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A pain in her arm: Romantic attachment orientations and the tourniquet task

CAROL L. WILSON[a] AND MOLLIE A. RUBEN[b]

[a]*The Pennsylvania State University–Erie and* [b]*Northeastern University*

Abstract

Prior research has linked attachment anxiety to heightened perceptions of chronic pain. However, few studies have examined attachment and acute pain, and none of these to our knowledge have included partner attachment effects in a dyadic context. Sixty-five healthy undergraduate women were exposed to an ischemic pain task in the presence of their romantic partners. As expected, women's higher attachment anxiety predicted lower pain thresholds, greater subjective pain, and greater catastrophizing. Higher avoidance was associated with longer pain tolerances and, unexpectedly, lower physiological arousal. More avoidant and more anxious women responded negatively to pain when accompanied by a high-anxiety romantic partner. Implications exist for attachment insecurity and hyperactivating emotion regulation strategies as vulnerability factors in coping with pain.

According to attachment theory (Bowlby, 1969, 1973, 1980), the attachment system serves an emotion regulatory function in relationships by enabling distressed individuals to preserve or reestablish emotional stability when faced with a perceived threat. By stimulating attachment behaviors such as seeking proximity or support from relationship partners (i.e., attachment figures), the attachment system enables individuals to minimize the extent and impact of negative affect within interpersonal contexts, thereby promoting more successful coping with threats. Effective threat management in turn increases the potential for individuals to avoid the potentially damaging psychological (Cooper, Shaver, & Collins, 1998) and physical (Repetti, Taylor, & Seeman, 2002) effects of sustained negative emotion while simultaneously promoting physical and mental well-being (Fox, 1994). Although prior studies have examined the regulatory function of the attachment system in interpersonal contexts involving psychological stressors (e.g., Carpenter & Kirkpatrick, 1996; Ognibene & Collins, 1998; Simpson, Rholes, & Nelligan, 1992), fewer investigations have explored attachment processes in response to physical stressors such as physical pain. Pain is defined as “an unpleasant sensory and emotional experience, associated with actual or potential tissue damage or described in terms of such damage” (International Association for the Study of Pain, 1979). Because physical pain involves a strong negative affective component in addition to serving as a primary trigger for attachment system activation (Bowlby, 1969), it represents an appropriate context for further examining attachment as an emotion

Carol L. Wilson, Department of Psychology, Pennsylvania State University–Erie; Mollie A. Ruben, Department of Psychology, Northeastern University.

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Correspondence should be addressed to Carol L. Wilson, Department of Psychology, School of Humanities and Social Sciences, The Pennsylvania State University–Erie, 4951 College Drive, Erie, PA 16563, e-mail: clw33@psu.edu.

regulation system that influences how individuals respond to perceived threats. Furthermore, given that attachment theory describes individual differences in the use of specific emotion regulation strategies (Mikulincer & Shaver, 2003, 2007), an attachment perspective offers insight into the specific ways in which the subjective, affective, and cognitive components of pain are susceptible to individuals' past experiences, expectations, and interpretations (Melzack, 1975, 2005; Melzack & Wall, 1965, 1982).

Prior research on pain in general has focused primarily on chronic pain (i.e., pain that lasts 3–6 months or longer, or that exceeds typical healing time for a given injury; Flor, 2001) rather than short-term acute pain (Porter, Davis, & Keefe, 2007; Turk, 2006; Zaslansky, Chapman, & Meissner, 2009). This disproportionate emphasis exists in the attachment literature as well, despite the high prevalence of acute pain instances in everyday life (cf. Apfelbaum, Chen, Mehta, & Gan, 2003; Edlow, Panagos, Godwin, Thomas, & Decker, 2008; Hing, Cherry, & Woodwell, 2005). Many experiences of acute pain are particularly likely to occur in the presence of a relationship partner (e.g., labor and delivery pain, postoperative surgical pain), whereas in other cases individuals may seek out relationship partners for support or empathy following an acute pain episode (e.g., sports or work-related injuries, non-migraine headaches, toothaches, menstrual cramps). Importantly, prior research has often failed to account for significant others and close relationships in previous examinations of pain (Porter et al., 2007; Turk, 2006). This research sought to address these gaps in the literature and to further explore the threat management function of the attachment system within interpersonal relationships by investigating attachment-based responses to acute physical pain. In doing so, we employed a multimethod approach (i.e., self-reports, behavioral measures, and physiological indicators) to assess reactions to acute pain while taking into account attachment influences from both acute pain sufferers and their romantic relationship partners within a dyadic context.

Attachment theory

Attachment theory (Bowlby, 1969, 1973, 1980) is a well-validated theory of emotion regulation grounded in individuals' interactions with caregivers during infancy. Individuals develop generalized mental models of close relationships based on the availability and responsiveness of caregivers when individuals are threatened or distressed. One important component of these models is "if–then" rules that specify behavioral contingencies and expectations of relationship partners, such as "if I feel vulnerable and approach my caregiver/partner with a need, she or he is likely to offer support or comfort and help alleviate my distress" (Collins & Allard, 2001). Although developed early in life, internal working models of attachment are relatively stable over time (Bowlby, 1982) and influence behaviors, thoughts, and feelings in future relationship contexts including those with romantic partners (Hazan & Shaver, 1987; Mikulincer & Shaver, 2003, 2007).

The attachment system and attachment-relevant behaviors are activated during times of perceived danger including external threats to one's safety as well as internal threats such as hunger, illness, and *pain* (Bowlby, 1969). The system is designed to bring a threatened or distressed individual into proximity to a close relationship partner (i.e., attachment figure) who can ideally offer protection, comfort, and support to the individual. According to Mikulincer and Shaver's (2007) process model of attachment, proximity seeking—the initiation of contact with an attachment figure to obtain support, comfort, and/or care—is the primary behavioral strategy for emotional regulation and threat management that is employed once the attachment system is activated. Individuals with a history of seeking proximity to available and responsive relationship partners (i.e., securely attached individuals) should have increased confidence in the use of proximity seeking as a threat response strategy, and therefore are more likely to employ this strategy again in future instances of distress. However, individuals who have historically sought proximity to unavailable and/or unresponsive partners when distressed (i.e., insecurely attached individuals) have typically been unsuccessful in garnering support and attention to their needs. As a result, they lack confidence in proximity seeking as an effective strategy and instead resort to secondary threat management techniques—namely, hyperactivating or deactivating strategies of emotion regulation. Use of these secondary strategies varies based on individuals' attachment orientations which in turn are best characterized along two continuous dimensions of anxiety and avoidance (Brennan, Clark, & Shaver, 1998; Fraley & Waller, 1998). Anxiety indexes the degree to which individuals monitor partners' availability and responsiveness and fear abandonment by relationship partners, whereas avoidance indexes the extent to which individuals are uncomfortable with closeness and dependency. Anxious attachment (high scores on anxiety and low scores on avoidance) is associated with reliance on hyperactivating strategies, whereas avoidant attachment (high scores on avoidance and low scores on anxiety) is associated with deactivating strategies (Mikulincer & Shaver, 2007). We elaborate next on how these secondary strategies of threat management operate, along with their implications for the experience of pain.

Attachment anxiety, hyperactivation, and pain

Hyperactivating strategies involve an exaggerated proximity seeking response that is employed when relationship partners are perceived as inconsistently responsive or available, a hallmark of anxiously attached individuals' prior interactions with attachment figures (Mikulincer & Shaver, 2007). Thus, more anxiously attached people tend to engage in hyperactivating strategies when threat is perceived in an effort to obtain the attention and protection of relationship partners whom they perceive as being unreliable. These strategies include increased monitoring of the partner in order to detect signs of potential disinterest, abandonment, or rejection; increased vigilance to potential sources of danger or threat; exaggerated appraisals of threat; and "emotion-focused coping" (Lazarus & Folkman, 1984), which involves rumination on negative thoughts and emotions and the amplification of negative affect. When faced with physical pain, anxious individuals' engagement in hyperactivating strategies should lead to rumination about pain, self-focus on negative affect and pain-related cognitions (e.g., pain catastrophizing), and the amplification of pain-related threat-appraisal and distress. As a result of increased partner monitoring and heightened negative self-focus, anxiously attached individuals should over time develop more negative self-views and overreliance on relationship partners rather than the self in coping with threats such as physical pain (Mikulincer & Shaver, 2003, 2007). Because hyperactivating strategies are based in anxious individuals' prior interactions with unreliably responsive and available relationship partners, they are likely to experience doubts that partners will support or help them and, combined with their tendency toward low self-efficacy, feel overwhelmed and unable to cope effectively with their pain. Thus, anxiously attached individuals must cope not only with the negative effects of a physical pain experience, magnified by their own hyperactivating tendencies, but also the added emotional pain of (perceived) rejection by relationship partners just when support is needed the most. Previous research suggests that individuals have limited cognitive resources that can be temporarily depleted through exertions of self-regulation, leaving them prone to subsequent lapses in self-control (Muraven & Baumeister, 2000). Expending effort to manage additional worry about relational uncertainty should threaten to limit the resources available for physical pain management, thereby leaving the anxiously attached individual less able to mitigate threatening pain-related thoughts and emotions, and less likely to persist at a painful task.

Prior research findings do support an association between attachment anxiety and pain, although previous researchers have focused primarily on chronic pain. Specifically, in samples of individuals suffering from chronic pain, anxious or preoccupied attachment has been associated with higher levels of pain (McWilliams, Cox, & Enns, 2000), greater pain affect (MacDonald & Kingsbury, 2006), lower perceived ability to cope with pain (Meredith, Strong, & Feeney, 2006a; Mikulincer & Florian, 1998), higher pain-related disability (Davies, Macfarlane, McBeth, Morriss, & Dickens, 2009) and greater pain catastrophizing (Meredith, Strong, & Feeney, 2005), as expected. Davies and colleagues (2009) also found that individuals suffering from chronic widespread pain (e.g., pain present for at least 3 months across two contra-lateral areas of the body) were 2.6 times as likely to report preoccupied (i.e., high anxiety, low avoidance) attachment and 1.9 times as likely to report fearful (i.e., high anxiety, high avoidance) attachment as pain-free individuals were. In addition, individuals suffering from pain that did not meet the above criteria were 40% more likely to report preoccupied attachment relative to pain-free individuals. In nonchronic pain sufferers, attachment anxiety has also been associated with greater fear of pain, greater awareness of pain, lowered perceptions of control over pain, greater severity of pain, and greater pain catastrophizing (McWilliams & Asmundson, 2007; Meredith, Strong, & Feeney, 2006b; Tremblay & Sullivan, 2010).

Being in the presence of a more highly anxious relationship partner may also influence an individual's pain experience. If a more anxious relationship partner experiences distress as a result of their romantic partner being in pain or perceives an opportunity to obtain the partner's attention by being helpful or solicitous, they may engage in emotion-focused coping strategies themselves and direct the partner's as well as their own attention to the pain experience. Yet individuals with different attachment styles appear to react differently when others initiate emotion-focused social interactions. For example, Mikulincer and Florian (1997) found that securely attached participants responded to a psychological stressor with reduced negative affect after engaging in an emotion-focused conversation initiated by an interaction partner compared to being in an alone condition. In contrast, avoidant individuals experienced significantly more negative affect after the emotion-focused conversation versus being alone and anxiously attached individuals showed no difference. Thus, securely attached individuals benefited from the type of emotion-focused interaction that an anxiously attached partner might be prone to initiate, whereas anxious individuals failed to benefit and avoidant individuals found the experience to be detrimental.

Avoidance, deactivation, and pain

Deactivating strategies inhibit proximity seeking in response to threat or distress when such behavior may be dangerous or prohibited, such as when interacting with consistently unavailable or inappropriately responsive relationship partners who are punitive or rejecting (Mikulincer & Shaver, 2007). Given that such negative interactions are a hallmark of avoidant attachment histories, more avoidantly attached individuals tend to engage in deactivating strategies when threatened or distressed. These strategies include "coping" with threat by downplaying or dismissing potential threats, suppressing threat-related thoughts and feelings, denying attachment needs, and pursuing excessive self-reliance (Cassidy & Kobak, 1988). When faced with physical pain, avoidant individuals should be likely to suppress the acknowledgment of pain or pain-related distress, inhibit or ignore pain-related affect and cognition, report lowered pain appraisals, deny the need to turn to relationship partners, and instead profess to manage pain just fine on their own. Such deactivating strategies are similar to Lazarus and Folkman's (1984) "distance coping" strategies intended to minimize the experience of distress by keeping threatening thoughts and feelings outside of conscious awareness. If their attempts to keep pain-related distress outside of conscious awareness are successful, avoidant individuals may be able to persist longer at a painful task than those using hyperactivating strategies who should more easily feel overwhelmed.

Although evidence linking avoidance to pain has been more sparse compared with attachment anxiety, some studies have shown avoidance to be unrelated to chronic pain affect (MacDonald & Kingsbury, 2006), fear of pain, and pain awareness (McWilliams & Asmundson, 2007). In contrast, other studies have found avoidance to be associated with greater threat appraisal of chronic pain (Meredith et al., 2005; Mikulincer & Florian, 1998) and increased catastrophizing about nonchronic pain (McWilliams & Asmundson, 2007). In the Davies and colleagues (2009) study noted previously, chronic pain sufferers were 1.4 times as likely to be dismissively avoidant (i.e., high avoidance, low anxiety) and 1.9 times as likely to be fearfully avoidant (i.e., high avoidance, high anxiety) compared to pain-free individuals.

Being in the presence of an avoidant relationship partner may also influence an individual's pain experience. Prior research has demonstrated that avoidant individuals are less likely to offer comfort and support when partners are in need (Ognibene & Collins, 1998; Simpson et al., 1992). Furthermore, they are more likely to derogate close others who request their support in a defensive effort to push them away and maintain autonomy (Wilson, Rholes, Simpson, & Tran, 2007; Wilson, Simpson, & Rholes, 2000). It is therefore likely that an individual partnered with an avoidant person may need to rely on their own internal resources for dealing with pain because the partner is emotionally and psychologically unavailable or inappropriately responsive to them. Thus, the anxious or avoidant participant's concerns about partner rejection would likely be validated with an avoidant partner, potentially leading to exacerbation of the participant's own threat-management tendencies when facing a painful situation.

Attachment security, secure-based strategies, and pain

As a result of having experienced positive interactions with consistently available relationship partners, securely attached individuals learn that distress is manageable, that relationship partners are benevolent and trustworthy agents, and that attempts to seek proximity and support from partners will be favorably received and result in the effective reduction of distress (Mikulincer & Shaver, 2007). Therefore securely attached individuals are confident in the use of proximity seeking to manage threat, whether by physically promoting contact with relationship partners or by activating mental reminders of past positive relationship experiences. They also acquire confidence in their own abilities to effectively overcome obstacles and are characterized by positive self-efficacy. Therefore securely attached individuals faced with physical pain should draw upon their own internal resources as well as the real or remembered security, comfort, and support of relationship partners to directly confront pain-related cognitions and affect. Because secure-based strategies are most closely associated with self-efficacy and effective coping, securely attached individuals are likely to render more realistic threat appraisals of pain to fall in between anxious individuals' potentially elevated pain appraisals and avoidant individuals' denials of pain. In past investigations, more securely attached individuals have reported lower threat appraisal of their chronic pain (Mikulincer & Florian, 1998), greater perceptions of control over chronic pain, and less pain catastrophizing in response to acute pain (Meredith et al., 2006b).

In addition, individuals facing a pain experience in the presence of a securely attached relationship partner may be better able to cope with pain. Unlike avoidant individuals, more secure individuals are willing and able to offer comfort and support when partners are distressed (Simpson et al., 1992; Simpson, Rholes, Campbell, Tran, & Wilson, 2003), and therefore a secure relationship partner represents available, responsive caregiving for the individual in need. Having a securely attached partner may therefore reduce an individual's characteristic tendency to engage in either hyperactivating or deactivating strategies given that the current partner is likely to be emotionally, psychologically, and physically available and responsive.

Prior acute pain research

Although attachment researchers have focused primarily on chronic rather than acute pain in prior investigations, a few researchers have investigated links between attachment and acute pain—for instance, by using hypothetical pain scenarios and pain questionnaires involving memory recall (McWilliams & Asmundson, 2007; Tremblay & Sullivan, 2010). However, because of cognitive biases such as the affective forecasting error (for reviews, see Wilson & Gilbert, 2003, 2005), individuals may fail to accurately predict their responses to future pain episodes. In addition, self-serving biases may promote the recall of prior painful experiences in ways that foster a more positive self-image (e.g., Wilson & Ross, 2001). Assessing immediate responses to an actual pain event in a controlled laboratory setting would help to alleviate the potential for such cognitive biases. To our knowledge, however, only two published studies to date have directly investigated attachment and acute pain using a laboratory pain task.

Meredith and colleagues (2006b) demonstrated associations between attachment anxiety on the one hand, and catastrophizing and lower pain thresholds on a cold pressor task on the other. Although this study provided important initial evidence that attachment and acute pain are linked, the researchers noted that their convenience sample involving friends and colleagues may have introduced selection bias and the potential for validity threats into their data, fostering the need to replicate their results. In addition, gender of the experimenter was not controlled. Prior research has shown that participants tested by an opposite-sex versus same-sex experimenter display higher pain tolerances and that participants report higher pain intensities when tested by female versus male experimenters (Kállai, Barke, & Voss, 2004).

MacDonald (2008) also studied attachment anxiety in two studies using a cold pressor task and one study using a finger pressor task. He administered two pain tasks in each study separated by a social exclusion condition and found no significant effects of attachment on pain threshold or pain tolerance in the initial baseline cold pressor or finger pressor tasks. However, anxiety did predict significantly higher perceptions of painful discomfort during one cold pressor task. Importantly, neither MacDonald's nor Meredith and colleagues' (2006b) studies involved a dyadic context. Because attachment theory applies uniquely to interpersonal interactions and because many acute pain experiences are shared and/or occur in the presence of close others (e.g., childbirth), it is important to examine the effect of the relationship partner's attachment orientation on the individual's experience of pain. In addition, neither study incorporated physiological measures of pain response which we turn to next.

Physiological versus subjective measures of pain

Laboratory manipulations of acute pain using "vigilance tests" such as the cold pressor and the submaximal effort tourniquet task typically produce increases in heart rate (HR; Fillingim, Browning, Powell, & Wright, 2002; Hugdahl, 1995), a response pattern thought to characterize tasks that involve passive coping (Obrist, 1976) and defensive responses to potential threats (Graham & Clifton, 1966). In addition, pain-related negative affect is commonly correlated with elevated physiological arousal under many circumstances, although the causal direction of this association is not always clear (for a review, see Janssen, 2002). By attenuating negative affect and promoting effective coping with threat via emotion regulation strategies, the attachment system may contribute to the regulation of physiological homeostasis within individuals, consistent with a psychobiological view of attachment (Bowlby, 1973; Diamond & Hicks, 2005). Thus, engagement in proximity-seeking strategies of emotion regulation should serve to dampen elevations in physiological arousal to pain, whereas secondary hyperactivating strategies should serve to heighten typical pain-related arousal responses. Because deactivating strategies divert attention away from relationship partners when individuals are distressed, avoidant individuals are less likely to notice and therefore benefit from support when it is actually available (Mikulincer & Shaver, 2003, 2007). Therefore deactivating strategies may undermine effective threat management at a basic level, even though avoidant individuals should be disinclined to acknowledge any evidence of vulnerability overtly. Based on this, avoidant individuals may show (typical) increases in physiological arousal in response to acute pain although they should *not* self-report higher subjective levels of pain for reasons previously discussed.

A recent study of physiological responses to a psychological stressor is consistent with these expectations. Roisman (2007) demonstrated greater HR reactivity for hyperactivating (preoccupied) adults, heightened skin conductance level (SCL) reactivity for deactivating (dismissive avoidant) adults, and lowered SCL reactivity for securely attached adults engaged in a conflict discussion with their relationship partner. Prior research has also demonstrated dissociations between avoidant individuals' physiological (i.e., autonomic nervous system [ANS]) and self-reported responses to negative stimuli while providing further evidence of primarily heightened physiological responses in anxious individuals (Carpenter & Kirkpatrick, 1996; Diamond, Hicks, & Otter-Henderson, 2006; Mikulincer, 1998). For instance, relative to those with secure attachments, avoidant individuals displayed greater HR changes in response to anger induction manipulations even though they did not self-report higher anger (Mikulincer, 1998). In contrast, anxious individuals' greater self-reported anger was accompanied by greater changes in HR. Diamond and Fagundes (2010), in a recent review of relevant studies, concluded that there is "strong evidence that individual differences in attachment anxiety and avoidance are characterized by heightened hypothalamic-pituitary-adrenocortical axis (HPA) and ANS reactivity to stress, consistent with the notion that attachment insecurity is associated with deficits in emotion regulation" (p. 220) although they also suggest a "general pattern of dissociation between avoidant individuals' self-reported stress and their physiological reactivity to stressors" (p. 220).

Current study

Female participants were exposed to a standardized laboratory pain paradigm designed to produce ischemic (muscle) pain—the tourniquet task—in the presence of their romantic partner. They reported their pain threshold and tolerance, provided online and posttourniquet subjective ratings of pain, and wore a pulse monitor to record HR during the task so that physiological arousal could be assessed. Pulse was chosen to index arousal because it represents a cost-effective and readily available measure of cardiovascular activity that requires minimal training to administer and interpret. In addition to being sensitive to ischemic pain (Fillingim et al., 2002), HR has been associated with attachment orientations and emotion regulation, particularly of negative experiences, in prior studies (Diamond & Hicks, 2005; Mikulincer, 1998).

Overall, we anticipated that systematic differences in women's reliance on hyperactivating, deactivating, and secure-based emotion regulation strategies would produce corresponding attachment-based differences in their responses to acute physical pain. Although anxious attachment on the part of both pain sufferers and their partners was expected to result in women's poorer coping responses (i.e., lower pain thresholds and tolerances, higher subjective pain, higher physiological arousal), secure attachment was expected to have the opposite effect. Avoidant women were expected to show dissociations between their physiological arousal and their (lower) self-reported and behavioral responses to pain.

Method

Sample

Participants were 65 heterosexual romantic couples, at least one member of which was an undergraduate student or staff member from a Northeastern private liberal arts college, who had been in a relationship with their current partner for at least 3 months. Participants received either partial course credit in psychology ($n = 10$), \$10 if they were a student not currently enrolled in a psychology course ($n = 116$), or a small gift (e.g., an embossed pen) if they were a nonstudent staff member ($n = 4$), as compensation for participation. Eight additional couples began the study but failed to follow instructions ($n = 5$), did not meet the inclusion criteria ($n = 2$), or completed a similar study previously ($n = 1$) and therefore their data were not included in analyses. One additional couple was excluded from data analyses because the woman failed to report a pain threshold, which suggests that the blood pressure cuff was not attached and/or inflated correctly during the procedure. The dropped participants did not significantly differ from the remaining participants in terms of attachment scores.

Participants ranged in age from 18 to 28 years with means of 20.6 for men ($SD = 1.5$) and 20.3 for women ($SD = 1.6$). The sample was 81% Caucasian, 7% Hispanic, 6% Asian, 4.5% Black, and 1.5% Other. Sixty-four couples were involved in exclusive relationships with 95.5% of these dating, 3% engaged, and 1.5% married.[1] Participants had been involved with the current partner on average for 1.63 years ($SD = 1.73$), ranging from 3 months to almost 9 years. Women filled out a preliminary health questionnaire to ensure that they were free of chronic pain (e.g., migraines occurring as often as every 3 months) and had no known health problems that would put them at risk during the tourniquet procedure (e.g., high/low blood pressure, heart disease/heart defects, diabetes, neurological disorders, circulatory problems, numbness in hands/feet, Reynaud's disease).

Measures

The Experiences in Close Relationships Inventory–Revised (ECR–R; Fraley, Waller, & Brennan, 2000) contains two subscales of 18 items each assessing individuals' thoughts and feelings about romantic partners in general (including but not limited to their current partner). The avoidance subscale assesses comfort with closeness versus distance in the relationship and contains items such as "I don't feel comfortable opening up to romantic partners." The anxiety subscale assesses concerns about partner availability and responsiveness and contains items such as "I worry that my partner doesn't really love me." All items were answered using Likert scales anchored at 1 (*strongly disagree*) and 7 (*strongly agree*). Coefficient αs for the subscales were .89 and .88 for women's and men's anxiety, respectively, and .89 and .92 for women's and men's avoidance, respectively.

The 13-item Pain Catastrophizing Scale (PCS; Sullivan, Bishop, & Pivik, 1995) assesses the degree to which individuals focus on pain-related thoughts (rumination subscale—four items; e.g., "I kept thinking about how much it hurt"), exaggerate pain in terms of threat (magnification subscale—three items; e.g., "I thought of other painful experiences"), and utilize a pain coping strategy characterized by helplessness (helplessness subscale—six items; e.g., "It was awful and I felt that it overwhelmed me"). Total scale coefficient α was .86 for women.

A one-item Visual Analogue Scale (VAS) consisting of a 100-mm line anchored at *no pain* to *the most intense pain you can imagine* was administered post-tourniquet task to assess participants' pain just prior to cuff deflation and ending the tourniquet task. Additional "online" VAS ratings of pain were completed by women every 30 s throughout the tourniquet procedure.

Because neuroticism has been associated with higher scores on attachment anxiety (Karney & Bradbury, 1997) as well as with chronic pain unpleasantness (Wade, Dougherty, Hart, Rafii, & Price, 1992), it was included as a control variable and assessed using a seven-item subscale from the Big Five Inventory (John & Srivastava, 1999). Items include "I worry a lot" and were answered using 5-point Likert scales anchored at 1

1. The woman in one couple reported dating her partner exclusively, whereas the man reported dating multiple partners. Exclusion of this couple from analyses did not alter the significance of any results with one exception (see footnote 10). Therefore analyses are reported based on all 65 couples.

(*strongly disagree)* and 5 (*strongly agree*). Coefficient αs were .80 for women and .85 for men.

Rejection sensitivity was also included as a control variable given its positive correlation with attachment anxiety and avoidance scores (Downey & Feldman, 1996), and prior research linking rejection induction manipulations to individuals' experiences of pain (e.g., MacDonald, 2008). The 18-item Rejection Sensitivity Questionnaire (RSQ; Downey & Feldman, 1996) targets individuals' anxious expectations of rejection across 18 hypothetical social situations. For each situation, participants assess how concerned or anxious they would feel and how likely it is that they would receive a positive response versus rejection using 6-point Likert scales anchored at 1 (*very unconcerned/very unlikely*) to 6 (*very concerned/very likely*). Coefficient αs were .79 for women and .81 for men.

Given that negative affect has been correlated with subjective pain in past research (e.g., Feldman, Downey, & Shaffer-Neitz, 1999; Janssen, 2002), baseline mood was also included as a control variable. The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) assesses the extent to which participants currently feel each of 10 negative (e.g., distressed, afraid) and 10 positive (e.g., strong, determined) feelings and emotions using 5-point Likert scales from 1 (*very slightly/not at all*) to 5 (*extremely*). Coefficient αs for positive affect were .87 for women and .89 for men. Coefficient αs for negative affect were .68 for women and .89 for men. Participants also rated pictorial stimuli on the Self-Assessment Maniken (SAM; Lang, 1980) using 9-point Likert scales to indicate their mood valence (one item with pictures ranging from 1 = *positive* to 9 = *negative*) and arousal level (one item with pictures ranging from 1 = *calm* to 9 = *aroused*).

Materials

A manual inflation, automatic deflation blood pressure monitor (Health Living Model BM-501S) was used to ascertain that women did not have high blood pressure (i.e., did not exceed 140/90 mmHg) prior to beginning the tourniquet task. A second cuff—a manual inflation, manual deflation aneroid sphygmomanometer (775 Series cuff by American Diagnostic Corporation)—was used to occlude blood flow during the tourniquet task.

A PL6000 Cateye Heartbeat Counter with earlobe sensor was used to monitor the participant's pulse while they completed surveys prior to the tourniquet task in order to establish an average baseline resting pulse. The earlobe pulse sensor was also used during the actual tourniquet task to obtain 30-s pulse ratings.

A Smedley spring hand dynamometer (manufactured by Baseline Evaluation Instruments) was used to determine participants' maximum grip strength, measured between 0 and 220 lbs. To ensure that participants exerted relatively equal amounts of effort during the tourniquet task hand exercises, they were asked to perform handgrips at 50% of their maximum strength.

Procedure

Prior to the study, women completed a preliminary health questionnaire to determine whether they could participate based on the exclusionary criteria listed previously. To standardize pain testing conditions (see Diamond & Otter-Henderson, 2007), qualified couples were only scheduled to participate between 11:00 a.m. and 6:30 p.m. and sessions were conducted by female undergraduate experimenters. Women were instructed to refrain from taking medication, using nicotine or tobacco products, and consuming caffeine within 3 hr of the experiment and from consuming alcohol within 12 hr of the study. On the day of the study, they reviewed and verified the health information on their prescreening questionnaire and then both romantic partners provided informed consent. All procedures were approved by Franklin & Marshall College's Institutional Review Board.

Men were then escorted to a separate room so that both partners could independently complete pretourniquet measures including demographic, attachment, personality, and mood questionnaires. Women wore an earlobe pulse sensor to obtain resting pulse while they completed questionnaires (~12–15 min), and afterward their baseline blood pressure was assessed using an automatic blood pressure cuff applied to their dominant arm. In only one instance was a participant excluded due to elevated resting blood pressure (i.e., in excess of 140/90). Women's maximum grip strength was assessed using the spring hand dynamometer.

After reuniting both partners, the experimenter announced that she had forgotten something in another room and then left the couple alone for approximately 3 min while she retrieved the forgotten item. This 3-min period was designed to provide a second pretourniquet baseline pulse reading for the woman while she was in the presence of her romantic partner. Given that physiological arousal is typically heightened in the presence of others, it was desirable to obtain this second baseline for control purposes in addition to the individual resting pulse collected at the beginning of the study.

Upon her return, the experimenter seated both partners across the table facing each other and briefly described the submaximal effort tourniquet task (Fillingim et al, 2002; Smith, Egbert, Markowitz, Mosteller, & Beecher, 1966). Participants were instructed to remain seated for the entire duration of the tourniquet experience and to interact with their relationship partner in whatever manner seemed most comfortable and natural to them. The experimenter placed a manual blood pressure cuff around the woman's upper nondominant arm and asked her to raise the arm above her head. The arm was exsanguinated for 1 min before inflating the cuff to 270 mmHg. Women were then instructed to drop their arm and perform 20 handgrip exercises at 50% maximum strength. Ischemic pain results from exercising the arm, which induces a need for blood flow, while simultaneously restricting the flow of blood and therefore oxygen to the arm muscles via the tightened tourniquet. Instructions conveyed via a PowerPoint slideshow dictated handgrip speed in addition to prompting participants to make subjective VAS pain ratings every 30 s using a paper-and-pencil form (completed using their dominant hand). Throughout the tourniquet task, participants wore the earlobe pulse sensor, placed on their dominant-side earlobe, which recorded 30-s pulse ratings.

Women signaled their pain threshold (i.e., time between onset of the handgrip exercises and the point at which they first felt pain) and their pain tolerance (i.e., time between onset of the handgrip exercises and the point at which they could "not stand the pain for even one more second" and wanted to end the task) by ringing a small bell. Although the experimenter left the room after initiating the tourniquet task, a second experimenter monitored participants from another location via audio-video camera and recorded pain threshold and tolerance times. If participants did not reach their tolerance at or before 15 min (a maximum limit not disclosed to participants), the slideshow automatically ended and the experimenter returned to deflate the cuff.

After the tourniquet task, the male partner was escorted to a separate room and both partners independently completed posttask questionnaires,[2] which included the pain catastrophizing and one-item VAS measures (women only). After questionnaire completion, both partners were reunited for the debriefing, provided with compensation, and thanked for their participation.[3]

Results

Initial analyses

Means and standard deviations of the primary study variables are included in Table 1. Zero-order correlations between the study variables are presented in Table 2. Women's anxiety and avoidance scores were positively correlated as well as being positively correlated with their partner's anxiety and avoidance

2. Additional questionnaires were administered that are not the focus of this study; therefore, they will not be discussed.
3. Follow-up questions were administered to all participants approximately 2 weeks later to investigate their memories regarding the tourniquet task experience. Because memory is not the focus of this article, these data will not be discussed further here.

Table 1. *Means and standard deviations for study variables by gender*

	Women		Men	
	M	*SD*	*M*	*SD*
Predictor and control variables				
Attachment anxiety	2.49	0.96	2.78	0.93
Attachment avoidance	1.99	0.73	2.28	0.86
Rejection sensitivity	6.77	2.51	7.44	2.92
Neuroticism	3.77	0.79	3.27	0.86
Positive mood	2.94	0.76	2.92	0.82
Negative mood	1.38	0.33	1.47	0.61
Mood valence	2.52	1.28	2.71	1.32
Mood arousal	3.43	1.70	3.29	2.08
Physiological and predicted variables				
Pain threshold (min)	2.82	2.26	—	—
Pain tolerance (min)	6.35	4.63	—	—
Baseline pulse alone (bpm)	73.43	12.46	—	—
Baseline pulse with partner (bpm)	74.97	11.44	—	—
Average pulse (bpm)	87.65	12.87	—	—
Average 30-s VAS (mm)	53.10	19.12	—	—
Post-tourniquet VAS (mm)	69.24	19.03	—	—
Pain catastrophizing	1.84	0.73	—	—

Note. bpm = beats per minute; VAS = Visual Analogue Scale.

scores, respectively. Women's anxiety scores were associated with greater rejection sensitivity and greater neuroticism. In addition, women who scored higher in anxiety reported more negative mood and higher mood arousal prior to the tourniquet task.

The zero-order correlations also indicate that women who scored higher in anxiety reported lower pain thresholds, higher VAS ratings, and greater pain catastrophizing, as expected. With regard to avoidance, higher scores were also linked to greater pain catastrophizing and, unexpectedly, lower average pulse across the tourniquet task. Men's anxiety and avoidance scores did not correlate with any subjective, behavioral, or physiological measures of women's pain.

Regression strategy

Hierarchical linear regression analyses were conducted after first centering all predictor variables. Because our investigation focused on women's pain experience, we considered women to be the "actors" and entered their anxiety and avoidance scores first in Step 1. Men's attachment scores were entered next in Step 2. To test the effects of secure attachment on pain experience, the two-way interactions between women's anxiety and avoidance and between men's anxiety and avoidance were each tested independently in Step 3 in separate regressions. We also examined whether having a higher anxiety or higher avoidant partner would affect women's pain experience differently depending on women's own attachment by testing the two-way interactions between women's and men's attachment scores independently at Step 3 (e.g., Women's Anxiety × Men's Anxiety, Women's Anxiety × Men's Avoidance, etc.). Furthermore, we investigated the partner's impact on more securely attached women by testing the three-way interaction between women's anxiety and avoidance and men's anxiety (avoidance) at Step 3. Finally, we tested whether the effect of having a more securely attached partner on women's pain would be moderated by women's own attachment scores by testing the three-way

Table 2. *Correlations for study variables for women and men*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Attachment anxiety	(.28*)	.22	.57**	.52**	.00	.37**	.13	.18	—	—	—	—	—	—	—
2. Attachment avoidance	.46**	(.26*)	.29*	.08	−.25*	.11	.21	−.24*	—	—	—	—	—	—	—
3. Rejection sensitivity	.55**	.20	(.09)	.60**	−.29*	.34**	.47**	.12	—	—	—	—	—	—	—
4. Neuroticism	.45**	−.02	.47**	(−.03)	−.16	.55**	.47**	.39**	—	—	—	—	—	—	—
5. Positive mood	−.07	−.15	−.04	−.17	(.17)	.20	−.29*	.30*	—	—	—	—	—	—	—
6. Negative mood	.35**	.16	.19	.32**	.17	(.12)	.29*	.18	—	—	—	—	—	—	—
7. Mood valence	.23	.22	.31*	.37**	−.25*	.31*	(.09)	−.03	—	—	—	—	—	—	—
8. Mood arousal	.34**	.10	.26*	.25*	.00	.32*	.17	(.16)	—	—	—	—	—	—	—
9. Pain threshold (min)	−.26*	−.10	−.12	−.05	−.25*	−.24	.08	−.24	—	—	—	—	—	—	—
10. Pain tolerance (min)	−.04	.20	−.05	−.22	−.18	−.21	−.04	−.11	.62*	—	—	—	—	—	—
11. Baseline pulse alone (bpm)	.11	−.05	.02	.07	.02	.16	.05	.23	−.16	−.15	—	—	—	—	—
12. Baseline pulse with partner (bpm)	.15	−.03	.01	.03	.03	.18	.13	.31*	−.28*	−.17	.83**	—	—	—	—
13. Average pulse (bpm)	−.12	−.38*	−.05	.08	.30	.11	−.01	.15	−.19	−.43**	.72**	.74**	—	—	—
14. Average 30-s VAS (mm)	.26	−.08	.26	.23	.25	.46**	.04	.29*	−.59*	−.52**	.19	.33**	.48**	—	—
15. Post-TQ VAS (mm)	.32**	−.01	.33**	.18	.22	.25*	−.05	.17	−.41*	−.28*	.22	.31*	.36*	.83*	—
16. Pain catastrophizing	.31*	.26*	.42**	.08	.02	.16	.25*	.38**	−.36**	−.26*	.20	.25	.23	.19	.23

Note. Correlations among variables collected from women appear below the diagonal; correlations among variables collected from men appear above the diagonal. The values on the diagonal (in parentheses) are the correlations between measures collected from each partner (e.g., the correlation between women's and men's attachment anxiety). bpm = beats per minute; TQ = tourniquet; VAS = Visual Analogue Scale.

* $p < .05$. ** $p < .01$.

interactions between men's attachment and avoidance and women's anxiety (avoidance) at Step 3. All the three-way interactions were tested after entering in the appropriate two-way interactions below in Step 2.

All significant main effects and interactions were retested controlling for the two mood measures, neuroticism and rejection sensitivity. Importantly, all control analyses were run with only one control variable entered into the regression model at a time in order to preserve statistical power. Significant effects remained significant controlling for the above correlates unless otherwise noted.

Pain tolerance analyses

Pain tolerance was examined as a behavioral indicator of participants' abilities to cope with and endure pain.[4] Because hyperactivating strategies should result in the exacerbation rather than alleviation of distress, we expected that higher anxiety women should more quickly feel overwhelmed during the tourniquet task and therefore display lower pain tolerance. In contrast, we expected that higher avoidant women should endure pain longer as a function of deactivating strategies and their compulsion to appear strong and self-sufficient. Contrary to predictions, no main effect of anxiety was found. However, consistent with expectations, a significant main effect of avoidance emerged, $\beta = .28$, $t(62) = 2.01$, $p < .05$, indicating that higher avoidance scores were associated with greater tolerance for pain.

This effect became marginally significant with men's attachment scores in the model ($p = .07$) but was qualified by a significant three-way interaction between women's attachment scores and men's anxiety, $\beta = .78$, $t(56) = 4.41$, $p < .001$. For low-avoidant

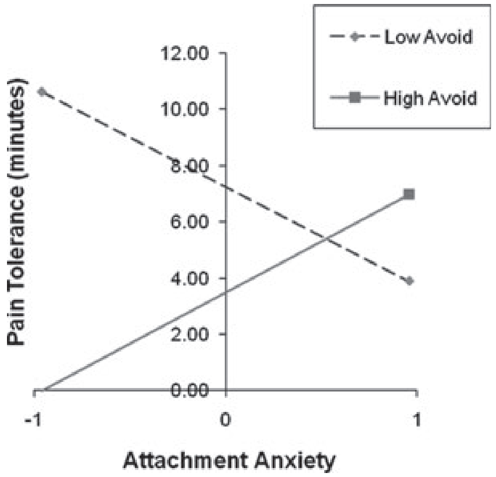

Figure 1. Women's Anxiety × Avoidance predicting pain tolerance when men's anxiety is high.

women partnered with high-anxiety men, women's higher anxiety scores (i.e., anxious attachment) were associated with lower pain tolerances than were lower anxiety scores (i.e., secure attachment), as expected (Figure 1[5]). Surprisingly, high-avoidant/low-anxiety (i.e., dismissive avoidant) women partnered with high-anxiety men displayed lower pain tolerances relative to both secure women and to high-avoidant, high-anxiety (i.e., fearful avoidant) women. In contrast, women partnered with low-anxiety men displayed relatively higher pain tolerances if they scored higher in avoidance although tolerance decreased as women's anxiety increased (Figure 2). The pain tolerances of low-avoidant women partnered with low-anxiety men did not differ based on women's anxiety scores. Overall, the pattern of this three-way interaction indicates that women scoring higher in avoidance displayed exceptionally high pain tolerances when partnered with low-anxiety men, but exceptionally low pain tolerances when partnered with high-anxiety men. More securely attached women showed the opposite pattern by displaying very high pain tolerances when partnered with high-anxiety

4. Eight participants did not report a pain tolerance time and therefore were discontinued from the tourniquet task when they exceeded the 15-min time limit. Because there were no significant differences in terms of either women's or men's attachment scores between these 8 and the remaining 57 participants who did quit the tourniquet task prior to the time limit, a tolerance of 15 min was assigned to each of the 8 individuals and all 65 participants were included in the pain tolerance analyses.

5. For all figures, x-axis variables are plotted $\pm$ 1 *SD* from the mean.

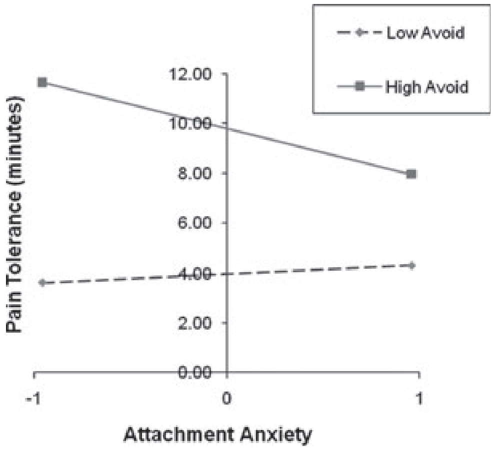

Figure 2. Women's Anxiety × Avoidance predicting pain tolerance when men's anxiety is low.

men but low pain tolerances when partnered with low-anxiety men. High-anxiety women displayed similar pain tolerances regardless of their partner's anxiety levels. No other significant effects emerged to predict pain tolerance. The three-way interaction remained significant for all control variables.[6]

Pain threshold analyses

Pain threshold was examined as a subjective index of participants' pain experience.[7] We expected that higher anxiety women, as a result of engaging in hyperactivating strategies of threat management, would report feeling pain at an earlier point during the tourniquet task, whereas higher avoidant women, due to deactivating strategies, would show the opposite pattern. Consistent with the first hypothesis, a marginally significant ($p < .06$) main effect emerged for women's anxiety, which became significant with men's attachment scores in the model, $\beta = -.35$, $t(60) = -2.46$, $p < .05$. As expected, higher anxiety scores were associated with lower pain thresholds.

However, this effect was qualified by a significant two-way interaction between women's anxiety and avoidance, $\beta = .39$, $t(59) = 3.01$, $p < .01$ and a significant three-way interaction between women's attachment scores and men's anxiety, $\beta = .64$, $t(56) = 3.90$, $p < .001$. For low-avoidant women partnered with high-anxiety men, higher anxiety scores (i.e., anxious attachment) were associated with lower pain thresholds than were lower anxiety scores (i.e., secure attachment), consistent with expectations (Figure 3). Interestingly, high-avoidant–low anxious (i.e., dismissive avoidant) women partnered with high-anxiety men displayed low pain thresholds relative to both secure women and to high-avoidant, high-anxiety (fearful avoidant) women. In contrast, women partnered with low-anxiety men displayed similarly low pain thresholds (Figure 4). Women partnered with low-anxiety men showed a slight trend toward lower pain threshold as anxiety increased, and slightly higher thresholds were displayed by women scoring higher versus lower in avoidance. Overall, the three-way interaction

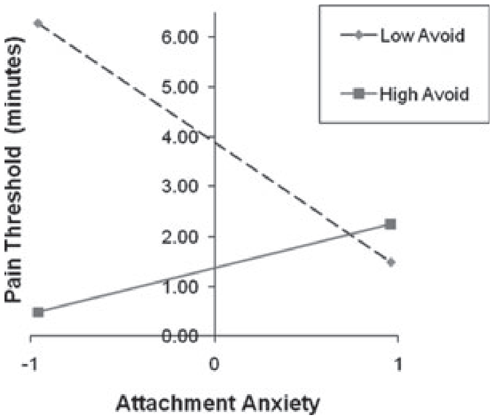

Figure 3. Women's Anxiety × Avoidance predicting pain threshold when men's anxiety is high.

6. Although none of the control variables were significant predictors of tolerance, the avoidance main effect was reduced to marginal significance controlling for positive mood ($p < .08$), mood arousal ($p < .06$), and rejection sensitivity ($p < .06$). Controlling for neuroticism reduced the avoidance main effect to nonsignificance.
7. A square transformation was computed on pain threshold data prior to regression analyses as a result of the data being positively skewed. Because the use of transformed scores did not alter the statistical significance of any of the reported results, regression results using the original pain threshold scores are reported and graphed for ease of interpretation.

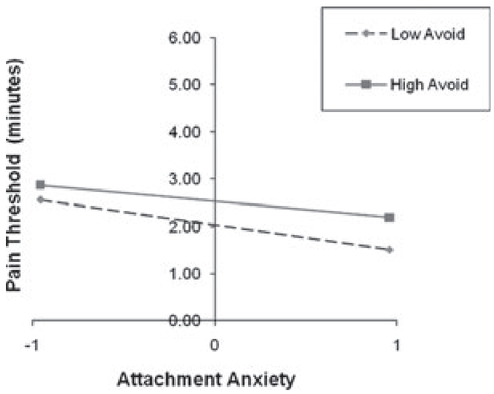

Figure 4. Women's Anxiety × Avoidance predicting pain threshold when men's anxiety is low.

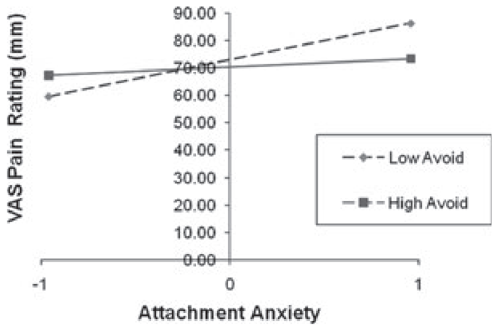

Figure 5. Women's Anxiety × Avoidance predicting posttourniquet Visual Analogue Scale (VAS) pain rating.

pattern indicates that women scoring higher in avoidance displayed relatively higher pain thresholds when partnered with low-anxiety men but relatively lower pain threshold when partnered with high-anxiety men. More secure women again showed the opposite pattern by surprisingly displaying exceptionally high pain thresholds when partnered with higher anxiety men but low pain thresholds when partnered with low-anxiety men. Higher anxiety women displayed similarly low pain thresholds regardless of their partner's attachment orientation. No other significant effects emerged predicting pain threshold. Both of these interactions remained significant in all control analyses, whereas the anxiety main effect remained significant or marginally significant.[8]

Posttourniquet VAS rating

The posttourniquet VAS was examined as a second index of subjective pain. A main effect of women's anxiety emerged and remained significant with men's attachment scores in the model, $\beta = .37$, $t(59) = 2.61$, $p < .01$, indicating that higher anxiety scores were associated with perceptions of greater pain just prior to ending the tourniquet task. However, this effect was qualified by a significant interaction between anxiety and avoidance, $\beta = -.28$, $t(58) = -2.06$, $p < .05$. For women who scored low in avoidance, higher scores on anxiety (i.e., more anxious attachment) were associated with significantly greater subjective pain relative to lower anxiety scores (i.e., more secure attachment), consistent with predictions (Figure 5). For women who scored higher on avoidance, subjective pain responses did not significantly differ based on anxiety scores. No other significant effects emerged. With one exception, both the interaction and main effect remained significant in all control analyses.[9]

30-s VAS ratings

In contrast to the VAS administered after the tourniquet task was complete and which therefore involved a degree of memory recall, the 30-s VAS ratings of women's pain responses collected during the tourniquet task provided "online" assessments of subjective pain. Because participants were performing handgrip exercises during the first 2.5 min of the tourniquet task, participants' average 30-s ratings across this time period likely reflect the confounding of exercise with pain response. To obtain a purer rating of pain, we analyzed mean 30-s VAS responses collected

8. The anxiety main effect was reduced to marginal significance in predicting pain threshold when either mood arousal ($p < .07$) or positive mood ($p < .06$) was controlled.

9. Although positive and negative mood scores using the PANAS were not significant predictors, controlling for either of these scores resulted in marginal significance ($p < .07$) for the interaction.

posthandgrips until the time of deflation. A significant main effect of anxiety emerged and remained significant with partner attachment scores entered into the model, $\beta = .35$, $t(44) = 2.13$, $p < .05$. As expected, higher anxiety scores were again associated with perceptions of greater subjective pain. However, this effect was qualified by two significant interactions, the first between women's anxiety and avoidance scores, $\beta = -.41$, $t(43) = -2.58$, $p < .05$. For women who scored lower in avoidance, higher anxiety (i.e., anxious attachment) was associated with significantly greater subjective pain during the tourniquet task relative to lower anxiety (i.e., secure attachment), as expected (Figure 6). In contrast, the pain reports of women who scored higher in avoidance did not significantly differ based on their anxiety scores.

A second two-way interaction emerged between women's anxiety and men's anxiety scores, $\beta = .29$, $t(43) = 2.01$, $p = .05$. Women partnered with high-anxiety men reported significantly higher pain during the tourniquet task as their anxiety scores increased (Figure 7). However, no significant differences in pain reports were found as a function of anxiety for women partnered with low-anxiety men. Importantly, when both two-way interactions were entered into the regression model simultaneously, only the interaction between women's anxiety and

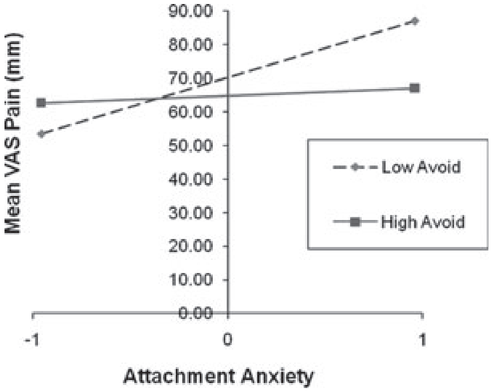

Figure 6. Women's Anxiety × Avoidance predicting mean online Visual Analogue Scale (VAS) pain ratings.

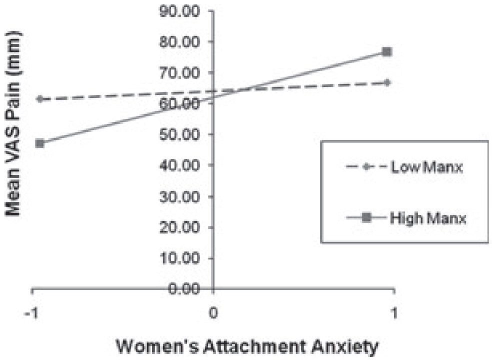

Figure 7. Women's Anxiety × Men's Anxiety predicting mean online Visual Analogue Scale (VAS) pain ratings.

avoidance scores remained significant. No other significant effects emerged to predict 30-s VAS ratings.

The last 30-s VAS rating prior to deflation was examined separately as it represents the participants' (theoretically) highest subjective pain rating during the tourniquet task. A main effect for attachment anxiety emerged and remained significant with men's attachment scores in the model, $\beta = .38$, $t(60) = 2.50$, $p < .05$. Consistent with predictions and previous findings, women who scored higher in anxiety reported greater online subjective ratings of maximum pain. However, this effect was qualified by a significant interaction between women's anxiety and avoidance scores, $\beta = -.37$, $t(59) = -2.93$, $p < .01$, which showed a similar pattern of attachment and pain responses to that shown in Figure 6 for average 30-s VAS ratings.

Importantly, the previous anxiety main effects and two-way interactions remained significant or marginally significant in all control analyses with only a few exceptions.[10] Negative mood that was assessed via the PANAS also predicted additional variance in

10. The Women's Anxiety × Men's Anxiety interaction predicting mean VAS ratings was reduced to marginal significance with neuroticism ($p < .06$) or rejection sensitivity ($p = .06$) controlled, or with the nonexclusive couple ($p < .06$) omitted (see footnote 1). It was reduced to nonsignificance when mood arousal was controlled. In addition, the main effect of anxiety predicting mean VAS ratings was also reduced to marginal significance controlling for neuroticism

average VAS ratings, β = .40, $t(43) = 3.02$, $p < .01$. Women who reported more negative mood prior to beginning the tourniquet task also reported greater subjective pain during the tourniquet task.

Physiological analyses

Physiological responses to pain were analyzed by regressing the average 30-s pulse readings collected posthandgrips up to the point of deflation onto attachment predictors.[11] This produced a main effect for women's avoidance that remained significant with men's attachment scores in the model, β = −.39, $t(38) = -2.34$, $p < .05$. Unexpectedly, higher avoidance was associated with lower average HR during the pain task. This effect remained significant controlling for baseline pulse[12] when the participant was alone but was reduced to marginal significance ($p = .06$) when baseline pulse in the partner's presence was controlled. Women's anxiety and men's attachment scores were unrelated to pulse rates, and no other significant effects emerged.

We also examined the last pulse reading collected prior to deflation of the blood pressure cuff when pain should have (theoretically) been at its peak. A significant main effect of avoidance was again found, which remained significant with men's attachment scores in the model, β = −.35, $t(52) = -2.46$, $p < .05$. Similar to the previous finding, higher avoidance scores were associated with lower HR just prior to deflation. This effect remained significant when either measure of baseline pulse was controlled. No additional effects emerged. Both main effects of avoidance predicting pulse remained significant in all control analyses.

Dissociation of physiological and self-reported pain indices

Although avoidant women in our study did not exhibit dissociation between their self-reported pain and physiological responses to pain in the direction that we anticipated—that is, by displaying lower self-reported pain but greater physiological arousal—it is nevertheless possible that dissociation may have occurred in a different direction. To examine this possibility, we tested whether the associations between self-reported and physiological indices of pain were moderated by avoidance. Specifically, we regressed women's average 30-s VAS ratings onto the two-way interaction between women's avoidance scores and their average 30-s pulse ratings. However, no significant interaction emerged. In addition to the anxiety main effect and two-way interaction between attachment scores found previously to predict VAS ratings, a main effect for average pulse rate, did emerge and remained significant with men's attachment scores in the model, β = .51, $t(37) = 3.47$, $p < .01$. Independent of attachment scores, women who displayed greater HR during the tourniquet task also reported higher subjective pain. This effect remained significant with baseline pulse rate controlled. We also tested the two-way interaction between women's anxiety scores and pulse rate in predicting VAS ratings; however, no additional significant effects emerged.

Pain catastrophizing analyses

Because hyperactivating strategies involve rumination on distress-related cognitions and emotions, we expected that higher anxiety women would be particularly likely to engage in pain catastrophizing in which they focus on negative pain-related thoughts and feelings. Although no main effects of anxiety or avoidance were found when both were

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($p < .07$) or mood arousal ($p < .07$) and to nonsignificance controlling for rejection sensitivity. Anxiety's main effect on the last VAS rating was similarly reduced to nonsignificance controlling for rejection sensitivity and marginal significance ($p = .06$) controlling for negative mood.

11. Owing to equipment problems, pulse data were not collected for 8 participants. Therefore, total sample size for analyses involving pulse data was 57.
12. Although the average baseline pulse of participants when waiting with their romantic partner was slightly greater than their average pulse when waiting alone (Table 1), a t-test comparison showed no significant difference between the two baselines. Nevertheless, regression analyses of pulse rates were conducted testing for each baseline pulse separately as a control variable.

simultaneously entered into the regression, testing each separately resulted in main effects for anxiety, $\beta = .30$, $t(62) = 2.52$, $p < .05$, and for avoidance, $\beta = .25$, $t(62) = 2.08$, $p < .05$. Both main effects remained significant with men's attachment scores in the model. Confirming expectations, women's higher anxiety scores were associated with greater self-reported pain catastrophizing. Interestingly, women who scored higher in avoidance also reported greater pain catastrophizing, although the anxiety and avoidant main effects were not independent of one another. Men's attachment scores did not predict women's pain catastrophizing and no significant interactions emerged. These effects remained significant for some, although not all, of the control analyses.[13] In addition, greater pain catastrophizing was reported by women who reported greater mood arousal, $\beta = .31$, $t(59) = 2.57$, $p < .05$, and who reported more sensitivity to rejection, $\beta = .37$, $t(60) = 2.73$, $p < .01$.

Discussion

This study tested and found support for the proposition that attachment-based emotion regulation strategies influence how individuals manage the aversive experience of acute physical pain. With regard to attachment anxiety, we predicted that women with higher scores would cope less effectively with the threat of pain because of their reliance on hyperactivating strategies. In fact, higher anxiety women, particularly those who were also low in avoidance, displayed significantly lower pain thresholds and greater subjective pain in response to an ischemic pain task. Thus, anxiously attached women showed less endurance of a physical stressor before evaluating it as painful, and consistently reported more intense pain, than did more securely attached women. Higher anxiety women also reported greater pain catastrophizing, adding further evidence that anxiety and hyperactivating strategies are linked to more threatening appraisals of pain. These results are consistent with Meredith and colleagues' (2006b) findings for anxiety and cold pressor pain threshold, with previous studies linking anxiety to more negative perceptions of chronic pain (e.g., MacDonald & Kingsbury, 2006; McWilliams et al., 2000), and with previously documented associations between anxiety and catastrophizing (Meredith et al., 2005, 2006b).

We also expected that relationship partner attachment should influence women's responses to acute pain, particularly when anxious partners engage in hyperactivating, emotion-focused coping behaviors. Corroborating past research showing that emotion-focused interactions benefited secure individuals but were detrimental to avoidant individuals (Mikulincer & Florian, 1997), dismissively avoidant women displayed lower pain thresholds and lower pain tolerances when in the presence of higher anxiety partners, whereas more securely attached women displayed the opposite pattern. Interestingly, women reported the highest average subjective pain across the tourniquet task when both they and their male partner scored higher in attachment anxiety, suggesting that female members of more anxious couples generate the most threatening appraisals of pain. Contrary to expectations, partner avoidance levels did not impact women's pain experiences in this study.

Because deactivating strategies and compulsive self-reliance characterize avoidant individuals (Mikulincer & Shaver, 2003, 2007), we also predicted and found that women who scored relatively higher in avoidance exhibited longer pain tolerances. Although avoidance scores were not significantly associated with lower subjective pain perceptions or higher pain thresholds, consistent with previous acute pain study findings (MacDonald, 2008; Meredith et al., 2006b), avoidance scores also did not predict greater perceptions of pain. Surprisingly, rather than predicting greater physiological arousal, women's higher avoidance scores were associated with significantly lower HRs during the tourniquet task. This was true even for the

13. Although these main effects remained significant controlling for neuroticism and positive and negative mood, they were reduced to nonsignificance when mood arousal, valence, or rejection sensitivity were controlled.

time point during the task when pain was (theoretically) at or approaching its maximum. No direct evidence of dissociation between avoidant women's self-reported VAS ratings of pain and their physiological arousal was found.

At first glance this pattern of low physiological arousal and higher avoidance scores appears to contradict prior research showing dissociation between avoidant individuals' greater physiological arousal and the absence of greater self-reported distress (Carpenter & Kirkpatrick, 1996; Diamond et al., 2006; Mikulincer, 1998). Yet research by Fraley and Shaver (1997) demonstrated reduced rather than greater physiological arousal for avoidant individuals. Specifically, dismissive-avoidant individuals who were instructed to avoid thinking about the loss of a relationship partner exhibited lower SCL reactivity, suggesting that they were able to successfully deactivate attachment-related emotion. Other research has shown that avoidant individuals tend to encode less threat-related information from the outset of a threatening event rather than suppressing threatening information after the fact (Fraley, Garner, & Shaver, 2000). In considering this conflicting evidence (and echoing Fraley et al.'s, 2000, reasoning), Diamond and colleagues (2006) have proposed that avoidant individuals may engage in preemptive strategies in which they direct attention away from threatening information or events as a primary means of defense, whereas they may defensively try to suppress unwanted thoughts or feelings as an alternate defensive strategy when they are unable to engage in the primary strategy. By redirecting attention preemptively, the avoidant individual can minimize negative affect and prevent activation of the attachment system with the consequence of little or no change in physiological arousal, such as occurred in Fraley and Shaver's research. However, when cognitive resources are limited or depleted, avoidant individuals may be unable to redirect attention away from threat and therefore must resort to other defensive strategies such as suppression of unwanted thoughts and emotions. Although these alternate strategies may be successful in limiting the subjective experience of distress, they are often unable to minimize the physiological arousal associated with distress as demonstrated in other research (Carpenter & Kirkpatrick, 1996; Diamond et al., 2006; Mikulincer, 1998). On the basis of this evidence, it is possible that women in our study who scored higher on avoidance, and who subsequently displayed lower physiological arousal during the pain task, may have been utilizing preemptive strategies to successfully minimize their affective as well as their physiological experience of distress.

Interestingly, women's anxiety did not predict HR during the tourniquet task, a finding that is also consistent with Diamond and colleagues' (2006) research using SCL reactivity although it differs from other research linking anxiety to increased physiological arousal (Fraley & Shaver, 1997). In conjunction with the link between higher anxiety scores and higher subjective ratings of pain, our evidence suggests that anxious women may have overstated their pain perceptions relative to their physiological indicators of arousal or pain. Such overstatement or exaggeration of pain may reflect a deliberate attempt to elicit sympathy or compassion from romantic partners consistent with an operant view of pain behavior (Flor, Kerns, & Turk, 1987; Fordyce, 1976; Gil, Keefe, Crisson, & Van Dalfsen, 1987; Paulsen & Altmaier, 1995), or it may stem from the ability to truly magnify distress, or both. Unfortunately our data do not allow for determination of participants' motivations behind their pain reports and therefore distinguishing between these possible mechanisms is beyond the scope of this study.

Importantly, our results were very robust when taking into account potential confounds (i.e., neuroticism, rejection sensitivity, and mood), with the majority of findings remaining significant or marginally significant when these variables were controlled. However, several control variables provided additional utility above and beyond attachment dimensions in predicting pain responses. Specifically, women who were more sensitive to rejection reported more pain catastrophizing, women who began the study in a more negative mood reported more subjective pain during the tourniquet task, and women who began the study in a less positive mood reported lower pain thresholds. Neuroticism, although significantly correlated with attachment anxiety, failed to be an independent predictor of pain in any of our analyses. Taken together, these findings suggest that whereas being characterized as emotionally unstable (i.e., neurotic) or chronically rejection sensitive does not influence pain perceptions per se, having an anxious attachment style with its accompanying hyperactivating emotion regulation system does.

Caveats and limitations

Although our results corroborate key tenets of attachment theory and provide support for our primary hypotheses, several caveats and limitations should be kept in mind. First, our data are correlational and therefore causal inferences cannot be made. Second, although many variables were controlled to standardize the pain test conditions (e.g., gender of pain participants and experimenters, time of day when the study was conducted), additional variables such as women's menstruation cycle could have influenced the pain results (Diamond & Otter-Henderson, 2007; Filligim et al., 1997).

Third, although approximately 75% of our participants indicated compliance with instructions not to consume nicotine, tobacco products, caffeine, or alcohol prior to testing, the remainder reported some form of noncompliance although the exact nature of the noncompliance (i.e., when and which product) could not be determined. Importantly, noncompliance was unrelated to participants' attachment scores and *t* tests between compliant and noncompliant participants showed no significant differences in any of our dependant measures with one exception: Mean HR from posthandgrips until deflation was significantly lower in compliant than noncompliant participants. Given that higher avoidance scores predicted lower HR across this period, inclusion of the noncompliant participants in this analysis should have made it less likely rather than more likely that this significant finding would have emerged, providing further confidence in the validity of our results.

Fourth, this study focused on women as the pain task participants in order to avoid the potential confound of using an opposite-sex experimenter (Kállai et al., 2004). Future work should determine whether or not our effects replicate in both sexes. Variability in pain responses associated with the menstrual cycle can be mitigated by testing male participants. In addition, given men's increased tendency to engage in fight-or-flight responses to stressors compared to women's tend-or-befriend reactions (Taylor, 2006), it is possible that male participants may show greater cardiovascular reactivity to the physical pain task.

Future directions

Although our study utilized a dyadic context in which the effect of romantic partners' attachment orientations on participants' pain was assessed, future studies should focus on the specific mechanisms by which partner attachment effects occur. For instance, follow-up work could examine what type of behavior(s) more highly anxious men are engaging in that leads to relatively lower pain thresholds and lower pain tolerances in more avoidant women and to the opposite pattern for secure women. Possible mechanisms include specific emotion-focused support behaviors such as asking participants how much pain they are in or sharing their own stories of painful experiences rather than engaging in strategies of distraction or cognitive reappraisal. Curiously, men's anxiety did not affect more avoidant women's physiological arousal or their online subjective reports of pain despite affecting pain threshold and pain tolerance, the latter representing a relatively nonverbal and behavioral measure. This raises a question for future research of whether more avoidant women may deliberately end a painful experience prematurely when confronted with a more anxious romantic partner, possibly because they find the partner's potentially emotion-focused behaviors to be averse.

Researchers might also investigate additional attachment-based mechanisms by which women may elicit particular responses from romantic partners, such as women's pain signaling behaviors. The possibility exists that higher anxiety women may use subjective pain reports as a means of extracting attention and caregiving from relationship partners. MacDonald (2008) recently provided evidence that pain threshold may be particularly susceptible to distortion by more anxious individuals in order to fulfill social needs of belongingness, although he argued that anxious people may self-present as being less rather than more vulnerable under certain conditions (i.e., rejection). Yet the operant conditioning perspective on pain (Flor et al., 1987; Fordyce, 1976; Gil et al., 1987; Paulsen & Altmaier, 1995) suggests the opposite—that a show of vulnerability via extensive pain signaling may help anxious people fulfill their need for the partner's love and affection. Perhaps both possibilities are true under different circumstances—for instance, whether rejection by the partner seems imminent or unlikely—an avenue that could be examined in future work.

It has been pointed out that "the use of psychophysiological measures in social psychology research is the exception to the rule of self-report and behavioral measures" (Blascovich & Kelsey, 1990, p. 45). We have attempted to address this critique by collecting multiple readings of one psychophysiological measure—namely, HR—throughout our study to supplement participants' self-reports and behavioral measures of pain. Yet future studies should incorporate multiple measures such as HR variability, vagal tone, and skin conductance while also gathering continuous data (Blascovich & Kelsey, 1990; Diamond & Fagundes, 2010; Diamond & Otter-Henderson, 2007). By taking a more multifaceted approach, it will be possible to disentangle the effects of the sympathetic nervous system and the parasympathetic nervous system on physiological responses, which can have different implications for health.

Finally, to tease apart the effects of preemptive and postemptive strategies on physiological arousal, future investigators could impose a cognitive load to increase the toll on avoidant individuals' primary defenses and the likelihood they will resort to alternate defensive strategies. Researchers could also employ a different type of pain task that allows for a more distressing pain experience rather than the slow, gradual buildup of pain involved in the tourniquet task.

Conclusions

This research corroborates Bowlby's (1973) view of attachment as a psychobiological system of emotion regulation in which the attachment system plays a fundamental role in establishing and maintaining emotional and physiological homeostasis. By demonstrating theoretically predictable differences in individuals' subjective and behavioral responses to acute physical pain, we provide evidence that individual differences in attachment index the use of primary versus secondary strategies of emotion regulation in an ecologically valid context (Mikulincer & Shaver, 2003, 2007). Our findings linking attachment avoidance to a measure of cardiovascular reactivity offer to advance knowledge concerning an understudied aspect of Bowlby's theory—namely, the proposition that emotion regulation is central to maintaining physiological as well as emotional homeostasis. Importantly, our findings extend prior work on attachment, emotion regulation, and threat management by focusing on a physical rather than psychological stressor, examining acute rather than chronic pain, incorporating a dyadic context and relationship partner attachment effects, employing a controlled laboratory pain task rather than hypothetical or recalled pain, and incorporating a multimethod assessment of threat (i.e., pain) responses while controlling for many potential confounds.

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