in response to a threat, they seek proximity to their caregiver. Second, caregivers who are sensitive and responsive help infants regulate their feelings of distress, enabling them to experience an emotional sense of well-being or "felt security" (Sroufe & Waters, 1977). These ideas have been extended to adult romantic relationships, which embody many of the features of an attachment relationship (e.g., Hazan & Shaver, 1987; Mikulincer & Shaver, 2003). Like children, when adults become distressed in the face of a threat, they may turn to an attachment figure (e.g., their romantic partner) in an attempt to regain an emotional sense of felt security (Simpson & Rholes, 1994).

Individual differences exist in the degree to which people experience distress in response to a threat and in their ability to rely on a partner to help with the regulation of distress (Pietromonaco & Feldman Barrett, 2000; Pietromonaco, Feldman Barrett, & Powers, in press). A number of studies (see Mikulincer & Shaver, 2003; Pietromonaco & Feldman Barrett, 2000) have documented that individual differences in adults' attachment styles predict self-reported patterns of distress and affect regulation strategies. Few studies, however, have examined the extent to which attachment style is connected to less consciously accessible distress reactions such as physiological reactivity (Diamond, 2001).

An investigation of the link between adult attachment and psychobiological responses to distress is important for several reasons (see Diamond, 2001). First, research has shown that attachment in some nonhuman mammals is closely tied to biological and neural mechanisms, and stress responses often play a central role in this connection (Carter, 1998; Insel, 2000; Kraemer, 1992; Schore, 2001). For example, following a stressor, contact with the mother dampens reactivity of stress hormones in rats (e.g., Wang, Bartolome, & Schanberg, 1996) and in rhesus monkeys (e.g., Gunnar, Gonzalez, Goodlin, & Levine, 1981). Few studies have examined attachment-related physiological responses to stress in humans, but some work suggests that human attachment relationships may function to modulate physiological reactions to distress in both children (Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996; Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996) and adults (Kirschbaum, Klauer, Filipp, & Hellhammer, 1995). Infants and young children with caregivers who are sensitive and responsive show less reactivity of the stress hormone cortisol in the face of stress, suggesting that attachment security serves a stress-buffering function (Gunnar, 1998). In adults, men who performed a stressful task and who received assistance from their romantic partner showed less cortisol reactivity than those who received assistance from a stranger or who did not receive any assistance, although women did not show this pattern (Kirschbaum et al., 1995). Taken together, this evidence suggests that, under some conditions, attachment relationships in humans, like those in animals, are connected to physiological distress reactions.

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Second, stressful, threatening experiences are thought to activate the attachment system (Bowlby, 1980; Mikulincer, Gillath, & Shaver, 2002; Simpson & Rholes, 1994), and physiological systems are an important mechanism for the expression of stress responses. Our work focuses on a physiological measure that reflects a major stress-response system, reactivity of the hypothalamic–pituitary–adrenal (HPA) axis (Chrousos & Gold, 1992; Goldstein & Halbreich, 1987; Stansbury & Gunnar, 1994). HPA activation occurs when the hypothalamus releases corticotropin releasing hormone (CRH), thereby stimulating the secretion of adrenocorticotropin hormone (ACTH) by the anterior pituitary, which leads the adrenal cortex to release cortisol into the blood. HPA reactivity is particularly likely to be connected to attachment processes because it occurs specifically in situations that evoke a threat (Blascovich & Tomaka, 1996; Dickerson & Kemeny, 2004; Dienstbier, 1989), and such situations also are likely to activate the attachment system. Furthermore, HPA activation may be linked to attachment processes because it has been shown to be sensitive to interpersonal stressors (Diamond, 2001; Kirschbaum et al., 1995; Stroud, Salovey, & Epel, 2002) and because it shows variation between individuals (Gerra et al., 2001; Klimes-Dougan, Hastings, Granger, Usher, & Zahn-Waxler, 2001). As Diamond (2001) pointed out in her thorough analysis of the connection between attachment and psychophysiology, basic questions about the link between adult attachment and psychophysiology, including HPA reactivity, need to be addressed to advance an understanding of the role of attachment processes in the experience and regulation of affect.

Third, physiological stress responses are less consciously controlled than are self-reports and therefore may reveal different patterns than those captured by self-report measures. Self-report measures of affective responses and physiological measures often are uncorrelated or, at best, weakly correlated (Cacioppo, Gardner, & Bernston, 1999; Lang, 1994), and this lack of concordance has been observed between self-report measures of stress and HPA reactivity (see Dickerson & Kemeny, 2004). In line with the view held by most emotion theorists (e.g., Bradley & Lang, 2000), we assume that emotional responses can occur in different response systems, including through subjective, consciously accessible verbal reports, physiological responses, and behavior. Self-reports provide one window into emotional experience, and they are useful for understanding individuals' consciously accessible feelings. Physiological responses provide a window into another response system, which is likely to reveal less consciously accessible aspects of emotional experience (Cacioppo et al., 1999; LeDoux, 2000). The present work extends research on attachment style and affective reactions by focusing on physiological responses, which have rarely been examined in studies of adult attachment (Diamond, 2001). Because physiological responses tap into a different and less consciously accessible response system than subjective reports, examining them will provide a more complete understanding of how attachment style is connected to distress reactions. HPA reactivity, in particular, indexes a physiological response to stress that is too subtle for individuals to subjectively detect but nevertheless is likely to be important for understanding the ability to regulate affect within the context of an attachment relationship.[1]

Fourth, understanding the relation between adult attachment and physiological reactions will have implications for the field of psychoneuroendocrinology, providing further elucidation of how psychological factors are connected to hormonal reactions that have been consistently tied to mental and physical health outcomes.

In the present research, we sought to extend previous work in adult attachment and in psychoneuroendocrinology by examining dating partners' HPA responses over the course of a conflict negotiation task. We focused on an interaction involving an area of conflict because this context is likely to induce threat in romantic partners, and threat is likely to activate the attachment system (Bowlby, 1980; Mikulincer et al., 2002). In adult relationships, interactions involving conflict are a common stressor that may threaten attachment security because such interactions can raise concerns about the partner's availability or responsiveness (Kobak & Duemmler, 1994; Simpson & Rholes, 1994; Simpson, Rholes, & Phillips, 1996). Furthermore, contexts that evoke threat are specifically tied to HPA reactivity (Dickerson & Kemeny, 2004). The present work investigated (a) the link between individuals' own attachment style and their physiological stress responses, (b) the contribution of the partner's attachment style to individuals' physiological stress responses, (c) the extent to which patterns observed for physiological stress responses parallel those for self-reported stress, and (d) whether the patterns of interest are similar or different for men and women. Previous work suggests that gender may serve as an important contextual variable because it is connected to HPA reactivity (e.g., Kiecolt-Glaser et al., 1996; Kirschbaum et al., 1995; Stroud et al., 2002), attachment (Simpson, Rholes, Campbell, Tran, & Wilson, 2003), and behavior for men and women during conflict discussions (Kelley et al., 1978).

Individual Differences in Attachment Styles

Adult attachment theory (e.g., Fraley & Shaver, 2000; Hazan & Shaver, 1987), like the original theory (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1973), assumes that individual differences exist in the quality of attachment and that these differences result from actual differences in recurring interaction patterns with attachment figures. Adults' general orientations toward romantic relationships, or their attachment styles, are thought to reflect underlying mental representations, or "internal working models," that include expectations and beliefs about the worthiness of the self in the eyes of significant others and about the availability and responsiveness of attachment figures (Bowlby, 1973).

Self-report measures of adult attachment have assessed individual differences in attachment style in terms of categories (Hazan & Shaver, 1987) or in terms of two dimensions underlying the categories (Bartholomew & Horowitz, 1991; Brennan, Clark, & Shaver, 1998). The current view is that adult attachment is best captured by measuring the two dimensions of anxiety and avoidance (Fraley, Waller, & Brennan, 2000), and this approach is adopted here. People high in anxiety desire closeness, but they are

[1] In general, people are not able to accurately report on their bodily reactions (i.e., they are not accurate at interoception). In the case of cortisol, we would not expect people to be able to detect the release of cortisol, but they might be able to detect a related process (e.g., their heart racing). However, even for heartbeat detection, people's subjective reports of emotion often do not correspond to their ability to detect their heartbeats (for a discussion, see Feldman Barrett, Quigley, Bliss-Moreau, & Aronson, 2004).

unable to achieve a stable sense of security; those high in avoidance are reluctant to rely on others and prefer to maintain emotional distance. Combining the dimensions of anxiety and avoidance yields each of the four attachment prototypes identified in previous research (Bartholomew & Horowitz, 1991). People who are low on both dimensions fit the secure prototype and are comfortable with closeness and able to rely on others. People high in anxiety but low in avoidance fit the anxious-ambivalent prototype and desire excessive closeness, are preoccupied with relationships, and worry about being abandoned. People high on both dimensions fit the fearful-avoidant prototype and both desire and fear closeness. Those high in avoidance and low in anxiety fit the dismissing-avoidant prototype and are reluctant to rely on others, tend to be self-reliant, and prefer to maintain emotional distance.

Attachment Styles and Affective Reactivity

A number of studies have examined the link between self-reported attachment style and self-reported affective reactivity. In general, people who are high in anxiety report greater emotional intensity, greater expressiveness, and more emotional ups and downs, whereas those who are more avoidant report dampened emotionality (Bartholomew & Horowitz, 1991; Brennan & Shaver, 1995; Collins & Read, 1990; Hazan & Shaver, 1987; Pietromonaco & Carnelley, 1994; Pietromonaco & Feldman Barrett, 1997).

Only a few studies have examined the link between self-reported adult attachment style and physiological reactivity (Carpenter & Kirkpatrick, 1996; Feeney & Kirkpatrick, 1996; Fraley & Shaver, 1997; Mikulincer, 1998). The general finding from these studies is that attachment insecurity (higher anxiety or higher avoidance) is associated with greater physiological reactivity.[2] For example, both anxious and avoidant participants showed increased heart rate and blood pressure when they were separated from their romantic partner during a stress task (Carpenter & Kirkpatrick, 1996; Feeney & Kirkpatrick, 1996) or when they imagined themselves in anger-evoking hypothetical scenarios involving their romantic partner (Mikulincer, 1998).

To our knowledge, no studies of adult romantic attachment have assessed HPA reactivity.[3] However, developmental work suggests that insecurely attached infants show greater HPA reactivity under stress (Gunnar et al., 1996; Hertsgaard, Gunnar, Erickson, & Nachmias, 1995; Nachmias et al., 1996; Spangler & Grossman, 1993; Spangler & Schieche, 1998). The precise form of insecurity associated with greater HPA reactivity varies somewhat from study to study, and because the number of infants in each attachment category tends to be small, it is difficult to determine from these studies whether HPA reactivity is associated with a particular type of attachment insecurity.

These pioneering studies with infants did not focus on two issues of particular relevance to the link between attachment and physiological reactivity in adults. First, the effects of gender socialization are more likely to provide an important context for stress reactions in adulthood, perhaps moderating links between stress reactions and adult attachment styles. Second, adults are more likely to anticipate stressful events than are infants, suggesting that it is important to examine not only adults' reactivity to the actual event but also physiological reactions that are initiated in expectation of an upcoming stressful event.

Partner's Attachment Style and Affective Reactivity

The extent to which individuals show heightened reactivity to a conflict situation may depend, in part, on whether their partner is someone who is able to help them regulate distress (Carnelley, Pietromonaco, & Jaffe, 1996; Collins & Feeney, 2000; Feeney & Collins, 2001; Simpson, Rholes, & Nelligan, 1992, 2002). The ability of partners to help with regulation appears to differ with the partner's attachment style. For example, men who are more avoidant have been found to be less likely to provide support when their female partner displays greater distress (Simpson et al., 1992). More securely attached women are able to respond more flexibly to their partner's needs, providing more support when their partner desires it and less support when he does not (Simpson et al., 2002). Studies of behavior during conflict interactions suggest that couples are more adept at communicating during conflict when both partners are secure (e.g., Bouthillier, Julien, Dube, Belanger, & Hamelin, 2002; Cohn, Silver, Cowan, Cowan, & Pearson, 1992), and couples including at least one secure partner resolve conflict more constructively than couples including two insecure partners (e.g., Creasey, 2002; Kobak & Hazan, 1991; for a review, see Pietromonaco, Greenwood, & Feldman Barrett, 2004). These findings suggest that secure partners may be more likely to reduce each other's distress, which may facilitate the constructive resolution of conflict.

This previous work suggests that one partner's attachment style may contribute to the other partner's physiological response to conflict stress. In particular, people with partners who are more responsive (i.e., more secure partners) are likely to show less HPA reactivity (i.e., an attenuated stress response). Furthermore, people with insecure partners may show greater HPA reactivity because their partners engage in behaviors that make the interaction more stressful. For example, the tendency of more avoidant partners to maintain distance during conflicts and the tendency of more anxious partners to display greater distress (Simpson et al., 1996) may heighten their partner's stress response.

Gender Differences

Several reasons exist for expecting that gender will moderate the link between attachment and HPA reactivity and recovery. First, although attachment processes are thought to be similar for women and men, the contexts in which attachment style differences arise sometimes differ with gender (Pietromonaco, Greenwood, & Feldman Barrett, 2004). For example, recent work on the transition to parenthood has shown that attachment style and perceptions of spouse support predict depression for wives but not for husbands (Simpson et al., 2003).

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[2] Only one of these studies (Fraley & Shaver, 1997) specifically examined dismissing–avoidance. When participants were required to suppress thoughts about an attachment threat, those high in dismissing–avoidance showed decreased skin conductance, whereas those high in preoccupation showed increased skin conductance. Thus, it is possible that, under some conditions, dismissing–avoidant individuals may not show the same physiological patterns as those with other forms of attachment insecurity.

[3] One study of adults (Adam & Gunnar, 2001) found that mothers with higher daily cortisol levels showed more secure attachment to parents and better relationship functioning, but this study did not assess romantic attachment or look at cortisol levels in response to a specific stressor.

Second, men and women differ in the contexts in which they show increased HPA responses (Kiecolt-Glaser et al., 1996; Kirschbaum et al., 1995; Stroud et al., 2002). For example, men show less HPA reactivity during a stress task when their romantic partner provides support but not when a stranger or no one provides support, and women do not show this pattern (Kirschbaum et al., 1995).

Third, men and women typically adopt different roles when discussing a conflict with a romantic partner. Women usually are more likely to initiate and promote problem discussions with romantic partners, and men are more likely to attempt to withdraw from the discussion (Christensen & Heavey, 1990; Kelley et al., 1978), and thus these differential roles may moderate attachment patterns for men and women. Although women in general may directly confront relationship problems, avoidant women may have difficulty doing so, and they may be particularly distressed because they are expected to be able to direct the discussion; for this reason, avoidant women may show a stronger physiological stress reaction. Similarly, anxious men may want to actively confront and manage the discussion, but this behavior also may be particularly stressful because it does not fit with the prescribed role for their gender in this context.

Stress Reactivity and Recovery

The majority of research on cortisol responses to stress examines the difference between one cortisol level sampled before a stress event and a second cortisol level sampled after the event. More recent methods of cortisol assessment examine an extended trajectory of temporal changes in multiple cortisol responses to a stress event, including cortisol secreted in anticipation of the event, during the event, and after the event as the participant calms down or recovers from the stressful event (Powers & McArdle, 2003; Kaiser & Powers, in press; Powers et al., in press).

As noted, cognitive anticipation of a stressful event is likely to provoke a physiological response. For some, anticipatory stress reactions might be as dramatic as reactions after a stressful event and could occur regardless of whether the perceived threat ever actually occurs. For these reasons, we examined links between attachment and anticipatory stress reactions as well as reactions to the actual stress event. In this study, the term *reactivity* refers to both cortisol responses in anticipation of the conflict task and responses to participation in the actual task.

Recovery is the extent to which cortisol levels return to pre-event levels after the event has ended. Dickerson and Kemeny (2004) argued that failure to efficiently return the cortisol system to normal levels after a stressful event could lead to even greater exposure to cortisol, creating greater health risks. Very few studies, however, have examined cortisol recovery and the factors that predict delayed recovery. Examination of the stages of anticipatory reactivity, reactivity during the event, and recovery requires multiple assessments of cortisol as well as analytic techniques such as growth modeling, which can model the entire stress response.

The Present Study

In the present study, we used growth modeling techniques to investigate whether individuals' own attachment style and their partner's attachment style predicted patterns of salivary cortisol reactivity and recovery in response to an experimental conflict discussion between dating partners. First, given that attachment theory and previous evidence (Carpenter & Kirkpatrick, 1996; Mikulincer, 1998) suggest a link between insecure attachment and physiological reactivity, we hypothesized that people with insecure attachment styles (i.e., either high anxiety or high avoidance) would show greater HPA reactivity, as evidenced by salivary cortisol levels. Second, if partners help each other with affect regulation, as attachment theory suggests, the partner's attachment style is likely to contribute to the extent to which people show reactivity to threat. Following this reasoning, we hypothesized that people who had partners who were more responsive and available (e.g., secure partners) would show less HPA reactivity in the face of conflict. Conversely, those with less responsive partners (e.g., more insecurely attached partners) should show greater HPA reactivity to conflict. Third, because understanding patterns of recovery from endocrine stress reactions is potentially important and given that few studies have examined factors affecting recovery, we examined how attachment style was linked to recovery patterns. We expected that anxious attachment in either partner would be associated with a slower recovery. In contrast, recovery patterns associated with avoidant attachment were more difficult to predict. On the one hand, it was possible that the heightened stress reaction to the conflict task that we expected to be associated with avoidant attachment would extend throughout the recovery period. On the other hand, it is possible that even with a heightened stress reaction to the task, persons with avoidant attachment styles would be quickly relieved and able to more effectively dismiss the conflict when they were allowed to actually end the task. Fourth, given the variety of evidence suggesting that gender may moderate the link between attachment and HPA reactivity, we examined whether the predicted patterns differed for men and women.

As noted, this study builds on work in developmental investigations of mother–infant attachment and stress reactivity because there are no prior investigations of adult romantic attachment and cortisol reactivity to relationship conflict. Previous work on romantic attachment, however, has examined self-reported affective reactivity. For continuity with this earlier work, we also assessed self-reported distress before and after the conflict interaction. Previous work (e.g., Pietromonaco, Feldman Barrett, & Holmes, 2006; et al., 1996) has shown that people with a more anxious attachment style report greater perceptions of distress or threat. For this reason, we expected that anxiety would be associated with greater subjective reports of distress (i.e., perceived threat). In addition, we examined the association between self-reported stress and HPA reactivity to evaluate our assumption that these two response systems are not identical. In line with previous work (see Dickerson & Kemeny, 2004), we expected that these two types of reactivity would be only weakly correlated.

Method

Participants

The sample of 248 participants consisted of 124 older adolescent heterosexual couples who had been in romantic relationships for at least 2 months (modal length of relationship = 1–2 years). Participants were between the ages of 18 and 21 years (mean age = 19.2 years). The sample was representative of individuals in this age range in the western Massachusetts community from which participants were recruited, and participants reported their ethnic identities as non-Hispanic European American (85.2%), Hispanic (4.8%), African American (1.2%), Asian American/ Pacific Islander (6.0%), Native American (.8%), or other (2.4%). Participants were recruited through flyers, posters, and presentations in university undergraduate courses. Each participant received $20, and those who were university students enrolled in psychology courses also received extra credit points, if desired.

Procedure

All data collection took place in a two-room suite of our university laboratory. The first room contained computers separated by a cloth screen where the participants completed a series of questionnaires. The second room had a couch and three small, but visible video cameras. Because cortisol levels follow a circadian rhythm, participants were invited into the lab at 4 p.m., the time of day that cortisol levels are most stable. Keeping daily cortisol levels as stable as possible decreases the amount of noise in the data and additionally increases the possibility that any shifts in cortisol due to the experimental interpersonal stressor will appear in the data. After signing consent forms, filling out questionnaires, and providing two saliva samples, each partner identified a topic that had been a source of heated and unresolved discussions in the past month. The researcher randomly selected one of the topics by flipping a coin, and the couple was taken to the room with the couch and cameras and asked to spend 15 min discussing the issue and attempting to come to a resolution to the problem. Researchers were not present in the room while the couples engaged in the conflict negotiation task. After the task was completed, participants returned to the first room, and five additional saliva samples were collected at regular intervals throughout an hour recovery period.

Measures

HPA reactivity to and recovery from interpersonal stress. To measure the participants' HPA reactivity before, during, and after the interpersonally stressful conflict negotiation task, seven salivary cortisol samples were collected over the course of 1 hr 35 min. After secretion from the adrenal gland, cortisol takes between 15 to 20 minutes to enter into saliva, therefore each salivary sample actually measured participants' cortisol reactions from 15–20 minutes earlier (Stansbury & Gunnar, 1994). Sample 1 was collected 10 min into the data collection session, and therefore assessed participants' cortisol levels 5–10 minutes prior to entering the lab.[4] Shortly after the first sample was taken, researchers presented participants with a detailed description of the upcoming conflict negotiation task. This description noted that the discussion "might take the form of an argument." Researchers then waited 15 min to allow for cortisol to be released and reach the saliva, and then obtained Sample 2, which measured the cortisol level in response to anticipation of the conflict task. Participants then engaged in the conflict negotiation task. Five post-task samples (Samples 3 – 7) were collected 10, 20, 30, 45, and 60 min after the interaction task. Thus, we were able to assess the trajectories of participants' stress responses from 5–10 min before they entered the laboratory, through their anticipation of conflict discussions with their romantic partners, during the conflict discussions, and throughout a recovery period of 40 min following the conflict discussion. Table 1 provides a description of the points along the trajectory of stress reactivity that each cortisol sample assesses. Table 2 presents mean scores for the seven observed cortisol levels for men and women.

Saliva samples were collected according to procedures suggested by Salimetrics, LLC (State College, Pennsylvania). Participants were instructed to "passively drool down a straw and into a small plastic vial" with their heads tilted forward until the required amount of saliva was collected. The vial was then sealed and immediately placed in frozen storage (−20 °C) until shipped on dry ice to Salimetrics, LLC for analysis of cortisol levels. All samples were divided into two vials and separately assayed for salivary cortisol with the use of a highly sensitive enzyme immunoassay (Salimetrics, State College, Pennsylvania). Thus, each cortisol sample had two values, resulting in a total of 14 values for the seven samples. The test used 25 μL of saliva (for singlet determinations), and it had a lower limit of sensitivity of .003 μg/dl, a range of sensitivity from .003 to 1.2 μg/dl, and average intraand interassay coefficients of 4.13% and 8.89% variation, respectively. Method accuracy, determined by spike recovery, was 105%, and linearity, determined by serial dilution, was 95%.[5]

Several procedures safeguarded the accuracy of the cortisol measurements: (a) researchers gave participants written and phone instructions to refrain from drinking alcohol, using illegal drugs, or visiting the dentist within the 24-hr period prior to the laboratory session, and they were required to not exercise, eat, drink (except water), smoke cigarettes, or brush their teeth up to 2 hr prior to participation; (b) upon arrival at the lab, if participants had an elevated temperature, felt ill, or reported that they had been unable to comply with the restrictions above, they were scheduled to return at a later date; and (c) participants rinsed their mouths thoroughly

Table 1
Description of the Point on the Stress Trajectory That Each Cortisol Sample Assesses

Cortisol sample	Description[a]	Name of sample
1	Cortisol level 5–10 minutes prior to entering lab	Entry
2	Cortisol level in response to a vivid description of the upcoming conflict negotiation task	Anticipation
3	Cortisol level during the middle of the conflict negotiation task (5–10 minutes into discussion)	Discussion
4	Cortisol level at completion of the conflict negotiation task (0–5 minutes after the end of the task)	P-1, Completion
5	Cortisol level 10–15 minutes after the end of the task; measuring recovery	P-2, Recovery
6	Cortisol level 25–30 minutes after the end of the task; measuring recovery	P-3, Recovery
7	Cortisol level 40–45 minutes after the end of the task; measuring recovery	P-4, Recovery

Note. P = Post-task.
[a] Description of approximate time cortisol was released from the adrenal gland in reaction to the stressor.

[4] Sample 1 was not designed to be a measure of "basal," or normal, nonstress levels of cortisol. We assumed that most couples would experience some stress simply by coming to a university lab study. Our design was structured to assess participants' reactions to an experimentally induced interpersonal stress task. Although not critical to our design and hypotheses, it is a likely assumption that any significant findings from this study regarding stress reactions to the experimental task would be even stronger if measured against a nonstress basal level of cortisol.

[5] Method accuracy of cortisol assays from saliva is typically assessed through tests of "spike recovery" and "linearity." Spike recovery tests whether a known amount of cortisol is measured accurately by the assay method when the known amount is "spiked" (inserted) into an existing sample. The acceptable range for spike recovery is 80% to 120%. Linearity signifies method accuracy when testing serial dilutions of samples with known amounts of cortisol. Perfect linearity would be 100%.

Table 2
Participants' Mean Cortisol Levels (μg/dl) for Seven Saliva Samples

Sample	Men		Women	
	M	*SD*	*M*	*SD*
1 (Entry)	.24	.15	.21	.13
2 (Anticipation)	.30	.27	.26	.18
3 (Discussion)	.27	.21	.26	.19
4 (Completion)	.24	.17	.24	.16
5 (Recovery)	.21	.17	.23	.15
6 (Recovery)	.18	.09	.21	.13
7 (Recovery)	.17	.09	.20	.11

with water 10 min before giving the first saliva sample to minimize the potential for saliva contamination. In addition to these procedural controls, other variables that potentially affect HPA functioning were assessed by questionnaire or laboratory assay and examined for statistical relations with cortisol. HPA functioning has been found in previous studies to be affected by medications, including psychotropic medications (Bhagwager, Hafizi, & Cowen, 2002; Meltzer, Bastani, Jayathilake, & Maes, 1997; Sagud et al., 2002), allergy medications (Wilson, McFarlane, & Lipworth, 1998), oral contraceptives (Kirschbaum, & Hellhammer, 1989), and other nonprescribed drugs, nicotine (Kirschbaum, Strasburger, & Langkrar, 1993), caffeine (Lovallo, Al'absi, Blick, & Whitsett, 1996), alcohol (King, Houle, de Wit, Holdstock, & Schuster, 2002), amount of sleep (Powers et al., 2000), recent meals, recent exercise, illness, mouth injury (Kivlighan et al., in press), and phase of menstrual cycle (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999). A questionnaire was developed for this project to assess these variables. In this sample, three of these variables—women's use of antibiotics and men's and women's use of allergy medications—were significantly associated with cortisol reactivity. These variables were statistically controlled in all of the reported analyses.

Blood contamination is also of particular concern in saliva samples because the levels of most analytes are higher in general circulation than in saliva and can falsely elevate salivary analyte levels (Kivlighan, Granger, & Schwartz,, 2005). Blood can leak into saliva for a variety of reasons, including poor oral health, abrasive brushing, or injury. Although precautions were taken against all of these effects in screening for participation in the study, saliva Sample 1 was assayed for blood contamination by Salimetrics, LLC for all participants with an enzyme immunoassay kit for transferrin. Blood contamination was significantly related to cortisol levels only for men and was statistically controlled in analyses.

Experiences in Close Relationships. The Experiences in Close Relationships scale is a 36-item self-report measure used to assess attachment in romantic relationships (Brennan, Clark, & Shaver, 1998). The measure was developed from a factor analysis of college students' responses to items taken from frequently used self-report measures of adult attachment. The factor analysis identified two dimensions of attachment: Avoidance and Anxiety. The Avoidance subscale assesses avoidance of intimacy and dependence on one's romantic partner. The Anxiety subscale measures individuals' anxiety about rejection and abandonment. Items are rated on a 7-point Likert scale, ranging from 1 (*disagree strongly*) to 3 (*neutral/mixed*) to 7 (*agree strongly*). Reliability (Cronbach's alpha) for this sample was .86 for Avoidance and .91 for Anxiety. Scores for the Anxiety and Avoidance dimensions were not significantly correlated for men, $r(124) = .07$, but they were correlated modestly for women, $r(124) = .24$, $p = .009$. Romantic partners' scores on similar attachment dimensions were significantly correlated: partners' scores on Anxiety, $r(248) = .20$, $p = .002$; partners' scores on Avoidance, $r(248) = .34$, $p = .0001$. To capture the combined effects of participants' scores on the two attachment dimensions, we computed the interaction between scores on Anxiety and Avoidance. This interaction provides information about the degree to which individuals are low on Avoidance and low on Anxiety (i.e., more secure), high on Avoidance and low on Anxiety (i.e., more dismissing–avoidant), low on Avoidance and high on Anxiety (i.e., more preoccupied), or high on Avoidance and high on Anxiety (i.e., more fearful–avoidant).

Perceived stress reactivity. Prior to the negotiation task, participants reported the level of stress they felt in anticipation of the conflict negotiation task, and after the task, reported their perceptions of the actual stressfulness of the task. Participants rated their anticipatory stress with four items: the extent to which they "were nervous about the task," "were looking forward to leaving the lab because the session will be stressful," "thought about the task last night," and "thought about the task today." Participants rated their perceptions of the actual stress that they experienced during the negotiation task with three items: "How stressful was this conflict?" "How intense was this conflict?" and "How negative was this conversation?" Each scale was subjected to principal-components analyses and we used the first principal component for each scale.[6] Internal consistency (Cronbach's alpha) of the scales were .69 (anticipatory stress) and .82 (stressful discussion).

Analytic Strategy

We used growth modeling to plot temporal trajectories of participants' hormonal stress responses and to predict variance in these stress trajectories from participants' attachment styles. We used the Hierarchical Linear Modeling, Version 5 (HLM5) program of Raudenbush and Bryk (2002) to estimate the parameters of these growth models. HLM has several distinct advantages that address challenges inherent in the analysis of dependent data from couples and from repeated measurements of cortisol levels in response to an experimental task. In our analyses, the couple was the unit of analysis, with female cortisol responses and male cortisol responses nested within the couple. Information about the association between the scores in the couple and among repeated measures was used to compute a more precise standard error in testing regression coefficients. HLM also allows for simultaneous estimation of male and female outcomes predicted from variables that are both unique to each person and common to each couple. A further advantage of this technique is that it adjusts the cortisol responses for measurement error, thereby providing true cortisol responses for each person and enabling a more precise estimation of effects. The notion of true responses follows from classical test theory, which hypothesizes that any observed score can be decomposed into a "true" component that measures the underlying latent trait or construct and a component that reflects random error due to context, ambiguous wording, and so forth. The HLM model decomposes the variance in the outcome into these two components. HLM also allows for the prediction of individuals' outcomes from their partner's scores. For our analyses, we used the multivariate outcomes model described by Lyons and Sayer (2005) and Raudenbush, Brennan, and Barnett (1995).

Results

Growth Models of Cortisol Stress Reactivity and Recovery

The multilevel modeling approach we used specified two linked models. The Level 1 model defined three parameters that characterized participants' curvilinear stress trajectories, where the coefficients that define the trajectory were allowed to take on different

[6] The first principal component is an average of the items, weighted by the magnitude of the correlation of each item and the underlying construct. The "anticipatory stress" principal component explained 45% of the variance among scale items, and the "stressful discussion" principal component explained 57% of the variance among scale items.

values for each participant. The Level 2 model included predictors to explain variance in these Level 1 coefficients.

The Level 1 HLM Model

The Level 1 model was represented by the following equation: $Y_{ij} = \beta_{f1j}(female\ intercept)_{ij} + \beta_{f2j}(female\ linear)_{ij} + \beta_{f3j}(female\ quadratic)_{ij} + \beta_{m4j}(male\ intercept)_{ij} + \beta_{m5j}(male\ linear)_{ij} + \beta_{m6j}(male\ quadratic)_{ij} + e_{ij}$. Y_{ij} is the cortisol score i for couple j, with $i = 1, \ldots 28$ data points and $j = 1, \ldots 124$ couples. For female participants, β_{f1j} is the model intercept. This represents the predicted value of the outcome when the origin of time is zero. We rescaled time in our models so that the intercept represents the anticipatory point. B_{f2j} is the linear rate of change in cortisol level at time zero, also called instantaneous rate of change. In polynomial functions that include both a linear and quadratic term, the tangent to the curve at any point is defined as the instantaneous rate, which indicates how fast the curve is changing at that point. We can estimate this rate at any point along the curve. In our model we estimate it at the point at which time is centered, thus allowing for analysis of differences in change at the point of anticipation of the upcoming conflict discussion. B_{f3j} is the rate of change in cortisol for the entire period of assessment (also called the quadratic effect or curvature of the growth trajectory). Finally, e is the error, which is assumed to have a mean of zero and a constant variance, s^2. B_{m4j},B_{m5j}, and B_{m6j} represent the same parameters for the men's trajectories.

The Level 2 HLM Model

The Level 2 model is represented by the following equations:

$$B_{f1j} = \gamma_{10} + \gamma_{11} + \gamma_{12} + \upsilon_{1j}$$

$$B_{f2j} = \gamma_{20} + \gamma_{21} + \gamma_{22} + \upsilon_{2j}$$

$$B_{f3j} = \gamma_{30} + \gamma_{31} + \gamma_{32} + \upsilon_{3j}$$

$$B_{f4j} = \gamma_{40} + \gamma_{41} + \gamma_{42} + \upsilon_{4j}$$

$$B_{f5j} = \gamma_{50} + \gamma_{51} + \gamma_{52} + \upsilon_{5j}$$

$$B_{f6j} = \gamma_{60} + \gamma_{61} + \gamma_{62} + \upsilon_{6}$$

In the Level 2 model, every β is equal to a predictor (e.g., avoidant attachment scores) or a control variable (e.g., allergy medications) plus a random effect, which represents the residual variance around the grand mean.

As noted, the major premise of this study was that attachment styles predict physiological stress reactivity and recovery in response to interpersonal conflict. Before directly testing this premise, we fit an unconditional HLM model with no predictors at Level 2 to determine whether there was a substantial amount of variance unexplained by the Level 1 model, warranting an analysis of predictor variables. We found significant individual variation in levels of cortisol, in rates of change in cortisol, and in the curvature of the entire stress trajectory for both men and women.[7] This significant variation meant that participants did not all respond to the conflict task in the same way and, thus, it was useful to examine whether attachment styles of self and partner might account for the variance among participants' stress trajectories. The unconditional model also clarified the importance of using a statistical technique that took into account the shared variance between romantic partners' scores. This dependency in the data is estimated as tau. Tau (when shown as correlations) between male and female partners' levels of cortisol, rates of change in cortisol, and the curvatures of their stress trajectories across the seven measurement points, ranged in our sample from −.85 to .17.

Does Attachment Style Predict HPA Reactivity to Conflict Negotiation?

Our first hypothesis was that participants' own attachment style scores (Avoidance scores, Anxiety scores, and the interaction between Avoidance and Anxiety scores) would predict the trajectory of their physiological stress reactions before, during, and after conflict negotiations. Our second hypothesis was that the attachment style of a person's romantic partner would also predict the trajectory of that person's stress reactivity before, during, and after a conflict negotiation with that partner. These hypotheses were examined for both men and women, to clarify whether there were gender differences in the model.

We present results of a full HLM model with all attachment and relevant control variables entered as Level 2 predictors and a reduced model with nonsignificant predictors omitted. These models provide statistical tests of: (a) the association of attachment styles to cortisol level at the anticipation point, (b) the association of attachment styles to the rate of change in cortisol at the anticipation point, and (c) the association of attachment styles to the curvature of the stress trajectory for cortisol across all seven time points. This last test of the complete curvature of the trajectory allows an examination of the rate of recovery in cortisol levels. Together, these three aspects of the model provide the best characterization of stress reactivity across all time points.

Hypothesis 1 was supported, but women and men differed in the type of insecure attachment that predicted stress reactivity and recovery. Table 3 shows results for the full model (including all control variables, attachment variables, and interactions) and for the final reduced model (including significant predictors). As seen in the final reduced model in Table 3, women's cortisol trajectories were best predicted by their degree of avoidant attachment and were not predicted by their anxiety.[8] Figure 1 illustrates this finding by presenting prototypical stress trajectories for women who score at the 75th percentile in avoidant attachment and for women who score at the 25th percentile in avoidant attachment. More highly avoidant women had higher cortisol levels prior to entering the laboratory, when explicitly anticipating the conflict task, and during the task. After the task was completed, however, women with higher avoidance attachment recovered more quickly, as their cortisol levels dropped more rapidly than those who were not as avoidant. The effect of avoidant attachment on the curvature of the stress reactivity trajectory was significantly different for women versus men, $\chi^2(1, N = 248) = 4.06$, $p = .001$.

[7] A table of results for the unconditional model is available from the authors.

[8] As noted, both female and male participants were included within each model because HLM can account for the dependency in the couple data. Tables 3 and 4 present results of these models separately for women and men for clarity of presentation and discussion.

Table 3
Final Estimation of Level 2 Predictors of Females' Cortisol Reactivity: Full and Reduced Models

	Full model				Reduced model			
Predictor	Estimate	*SE*	*t* (*df*)	*p*	Estimate	*SE*	*t* (*df*)	*p*
Female cortisol level at anticipation point								
Intercept	.245	.013	18.28 (116)	.000	.245	.013	18.89 (121)	.000
Female antibiotic medication	.164	.061	2.69 (116)	.009	.166	.059	2.80 (121)	.006
Female avoidance	.065	.021	3.12 (116)	.003	.061	.017	3.52 (121)	.001
Male partner avoidance	.007	.019	0.38 (116)	.707				
Female anxiety	−.004	.014	−0.30 (116)	.762				
Male partner anxiety	−.002	.014	−0.18 (116)	.861				
Female avoidance × anxiety	.003	.020	0.15 (116)	.885				
Male partner avoidance × anxiety	−.002	.021	−0.12 (116)	.906				
Female rate of change at anticipation point								
Intercept	.052	.013	4.02 (115)	.000	.048	.013	3.72 (122)	.001
Female antibiotic medication	.191	.059	3.23 (115)	.002	.170	.058	2.90 (122)	.005
Female allergy medication	.083	.078	1.06 (115)	.292				
Female avoidance	.023	.021	1.12 (115)	.264				
Male partner avoidance	−.019	.019	−1.01 (115)	.316				
Female anxiety	.015	.013	1.09 (115)	.277				
Male partner anxiety	.001	.013	0.08 (115)	.937				
Female avoidance × anxiety	−.022	.020	−1.10 (115)	.276				
Male partner avoidance × anxiety	.002	.020	0.10 (115)	.921				
Female curvature across trajectory								
Intercept	−.068	.011	−6.33 (115)	.000	−.065	.011	−66.14 (121)	.000
Female antibiotic medication	−.178	.048	−3.71 (115)	.001	−.168	.047	−3.56 (121)	.001
Female allergy medication	−.071	.052	−1.35 (115)	.181				
Female avoidance	−.044	.016	−2.63 (115)	.010	−.026	.008	−3.34 (121)	.001
Male partner avoidance	.016	.016	1.02 (115)	.312				
Female anxiety	−.006	.011	−0.54 (115)	.587				
Male partner anxiety	.005	.011	0.45 (115)	.652				
Female avoidance × anxiety	.015	.016	0.94 (115)	.348				
Male partner avoidance × anxiety	.003	.017	0.19 (115)	.849				

In contrast to the findings for women, anxious scores added significantly to the prediction of stress reactivity and recovery for men (see the final reduced model in Table 4). The interaction of men's own anxious and avoidant attachment scores significantly predicted both the level and the rate of their stress reactivity at the point of anticipating the upcoming negotiation task. Table 5 illustrates these findings by displaying predicted values for men's cortisol levels and rates of increase in cortisol at the anticipatory point for the four prototypical attachment styles. The prototypical styles have different combinations of high (75th percentile) and low (25th percentile) scores on the Anxiety and Avoidance dimensions. As seen in column 1 of Table 5, the securely attached prototypical man has the lowest level of cortisol during anticipation of a conflict discussion with his girlfriend. The three insecurely attached prototypical men have higher levels of cortisol in anticipation of the upcoming conflict. Column 2 of Table 5 shows the rate of change (increase or decrease) in the growth curve of cortisol levels at the anticipation point for each prototype. The cortisol levels of the preoccupied and fearful–avoidant prototypes are increasing the most rapidly at this point. The securely attached prototypical man experiences a more gradual rise as he anticipates the conflict discussion. In contrast to all others, the cortisol level of the dismissing prototype is beginning to slightly decrease.

Examination of the third set of terms in the final reduced model (the quadratic terms) in Table 4 shows that men's anxious scores alone significantly predicted the overall curvature or shape of the men's stress trajectories. Figure 2 illustrates the effect of men's anxiety. Prototypical stress trajectories of men at the 75th percentile of anxiety and men at the 25th percentile of anxiety are contrasted, showing that highly anxiously attached men have steeper increases in stress as they negotiate conflict with their partners. The pattern of higher stress levels for anxiously attached men persists throughout most of the recovery period.

Hypothesis 2 was supported for men but not for women (see Tables 3 and 4). That is, partners' attachment styles did not predict women's cortisol reactivity or recovery, but the attachment styles of men's girlfriends (the interaction of her Anxiety and Avoidance scores) predicted both the rate of change in men's cortisol at the anticipatory point and the shape of their trajectories over time. The effects of partner attachment style (Anxiety by Avoidance dimensions) were significantly different for women versus men, $\chi^2(1, N = 248) = 7.42$, $p = .007$. Figure 3 presents four prototypical stress trajectories to illustrate the effect of girlfriends' attachment styles predicted from different combinations of high (75th percentile) and low (25th percentile) Anxiety and Avoidance scores. Men with securely attached girlfriends had the lowest levels of cortisol during the conflict task and the flattest growth curve, indicating the least reactivity during and after the conflict negotiation task. Men with girlfriends who were insecurely attached showed the most extreme levels of reactivity; their cortisol levels were higher throughout the task and during the recovery period, and the curvature of their trajectories was steeper than that of men with secure girlfriends.

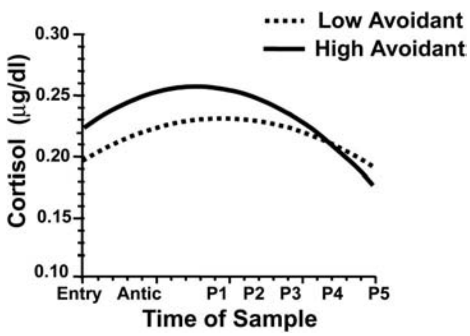

Figure 1. Cortisol reactivity and recovery trajectories of two prototypical women with avoidant attachment scores at the 25th and 75th percentile. Entry = cortisol level immediately prior to entering the lab; Antic = cortisol level in response to vivid description of the upcoming task; P-1 = cortisol level during the middle of the task; P-2 = cortisol level at the end of the task; P-3, P-4, and P-5 = cortisol levels during successive periods of the recovery phase. Please refer to Table 1 for further details on cortisol measurement points.

Does Attachment Predict Self-Reported Perceptions of Stress Before and During Conflict Negotiations?

Before we ran HLM models to analyze the relation of attachment to self-reports of stress, we examined simple correlations of self-reports of stress before and during the conflict task with cortisol levels before and during the task for both men and women. Men's and women's self-reports of stress before the conflict were positively correlated with cortisol sampled in anticipation of the conflict task (men: $r = .26$, $p = .004$; women: $r = .19$, $p = .04$). Men's, but not women's, self-reports of stress during the discussion were significantly correlated with cortisol levels during the discussion (men: $r = .21$, $p = .02$; women: $r = .13$, *ns*). Results clarify that, in this sample, self assessments of stress were positively and fairly weakly related to physiological assessment of stress. Thus, it was reasonable to examine whether attachment styles were differentially associated with HPA reactivity and self-reported stress in response to conflict.

On the basis of previous empirical reports on the relation of attachment to self-reported stress, we hypothesized that Anxiety, but not Avoidance, attachment scores would be associated

Table 5
Predicted Values of Cortisol Level and Rate of Change at the Anticipation Point for Four Prototypical Men With Different Attachment Styles

Attachment style	Cortisol level at anticipation point	Rate of change at anticipation point
Fearful–Avoidant (high anxiety, high avoidance)	.33	.06
Dismissing (low anxiety, high avoidance)	.32	−.02
Preoccupied (high anxiety, avoidance)	.30	.07
Secure (low anxiety, low avoidance)	.24	.03

Table 4
Final Estimation of Level 2 Predictors of Males' Cortisol Reactivity: Full and Reduced Models

	Full model				Reduced model			
Predictor	Estimate	*SE*	*t* (*df*)	*p*	Estimate	*SE*	*t* (*df*)	*p*
Male cortisol level at anticipation point								
Intercept	.278	.017	16.37 (116)	.000	.276	.017	16.52 (119)	.000
Male blood contamination	.062	.020	3.05 (116)	.003	.063	.020	3.11 (119)	.003
Male avoid	.033	.024	1.37 (116)	.175	.051	.016	3.21 (119)	.002
Female partner avoid	.011	.026	.43 (116)	.666				
Male anxiety	.029	.017	1.70 (116)	.092	.026	.016	1.65 (119)	.102
Female partner anxiety	−.024	.017	−1.35 (116)	.179				
Male avoidance × anxiety	−.042	.025	−1.63 (116)	.106	−.036	.018	−2.02 (119)	.046
Female partner avoidance × anxiety	−.019	.026	−0.73 (116)	.466				
Male rate of change at anticipation point								
Intercept	.028	.015	1.81 (116)	.073	.026	.015	1.71 (116)	.089
Male allergy medication	.229	.073	3.15 (116)	.002	.223	.073	3.07 (116)	.003
Male avoidance	−.060	.022	−2.73 (116)	.008	−.028	.012	−2.36 (116)	.020
Female partner avoidance	.036	.024	1.54 (116)	.127	.020	.022	0.90 (116)	.370
Male anxiety	.034	.015	2.23 (116)	.028	.040	.015	2.72 (116)	.008
Female partner anxiety	−.004	.016	−0.27 (116)	.792	.000	.015	−0.02 (116)	.982
Male avoidance × anxiety	.017	.023	0.71 (116)	.477	.027	.013	2.13 (116)	.035
Female partner avoidance × anxiety	−.060	.023	−2.56 (116)	.012	−.051	.022	−2.33 (116)	.021
Male curvature across trajectory								
Intercept	−.087	.015	−5.99 (116)	.000	−.085	.015	−5.84 (118)	.000
Male allergy medication	−.110	.050	−2.17 (116)	.032	−.106	.051	−2.09 (118)	.039
Male avoidance	.032	.021	1.52 (116)	.132				
Female partner avoidance	−.033	.022	−1.49 (116)	.139	−.016	.015	−1.06 (118)	.290
Male anxiety	−.035	.015	−2.41 (116)	.018	−.037	.013	−2.79 (118)	.007
Female partner anxiety	.016	.015	1.08 (116)	.282	.003	.010	0.29 (118)	.775
Male avoidance × anxiety	.010	.022	0.47 (116)	.640				
Female partner avoidance × anxiety	.049	.022	2.22 (116)	.028	.034	.015	2.24 (118)	.027

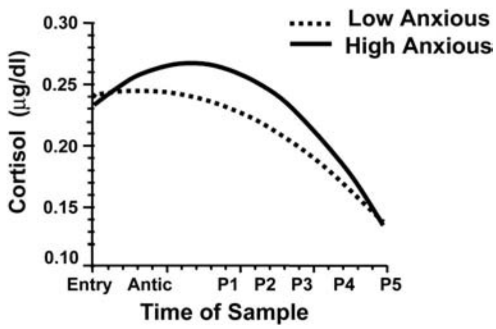

Figure 2. Cortisol reactivity and recovery trajectories of two prototypical men with anxious attachment scores at the 25th and 75th percentile. Entry = cortisol level immediately prior to entering the lab; Antic = cortisol level in response to vivid description of the upcoming task; P-1 = cortisol level during the middle of the task; P-2 = cortisol level at the end of the task; P-3, P-4, and P-5 = cortisol levels during successive periods of the recovery phase. Please refer to Table 1 for further details on cortisol measurement points.

with self-reports of greater stress before and during the conflict task. We ran two HLM models, with self-reported stress experienced before and during the task as dependent variables. Partners' scores on the Anxiety and Avoidance attachment dimensions and their interaction were the predictor variables. We did not use HLM to model growth curves in these analyses because participants' self-reports of anticipatory stress were measured only at one point (before the conflict task), and participants' self-reports of the amount of stress they experienced during the discussion were also assessed only at one point (after the conflict task). HLM was used in order to account for dependency between partner data in outcome scores. As shown in Table 6, our hypothesis was confirmed. For both men and women, anxious attachment predicted greater self-reported stress before the conflict task; a similar pattern emerged for perceived stress during the conflict, although for women, this association was only marginally significant ($p < .07$). In addition, women perceived greater stress during the task when their boyfriends were higher in anxiety. Avoidant attachment did not predict self-reports of stress.

Discussion

Adult attachment style is associated with the experience and regulation of affect, but the degree to which physiological processes play a role in this connection has received little attention in the literature (Diamond, 2001). The present study is the first to demonstrate a link between adult romantic attachment and patterns of HPA reactivity and recovery over the course of a stressful interaction. Findings from this study extend previous work in several ways. First, they demonstrate that individuals' own attachment styles predict their HPA stress responses and that the nature of this association differs for men and women. Second, the findings suggest that the partner's attachment security (or insecurity) contributes to men's physiological stress responses. Third, the results highlight the importance of gender as a contextual variable that moderates the association between adult attachment and physiological stress responses. Fourth, these findings suggest that affective reactivity assessed with a less conscious response system (i.e., physiological responses) may yield different findings from those based on more conscious self-reports. Fifth, this study provides a methodological advance over previous work by looking at cortisol trajectories over multiple time points, allowing for an assessment of physiological reactivity and recovery over the course of a stressor. We elaborate on these points in the following sections.

Individuals' Own Attachment Style, Gender, and HPA Reactivity

As hypothesized, insecure attachment predicted greater HPA reactivity, but the type of insecure attachment that predicted reactivity varied for women and men. For women, greater attachment avoidance was associated with higher cortisol levels as they entered the lab and with more extreme reactivity to the conflict task. After the task was completed, however, highly avoidant women recovered quickly.

For men, in contrast to the pattern for women, anxious scores added significantly to the prediction of stress reactivity and recovery. Anxiety interacted with avoidance to predict cortisol levels at the anticipation point, as well as acceleration or deceleration of cortisol levels from that point. Men who were more secure showed less reactivity in anticipating the task than those who were more insecure, and the rate at which their cortisol rose was slower than for men who were more preoccupied (high in anxiety, low in avoidance) or fearful–avoidant (high in anxiety, high in avoidance). Anxiety alone predicted the curvature of men's overall trajectories (from entry through recovery). Men higher in anxiety showed a more rapid increase in stress reactivity at the anticipation point, their cortisol levels remained higher throughout the task, and they began to recover later than those lower in anxiety. Thus,

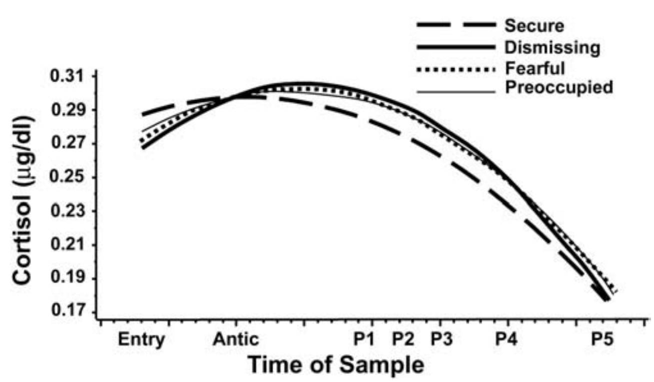

Figure 3. Cortisol reactivity and recovery trajectories of four prototypical men with female partners at different combinations of high (75th percentile) and low (25th percentile) scores on the Avoidance and Anxiety attachment dimensions, including when the partner is low on both dimensions (Secure), low on Anxiety and high on Avoidance (Dismissing), high on Anxiety and low on Avoidance (Preoccupied), and high on both dimensions (Fearful). Entry = cortisol level immediately prior to entering the lab; Antic = cortisol level in response to vivid description of the upcoming task; P-1 = cortisol level during the middle of the task; P-2 = cortisol level at the end of the task; P-3, P-4, and P-5 = cortisol levels during recovery phase. Please refer to Table 1 for further details on cortisol measurement points.

Table 6
Final Estimation of Level 2 Attachment Predictors of Male and Female Self-Reported Stress Before and During the Conflict Task

	Male stress				Female stress			
Predictors of self-reported stress	Estimate	*SE*	*t* (*df*)	*p*	Estimate	*SE*	*t* (*df*)	*p*
Anticipatory stress								
Intercept	−.154	.104	−1.49 (107)	.139	.141	.111	1.26 (107)	.210
Male anxiety	.326	.104	3.12 (107)	.003	.176	.114	1.54 (107)	.127
Male avoidance	.081	.149	0.54 (107)	.588	−.055	.166	−.33 (107)	.743
Male interaction term	−.081	.148	−0.54 (107)	.587	.127	.183	.69 (107)	.489
Female anxiety	−.056	.107	−0.52 (107)	.601	.297	.118	2.52 (107)	.014
Female avoidance	−.161	.169	−0.95 (107)	.343	−.099	.169	−.59 (107)	.559
Female interaction term	−.184	.174	−1.06 (107)	.292	.210	.070	1.24 (107)	.219
Discussion stress (stress during the conflict task)								
Intercept	.038	.107	0.36 (107)	.718	.047	.114	0.41 (107)	.683
Male anxiety	.266	.108	2.47 (107)	.015	.320	.117	2.74 (107)	.008
Male avoidance	.176	.154	1.15 (107)	.718	.153	.170	0.90 (107)	.370
Male interaction term	.060	.153	0.39 (107)	.696	.093	.187	0.50 (107)	.619
Female anxiety	.006	.111	0.06 (107)	.952	.224	.120	1.86 (107)	.066
Female avoidance	.207	.174	1.19 (107)	.237	.133	.173	0.77 (107)	.444
Female interaction term	−.054	.180	−0.30 (107)	.763	.277	.174	1.60 (107)	.113

aspects of men's patterns of reactivity and recovery were associated with both greater anxiety and greater avoidance, but women's patterns of reactivity and recovery were associated only with attachment avoidance.

These gender-related patterns may reflect differences in the context of the conflict negotiation task for men and women. Previous work (Christensen & Heavey, 1990; Kelley et al., 1978) indicates that women are more likely to raise relationship concerns and to guide discussions about areas of disagreement. The conflict negotiation task may be particularly difficult for avoidant women who prefer to cope by distancing rather than by confronting stressful issues (see Pietromonaco, Feldman Barrett, & Holmes, 2006) but who are forced by the nature of this experimental task to engage in at least some discussion of an area of conflict. These more avoidant women show a rapid physiological recovery when the discussion ends, indicating that they experience relief, at least at a physiological level, when they are able to disengage from the conflict discussion. Indeed, this pattern suggests that more avoidant women actually benefit physiologically when they are able to exit a conflict interaction, an internal experience that may reward this avoidant coping behavior. Although avoidant men also showed stress reactivity when they were anticipating the conflict task, their stress decelerated from that point, and their overall trajectories were not distinct from those of less avoidant men. Avoidance may be less predictive of stress reactions for men than for women because gender norms dictate that men need not engage as actively in the conflict discussion.

Men with a more anxious attachment style showed greater reactivity and were slower to enter recovery than those who were less anxious, whereas more anxious women did not differ from less anxious women. This pattern, like the one for avoidance, also may be related to differential norms for men and women. Anxious men may be expected to express distress to their partner and to take a directive role in the interaction. At the same time, gender norms prescribe that men should take a less active role. The tension between these demands may make the task particularly stressful for more anxious men. In contrast, more anxious women may be better able to manage the task and, as a consequence, experience less physiological stress because the context affords them the opportunity to engage in strategies that are consistent with their attachment style—that is, it is appropriate within the context of the task to directly discuss and confront a relationship problem. Thus, the findings expand our understanding of the link between adult attachment and the experience and regulation of affect by providing evidence that physiological stress responses are implicated in these processes, but they also emphasize the importance of taking into account contextual aspects of stressful tasks, in particular, gender role norms, when examining romantic attachment processes.

A potential alternative explanation for the gender differences observed in our study is that they reflect some underlying physiological difference between men and women. This explanation needs to be considered because we did not directly assess gender role norms but rather relied on biological sex to infer whether participants would be more or less likely to be influenced by particular norms. Although we cannot rule out this possibility, it does not seem plausible for two reasons. First, even though men and women have been shown to differ in HPA reactivity, the differences are not consistently in one direction or another because they vary depending on the nature of the task (Kiecolt-Glaser et al., 1996; Kirschbaum et al., 1995; Stroud, Salovey, & Epel, 2002). Second, our hypothesis focused on the interaction between gender and attachment in the context of a conflict interaction. It seems unlikely that biological sex per se would lead men who are more anxious to respond differently at a physiological level than men who are less anxious, but that it would lead women who are more avoidant to respond differently from those who are less avoidant. Nevertheless, this question can be better addressed in future work by including more direct assessments of beliefs about gender role norms. For example, it may be that the observed patterns would be stronger for individuals who adhere more closely to particular gender role norms.

In addition, our findings extend psychoneuroendocrinological work (Stroud et al., 2002) showing that men and women differ in the contexts in which they evidence greater HPA reactivity by suggesting that individual differences in attachment style may moderate this effect. Although Stroud et al. (2002) found that men showed greater HPA reactivity to achievement stressors, whereas women showed greater HPA reactivity to interpersonal stressors, our findings indicate that both men and women who evidence insecure attachment styles are more reactive to an interpersonal stressor. The two studies differ, however, in the nature of the interpersonal stressor. The task in the Stroud et al. (2002) study involved social rejection by strangers, whereas the task in the present study involved discussing a conflict with a romantic partner. It is possible that the link between gender and HPA reactivity differs for these two kinds of interpersonal tasks. Indeed, a recent meta-analytic review (Dickerson & Kemeny, 2004) has demonstrated that HPA reactivity varies substantially across different kinds of stressful tasks, suggesting that future investigations will need to examine whether the connection between attachment, gender, and HPA reactivity varies as a function of whether the interpersonal stressor occurs within a close relationship.

Partner's Attachment Style, Gender, and HPA Reactivity

On the basis of attachment theory, we expected that individuals who had partners who were high in attachment security would show less physiological stress reactivity. Consistent with this expectation, men interacting with female partners who were high in attachment security showed some HPA reactivity before the task, but their levels did not rise as much in anticipation of the task, and their cortisol levels dropped throughout the periods during and after the task. In contrast, men with female partners who were high in any form of insecurity (i.e., anxious–ambivalence, fearful–avoidance, or dismissing–avoidance) showed a sharper increase in cortisol levels in anticipation of and during the conflict task and they were slower to recover after the task. This pattern is consistent with the idea that attachment relationships function as a regulatory system in which people who are more securely attached are better able to help their partners regulate feelings of distress in the face of threat.

Women's patterns of HPA reactivity and recovery, however, did not depend on their male partners' attachment style. Although attachment theory does not provide a basis for explaining this gender difference, gender-specific norms are likely to have contributed to this pattern. If women are expected to guide and manage discussions about relationship problems, then they also may have a greater impact on their male partner's outcomes, including his HPA reactivity. Our findings parallel those of previous work (Kirschbaum et al., 1995) in which men evidenced less HPA reactivity when their romantic partner provided support, whereas women did not show less reactivity when their partner provided support. Furthermore, the present findings extend this earlier work by suggesting that this pattern may characterize men primarily when they are interacting with a female partner who is securely attached.

Different Patterns for Physiological Versus Self-Reported Reactivity

Our findings for self-reported stress before and after the conflict task were consistent with previous studies (e.g., Simpson et al., 1996), but they did not parallel the patterns of cortisol reactivity. As in previous work, we found that both men and women with higher anxious attachment scores subjectively reported greater stress. This finding is comparable to cortisol patterns for men (i.e., more anxious men showed greater cortisol reactivity) but not for women. Also, in contrast to the physiological data, men's subjective reports were not associated with their female partner's attachment style. Instead, it was women's subjective reports that were associated with their partner's attachment style; women reported greater stress after the task when their male partner was more anxious. In general, findings based on subjective reports of distress often do not correspond with those based on patterns of cortisol reactivity (Dickerson & Kemeny, 2004; Stroud et al., 2002). These findings suggest that the link between attachment and affective reactivity and regulation may vary depending on whether responses are assessed at a more conscious level (e.g., via self-reports) or at a less conscious level (e.g., via physiological responses), and they point to the importance of investigating attachment processes at these different levels (see Pietromonaco & Feldman Barrett, 2000).

Notably, participants' self-reports of perceived stress before and during the conflict task were positively, although fairly weakly, correlated with their cortisol levels before and during the task, supporting the notion that these two methods of assessing stress tap into somewhat related, but clearly not identical, reactivity processes (see Cacioppo et al., 1999; Dickerson & Kemeny, 2004; Lang, 1994). The distinction between threat and challenge situations may be relevant for understanding these associations. For example, individuals who feel less able to cope with a situation may perceive the situation as a threat and show high HPA reactivity. In contrast, individuals who feel able to cope may perceive the situation as a challenge and not show elevated HPA reactivity, yet still consciously perceive and report a high level of stress. Future work that includes assessments of threat and challenge appraisals will allow for an evaluation of this possibility.

Methodological Contribution

Multilevel growth modeling was used to analyze trajectories of HPA reactivity and recovery while also enabling the use of dependent couple data to examine both gender and partner effects in a single model. Growth modeling of the entire trajectory of stress responses, including responses in anticipation of the stress event, during the event, and recovery after the event, provided critical information beyond pre–post event difference scores in cortisol levels. We found that individual differences in attachment consistently predicted men's and women's cortisol responses in anticipation of the conflict task as well as their pattern of recovery from heightened cortisol secretions. The vast majority of empirical work and scientific discussion concerning cortisol reactivity to stress and its impact on mental and physical health has been unconcerned with examining these two "ends" of the stress response. Anticipatory stress and recovery demand a closer look, however, because these portions of the stress response may have implications for the link of cortisol with mental and physical health outcomes. For example, it is plausible that individuals with strong anticipatory stress reactions may be exposed over a lifetime to equally high levels of cortisol as do individuals who do not anticipate stressors but encounter a higher number of actual stress events. Chronically heightened anticipatory reactions could potentially contribute to the development of defensive coping behaviors and health risks, such as depression and immunological dysfunction, which are typically associated with exposure to negative life events. Similarly, failure to efficiently recover from HPA reactions may exacerbate health risks by maintaining exposure to high levels of circulating cortisol.

Notably, our findings also highlight the notion that the effects of unusually rapid recovery are important to understand. Rapid recovery from physiological stress may serve as a potent reward for avoidance and associated maladaptive interpersonal behaviors, such as withdrawal, and therefore lead to the development or exacerbation of behavior patterns that are associated with negative health outcomes. In a review of studies of cortisol responses to laboratory stressors, Dickerson and Kemeny (2004) noted that for a subset of individuals, a rapid and strong elevation of cortisol levels is coupled with a rapid recovery, and they suggest that more research studies should focus on investigating the contexts and predictors of such recovery processes. Our findings suggest that insecure attachment, particularly avoidant attachment for women, may be associated with this pattern of HPA response. Thus, including analysis of the entire stress trajectory in future studies could help elucidate how physical stress reactivity may serve as a catalyst (anticipatory reactions) or a reward (quicker recovery) for maladaptive behavior, leading to greater health risks.

Limitations

Despite the considerable strengths of multilevel growth modeling of cortisol trajectories, it is important to note that the analyses are correlational and do not address whether attachment style is a cause or a consequence of patterns of physiological stress responses, or whether some related variable (e.g., temperament) might account for the observed associations. It is likely that there are reciprocal effects between attachment styles and physiological manifestations of stress. Evidence from twin studies (Bartels, de Geus, Kirschbaum, Sluyter, & Boomsma, 2003; Kirschbaum, Wüst, Faig, & Hellhammer, 1992) suggests that HPA reactivity has a heritable component and, therefore, people who show greater HPA reactivity may be more vulnerable to attachment insecurity because they may have greater difficulty deriving comfort from their caregivers' responses. However, caregivers' responses also can shape neuroendocrine responses (see Glaser, 2000; Gunnar, 1998; Polan & Hofer, 1999; Schore, 1996), suggesting that the quality of the attachment relationship also can contribute to stress reactivity. This point is supported by research demonstrating that peer-reared rhesus monkeys show markedly greater HPA reactivity to social separation than mother-raised monkeys (see Suomi, 1999), presumably because those reared with their mother learned to cope more effectively with stressors. It is possible that this reciprocal relationship continues into adulthood. For example, more avoidant women may be predisposed to experience greater HPA reactivity in response to threat. If, however, they also tend to experience quicker physiological relief of stress after exiting a conflict discussion, this pattern may further reinforce an avoidant romantic attachment style. Over time, an entrenched avoidant attachment style, in turn, may exacerbate the HPA response to interpersonal conflict. In addition, our finding showing that men who were paired with more secure partners evidenced less HPA reactivity suggests that, even in adulthood, interactions with attachment figures may serve to modulate physiological stress responses.

As noted earlier, determination of the relevance of threat/challenge appraisals for understanding differences between self-report and physiological measures of stress relies on accurate assessments of individual's coping resources. Our analyses did not include participants' assessments of their ability to cope with the conflict discussion task. Including assessments of coping resources in future studies will facilitate the examination of whether challenge situations accentuate differences between self-reported stress and physiological stress responses. However, it is important to note that the correspondence between self-reports and physiological responses may remain an issue; threat and challenge appraisals do not always map onto physiological reactions (Blascovich & Mendes, 2000).

This study focused on young, dating couples, and it is not possible to know whether findings would be similar for older couples in longer, more committed relationships. Our finding of strong links between attachment and physiological stress reactions to interpersonal conflict in these dating couples raises the question of whether this link might be weaker or stronger in married couples whose stress reactions to conflict are based on a long history of shared interaction patterns and, thus, may have become relatively more automatic over time. On the one hand, this greater experience may reduce stress reactions. On the other hand, such routinized patterns may mean that less input from a partner or a situation is required to rapidly trigger a strong stress response.

Conclusions

This study demonstrates that individual differences in adult attachment style predict stress-related physiological patterns of reactivity and recovery and that these patterns vary with features of the context, including the partner's attachment style and gender role norms. The findings suggest the possibility that particular forms of insecure attachment may be reinforced by physiological stress responses. For example, when avoidant women are able to disengage from a task that demands personal disclosure and confronting an unpleasant topic, they experience physiological relief, which may serve to reinforce their avoidant style. Results clarify that individuals regulate negative affect during conflict with their romantic partners through a complex interplay between attachment style, psychoendocrinological processes, and contextual variables.

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