

# **Attachment style, current relationship security, and negative emotions: The mediating role of physiological regulation**

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ABSTRACT

Young men were subjected to laboratory inductions of anger and anxiety after undergoing a physiological assessment of *vagal tone*, an index of parasympathetic nervous system functioning that has been associated with emotion regulation in prior research. We tested whether: (i) young men's emotional reactivity and recovery were associated with their global attachment style or their perceptions of security in specific, current attachment relationships; (ii) such associations were mediated by vagal tone; and (iii) such effects were moderated by the *physical presence* of romantic attachment figures. As predicted, vagal tone was negatively associated with attachment anxiety and positively associated with perceptions of security in current attachment relationships. Men with high perceptions of security in current relationships showed more effective recovery from laboratory-induced anger, and vagal tone mediated this association. In contrast, the physical presence of romantic attachment figures showed no association with emotional reactivity or recovery and did not moderate the aforementioned effects.

KEY WORDS: adult attachment • emotion regulation • physiological regulation • vagal tone

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There is extensive evidence that exaggerated and sustained negative emotional reactivity is associated with psychological maladjustment (Cooper, Shaver, & Collins, 1998; Gross & Munoz, 1995), anxiety and depressive disorders (Nolen-Hoeksema, Parker, & Larson, 1994) and even impaired neuroendocrine, autonomic, and immune functioning (Repetti,

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Taylor, & Seeman, 2002). Accordingly, effective *emotion regulation*, the process by which individuals modulate their positive and negative emotional responses to internal and external stimuli (Porges, Doussard-Roosevelt, & Maiti, 1994; Thompson, 1994), is considered essential for effective coping, problem solving, social functioning, and overall physical and mental health (reviewed in Fox, 1994a). Relationships with *attachment figures* over the life course may play a key role in these processes. Specifically, Mikulincer, Shaver, and Pereg (2003) argued that as a result of specific experiences of security and successful distress-alleviation with attachment figures, individuals develop effective strategies for regulating negative emotions, as well as enduring representations of their own strengths, resources, worth, and efficacy. Yet the specific mechanisms through which attachment histories and current experiences shape emotion-regulation processes have not been fully specified, and remain an active topic of theory and empirical research (see, e.g., Mikulincer & Shaver, 2004).

The present study adds to this effort by investigating *physiological* aspects of emotion regulation. Specifically, we test whether generalized expectations of attachment figures and current experiences in attachment relationships are related to *vagal tone*, an index of parasympathetic nervous system functioning that has shown in prior research to be associated with flexible and efficient regulation of negative emotions (Fabes & Eisenberg, 1997; Porges et al., 1994). We further test whether vagal tone mediates links between young men's attachment experiences and their reactivity and recovery to experimentally induced anger and anxiety (we focus exclusively on men because of well-documented gender differences in responses to experimental manipulations of anger: see Earle, Linden, & Weinberg, 1999; Lai & Linden, 1992; Rholes, Simpson, & Orina, 1999), and we investigate whether the aforementioned effects are moderated by the physical presence of romantic attachment figures.

### **Negative emotional reactivity and recovery**

Much research on the factors that influence negative emotional reactivity and recovery has focused on the role of social relationships. At all stages of life, social partners assist us with day-to-day emotion regulation by providing comfort and support, communicating empathy, providing an alternative perspective, or simply distracting us from our troubles (Magai, Cohen, Gomberg, Malatesta, & Culver, 1996; Thompson, 1994). Social support researchers have extensively investigated this phenomenon by exposing individuals to experimental inductions of negative emotions and examining whether the supportive behavior of social partners attenuates reactivity (reviewed in Uchino, Cacioppo, & Kiecolt-Glaser, 1996).

Yet researchers have increasingly noted that robust emotional reactivity to negative experiences is not necessarily maladaptive, as long as individuals are able to engage relevant coping and recovery processes (reviewed in Larsen, Hemenover, Norris, & Cacioppo, 2003). Consequently, *recovery*

from laboratory-induced stressors and emotion inductions has received increasing attention as an index of effective emotion regulation (Linden, Earle, Gerin, & Christenfeld, 1997). Also, researchers have increasingly emphasized the importance of examining the regulation of emotions other than generalized stress or anxiety. Anger, in particular, has received much recent attention (e.g., Brosschot & Thayer, 1998; Mikulincer, 1998b; Rholes et al., 1999) because angry feelings are extremely common on a day-to-day basis and their effective regulation is important for both social functioning and physical health (Cooper et al., 1998).

### **Attachment and emotion regulation**

There is considerable evidence that interindividual differences in *attachment security* shape the regulation of negative emotions. Bowlby (1958, 1982) conceptualized attachment as an evolved behavioral system that motivates infants to seek proximity to caregivers in times of distress. In normative cases, this reassures and soothes the infant, providing him/her with a fundamental sense of psychological security that supports the development of adaptive strategies for the regulation of emotional states (e.g., support seeking, activation of competing positive cognitions, attention shifting). Extensive research has found that the same emotional and behavioral dynamics underlie *adults'* romantic relationships (Shaver & Hazan, 1993; Shaver, Hazan, & Bradshaw, 1988), and thus the provision of security in attachment relationships has been hypothesized to play a critical role in the development and maintenance of emotion regulation over the life course (Cassidy, 1994; Magai, 1999; Mikulincer et al., 2003).

### **Attachment style**

The present study focuses on two different types of interindividual variation in attachment security that have been theorized to shape emotion regulation capacities and strategies: *attachment style* and *current relationship security*. The former represents global, stable, trait-like interpersonal orientations that presumably develop on the basis of early interactions with attachment figures (Ainsworth, Blehar, Waters, & Wall, 1978). Specifically, it is theorized that through repeated, emotionally relevant interactions with their caregivers, individuals develop stable expectations about themselves and others that come to organize the encoding, storage, retrieval, and manipulation of information related to affective states and – in particular – experiences of stress versus security (see review in Mikulincer, 1998a). ‘Secure’ individuals, who received sensitive and responsive caregiving and distress-alleviation, consequently come to view themselves as competent and worthy of love, to view *others* as willing and able to provide comfort and support, and to appraise external demands as manageable challenges rather than unmanageable threats. In contrast, ‘insecure’ individuals, who

did not receive consistently sensitive and responsive caregiving and distress-alleviation, develop negatively valenced models of self and others that lead to negative, threat-based appraisals of environmental demands. These individuals are thought to develop alternative – and suboptimal – emotion regulation strategies. Specifically, individuals with high attachment *anxiety* tend to maximize experiences of negative affect and to be hyper-vigilant to threat cues, whereas those with high attachment *avoidance* tend to minimize experiences of negative affect and to direct attention away from threat cues (Mikulincer, 1998b).

These patterns have direct implications for emotional experience. Specifically, securely attached individuals have been found to report more frequent, more intense positive emotions, and insecurely attached individuals more sustained and intense negative emotions (Feeney, 1995; Mikulincer & Orbach, 1995). This basic pattern is reflected both in response to everyday events and interactions (Tidwell, Reis, & Shaver, 1996) as well as in response to naturally occurring (Magai & Cohen, 1998; Mikulincer, 1998b) or laboratory-induced stressors (Mikulincer, 1998b; Rholes et al., 1999). Importantly, although much of the literature reviewed earlier has conceptualized attachment styles as discrete types ('secure,' 'anxious,' and 'avoidant') attachment style is now typically conceptualized in terms of continuous variation along the two orthogonal dimensions of anxiety and avoidance. This dimensional approach to attachment style is supported by taxometric analyses (Fraley & Waller, 1998) indicating that it provides a better fit to the actual distribution of interindividual differences in attachment organization, and is also more theoretically plausible given that the multiple factors that *contribute* to attachment style (such as maternal sensitivity and prior experiences with attachment figure) also vary continuously rather than categorically (Fraley & Waller, 1998).

### **Current relationship security**

In contrast to attachment style, current relationship security represents the degree to which individuals successfully derive feelings of emotional security within a *specific, current* attachment relationship. Such perceptions of security within specific, current relationships have been the topic of increasing attention in recent years, as they have been found to contribute unique variance to individuals' interpersonal behavior and overall functioning (Cook, 2000; La Guardia, Ryan, Couchman, & Deci, 2000). Of course, feelings of security in current relationships are necessarily associated with *overall* attachment orientations (Feeney & Noller, 1990), but are additionally influenced by multiple situational, environmental, and personality factors affecting each partner separately as well as their joint experiences of comfort-seeking and comfort-provision (Cook, 2000; La Guardia et al., 2000).

Previous studies suggest the importance of attending to current relationship experiences in investigating social influences on emotion regulation. For example, one study found that strong feelings of affection for spouses were negatively associated with stress reactivity measured 2 years later

(Uchino, Kiecolt-Glaser, & Cacioppo, 1994), and other research has found that highly specific qualities of supportive social partners can moderate the 'stress buffering' effects of their presence during laboratory stress inductions (Uno, Uchino, & Smith, 2002). Such findings indicate that we must take into account both the 'trait-like' dimension of attachment style and the more 'state-like' dimension of *current* relationship security when modeling the development and maintenance of emotion regulation.

### **Vagal tone as a potential mediator**

Research has also detected individual differences in *physiological capacities* for effective emotion regulation (Fox, 1994b; Porges et al., 1994). One of the most important and widely researched of these individual differences concerns parasympathetic nervous system (PNS) functioning. Briefly, both the PNS and the sympathetic nervous system (SNS) are involved in the moment-by-moment physiological changes triggered by environmental demands – changes in heart rate, blood pressure, sweating, etc. Yet the SNS and the PNS have antagonistic effects on autonomic functioning, and thus autonomic reactivity can be effected by *activation* of one system and/or *withdrawal* of the other. This has important implications for emotion regulation because autonomic changes that are driven by adjustments in the PNS appear to be more rapid, more flexible, and easier to disengage than SNS-dominated changes (Berger, Saul, & Cohen, 1989). Therefore, individuals with robust PNS functioning, typically described as high *vagal tone*, are conceptualized as having nervous systems that respond more quickly and flexibly to attention-demanding or stressful tasks, and recover more effectively from stress-induced emotional arousal (see Porges, 1991, 1992; Porges et al., 1994).

This is borne out by studies relating higher vagal tone (indexed by resting levels of respiration-related variability in heart rate, also known as *respiratory sinus arrhythmia* or RSA) to a variety of indices of emotion regulation. For example, infants with low vagal tone show poor emotional control (Fox, 1989; Porges, 1991), and high behavioral inhibition (Snidman, 1989). Children and adults with low vagal tone show heightened emotional reactivity and ineffective behavioral coping in response to stress (Fabes & Eisenberg, 1997; Fabes, Eisenberg, & Eisenbud, 1993), as well as higher levels of depression, anger, mental stress, generalized anxiety, and panic anxiety (reviewed in Brosschot & Thayer, 1998; Friedman & Thayer, 1998; Horsten et al., 1999). Given that the same constellation of emotion regulation phenomena have been theoretically and empirically linked to attachment insecurity (Mickelson, Kessler, & Shaver, 1997; Mikulincer, 1998a; Mikulincer & Orbach, 1995), this raises the possibility that individual differences in vagal tone partially account for attachment-related interindividual differences in emotional reactivity and recovery.

This implies that relationship experiences might themselves influence vagal functioning, consistent with Mikulincer and colleagues' (2003)

hypothesis that interpersonal interactions with caregivers have a direct influence on emotion regulation processes (Mikulincer et al., 2003). There is some support for this possibility with respect to vagal tone. Although twin studies suggest that interindividual variability in vagal tone is partly heritable (Piha, Ronnema, & Koskenvuo, 1994), some research indicates that approximately two-thirds of interindividual variability in vagal tone is environmentally determined (Snieder, Boomsma, Van Doornen, & De Geus, 1997), and sensitive to situational factors such as chronic stress. Prior research, for example, has found that women who were currently living with a romantic partner showed greater vagal control of heart rate than those who lived alone (Horsten et al., 1999) and that *increases* in parasympathetic control can be effected by consciously focusing on feelings of care and appreciation (McCraty, Atkinson, Tiller, Rein, & Watkins, 1995) or undergoing structured relaxation tasks (Sakakibara, Takeuchi, & Hayano, 1994; Toivanen, Laensimies, Jokela, & Haenninen, 1993).

Such findings raise the possibility that repeated, security-enhancing interactions with attachment figures might influence one's pattern of physiological regulation (Diamond, 2001). Notably, such influences might operate in the context of early infant-caregiver interactions, in which case one might expect associations between vagal tone and *attachment style*, or they might occur in the context of one's *current* attachment relationship (akin to the situational effects reviewed earlier), in which case one might expect associations between vagal tone and *current relationship security*. Of course, both associations might be expected to hold, particularly given that attachment style and current relationship security are not independent of one another: Insecure individuals are less likely to perceive current partners as reliable and security-enhancing, and individuals in unsupportive, low-security relationships may gradually develop more insecure orientations toward close relationships in general (Feeney & Noller, 1990; Kirkpatrick & Davis, 1994). However, one might expect the strongest association between vagal tone and current relationship security, given that current relationship security might better capture the *combined* effect of one's overall attachment style and one's present attachment relationship.

More interestingly, associations between vagal tone and either attachment style or current relationship security would raise the possibility that the effects of attachment style or current relationship security on negative emotional reactivity/recovery are *partially mediated* by vagal tone. Of course, there are other plausible patterns of association among these constructs to consider: for example, perhaps individual differences in vagal tone shape children's patterns of emotional reactivity/recovery, making certain individuals more likely to develop consistently unsupportive and low-security relationships. Investigating such possibilities is important for clarifying potential pathways through which internal psychological models of attachment relationships are linked to emotional experiences over the life course.

### **Presence of attachment figures as a potential moderator**

Another important factor to consider when investigating associations between attachment security and emotion regulation is the *immediate availability* of the attachment figure as a source of distress alleviation. Although children typically seek proximity to attachment figures when distressed (Bowlby, 1988), such proximity to attachment figures may not be necessary or facilitative for distress-alleviation in adulthood, given that adults have generally internalized their own emotion regulation abilities. This is consistent with the fact that although reactivity to negative emotional experiences is often attenuated in the presence of supportive social partners (comprehensively reviewed in Uchino et al., 1996), this is not uniformly the case (Allen, Blascovich, Tomaka, & Kelsey, 1991; Fontana, Diegnan, Villeneuve, & Lepore, 1999). Notably, one study (Carpenter & Kirkpatrick, 1996) found that that partner presence interacted with attachment style to influence individuals' responses to laboratory stressors. Specifically, avoidantly attached individuals actually showed *more* physiological stress reactivity in the presence of their partner than when alone, perhaps because the partner's presence increased the immediate salience of their negative expectations of attachment figures' availability and supportiveness. To further investigate this possibility, the present study examines whether associations between attachment security and individuals' recovery from controlled emotion inductions vary as a function of whether individuals undergo the recovery period in the presence of their partner, in the presence of a friend, or alone (the friend condition makes it possible to examine whether any 'romantic partner' effects are actually generalizable to the presence of *any* familiar social acquaintance). The current research takes a notably different approach from prior studies of social support and emotional reactivity by eliminating both naturalistic and choreographed displays of support altogether and focusing instead on the simple presence of social partners, and by introducing the social partner *after* the distressing experience to focus particularly on recovery effects.

### **Goals of the present study**

The present study investigates whether: (i) young men's patterns of emotional reactivity and recovery to laboratory inductions of anger and anxiety are associated with their global attachment styles or their perceptions of security in specific, current relationships; (ii) vagal tone mediates such associations; and (iii) these effects are moderated by the presence of attachment figures (in comparison with the presence of a friend, or no one at all). The specific hypotheses to be tested are as follows:

*H1:* Vagal tone (assessed via resting RSA) will be negatively associated with attachment anxiety and positively associated with perceptions of security in current attachment relationships.

*H2*: Effective recovery from laboratory inductions of anger and distress (i.e., quicker return to baseline levels) will be negatively associated with attachment anxiety and positively associated with perceptions of security in current attachment relationships.

*H3*: Individual differences in vagal tone will partially mediate the associations between attachment and anger/distress recovery outlined in *H2*.

*H4*: The aforementioned effects will be more pronounced when individuals are in the presence of their romantic partners than when they are either alone or with a friend.

## Method

### Participants

Participants were 75 young men (mean age = 21.69,  $SD = 3.47$ ) who were not currently using prescription or over-the-counter medications with cardiovascular side effects. Four percent of respondents were Latino, 4% were Asian, and 4% were South Asian. Participants were recruited through undergraduate psychology courses and through flyers posted in university buildings. Participants from the introductory psychology subject pool were contacted by telephone and asked to take part in a study investigating the effects of social partners on cognitive performance. Participants from the introductory psychology subject pool received course credit for participation; all others received \$10.

### Procedure

Participants who were currently involved in romantic relationships were assigned to either the *alone*, *friend*, or *partner* groups. Participants who were not currently involved in romantic relationships were assigned to either the *alone* or *friend* groups. The total sample sizes for the *alone*, *friend*, and *partner* groups were, respectively,  $n = 28$ ,  $n = 20$ , and  $n = 27$ . Participants in the *partner* group were instructed to bring their romantic partner with them to the study; those assigned to the *friend* group were instructed to bring a female friend with whom they were not romantically involved (verified during debriefing). Participants in the *alone* group were instructed to come to the study alone. All participants were instructed to refrain from smoking cigarettes or consuming caffeinated beverages within 2 hours of the experiment (verified at the laboratory). Individuals in the *partner* group reported a median relationship length of 1.5 years (range: 4 months to 6 years). Of those individuals in the *friend* or *alone* groups who currently had romantic partners (56%), their median relationship length was 14 months (range: 1 month to 6 years). The proportion of respondents in the *alone* and *friend* groups who had romantic partners was not significantly different.

After being fitted with the physiological equipment (described later) and seated on a small couch, participants were instructed to sit quietly and relax for 10 minutes to get adjusted to the physiological equipment. The last 3 minutes of this period were averaged to provide a baseline index of physiological parameters. Immediately after this period, they filled out the baseline assessments of self-reported affect. Next, the first emotion-induction task was initiated. This task involved performance of serial subtraction accompanied by discouraging feedback (sometimes called 'harassment') from the experimenter.

This method of inducing anger and anxiety has been widely used in previous social psychophysiological studies (for example Earle et al., 1999; Lai & Linden, 1992). At 30-second intervals, participants were interrupted by the experimenter with verbal prompts intended to frustrate and anger the participant. The prompts were as follows: (1) 'Stop a second – remember to go as fast as you possibly can. Okay, keep going.' (2) 'Stop again. Um, so far you're much slower than average. . . . Why don't you just start again, and this time just try harder.' (3) 'I think I'm just going to give you an easier number. Start from the beginning again, but this time try subtracting 7 instead of 13 and we'll see how that goes.' (4) Don't slow down . . . (5) Okay just stop, I guess that'll do. Debriefing after the experiment revealed that none of the participants could tell that these interruptions were staged.

Immediately after the math task, participants filled out another round of state affect measures. As soon as they finished, the friend/partner (who had been fetched by a second experimenter and was waiting in the hallway) was cued to enter the experimental room and to sit next to the participant. As soon as the friend/partner was seated, the experimenter told them that a 'calibration cycle' had to be executed on the physiological equipment and they should sit quietly for the next few minutes *without talking* (the same exact instructions were given to participants in the *alone* condition). This silent period lasted for the next 5 minutes, after which participants completed another round of state affect measures. Next, the second emotion-induction was initiated. Participants were asked to describe, for 2 minutes, a recent experience that made them feel extremely angry, and to 'try and put yourself in that state of mind all over again.' This 'anger-recall' speech task has been shown to be a reliable elicitor of both anger and anxiety in previous research (Anderson & Lawler, 1995; Siegman & Snow, 1997). Afterwards, participants completed another round of state affect measures, and then the experimenter stated that another calibration cycle needed to be completed. After the 5-minute recovery period, participants completed a final round of state affect measures. After the experiment, the participant filled out a packet of questionnaires (containing all of the self-report measures described later) while his partner/friend waited in a separate room. The participant and his partner/friend were then debriefed and reimbursed.

## Materials

All participants completed self-report measures of attachment anxiety, attachment avoidance, perceptions of security in current relationships, and measures of state anger and state distress. Attachment anxiety and avoidance were measured with the Experiences in Close Relationships (ECR) scale (Brennan, Clark, & Shaver, 1998), a multi-item scale that yields two continuous 4-point scale ratings – one for attachment anxiety and one for attachment avoidance (means and *SDs* are presented in Table 1). The ECR has demonstrated good reliability and validity and is currently the measure recommended in the recently-published handbook of attachment research (Crowell, Fraley, & Shaver, 1999). Cronbach's alpha was .89 for anxiety and .93 for avoidance. A multivariate analysis of variance detected no differences between the *alone*, *friend*, and *partner* groups on attachment anxiety, avoidance, or trait anxiety (see descriptive statistics in Table 1, stratified by experimental group).

To assess perceptions of security in participants' current attachment relationships, participants completed the emotional security subscale of the *WHOTO*,

**TABLE 1**  
**Summary statistics for self-report and physiological measures, stratified by experimental condition**

Measure	Alone (n = 28)		With friend (n = 20)		With partner (n = 27)		Total (N = 75)	
	M	SD	M	SD	M	SD	M	SD
Attachment avoidance	1.66	.52	1.93	.65	1.92	.59	1.83	.60
Attachment anxiety	2.06	.54	2.21	.54	2.37	.56	2.20	.55
Perceived Security in Current Attachment Relationship	5.55	3.03	5.68	3.43	6.22	3.60	5.83	3.31
Vagal Tone (resting RSA)	4.27	.53	4.07	.55	4.14	.64	4.16	.56
Baseline Distress	1.74	.35	1.65	.35	1.77	.50	1.73	.40
Distress Reactivity	.60	.43	.70	.52	.65	.38	.64	.44
Distress Recovery	-.24	.41	-.22	.40	-.17	.29	-.21	.37
Baseline Anger	1.05	.14	1.08	.14	1.10	.23	1.06	.17
Anger Reactivity	.60	.64	.68	.76	.54	.61	.60	.65
Anger Recovery	-.28	.45	-.25	.56	-.13	.24	-.22	.42

Note. Reactivity is calculated as task minus baseline levels and recovery is calculated as baseline minus post-task levels.

a measure (named for the phrase ‘who to’) that has been used in previous research (Fraley & Davis, 1997; Hazan, Hutt, Sturgeon, & Bricker, 1991) to assess the degree to which individuals turn to various members of their social network (i.e., mother, father, best friend, romantic partner) for specific attachment functions. The three items for the security subscale are: ‘Who do you know you can always count on, through good times and bad? Who do you know who will always be there for you, no matter what? Who do you know would do just about anything for you?’ Respondents list up to three individuals in their social network, in order of importance, and security scores can be calculated for any or all of these individuals. If an individual is listed *first*, he/she receives a rating of ‘3.’ Second-place listings receive a rating of ‘2,’ and so on. If the target individual was not listed at all for a particular item, he/she receives a score of ‘0.’ Scores are averaged so that the maximum score is 9 and the minimum is 0, with higher scores representing greater perceptions of security in the target relationship. Security ratings for romantic partners were calculated for all participants who were currently involved in romantic relationships. For all other individuals, security scores were calculated for the highest ranking individual in their social network (typically a family member). Chronbach’s alpha for the scale was .78.

During the experiment, participants completed state measures of anxiety and anger in order to assess their subjective responses to the experimental manipulations (Spielberger, 1983, 1988). Individual items for each measure are rated on a 4-point scale, and we used averages of items in all analyses so that overall responses could be interpreted along the same 1–4 dimension. State anxiety will henceforth be called ‘distress’ to avoid confusion with attachment anxiety. Cronbach’s alphas for distress ranged between .89 and .92 across the five assessments (baseline, the two tasks, and the two recovery periods) with a mean of .91; alphas for anger ranged between .78 and .89, with a mean of .84.

To assess individual differences in RSA, continuous recordings of ECG and respiration were amplified and filtered through a James Long Company (Caroga Lake, NY) four-channel bioamplifier, model LMD-04, with the ECG channel high-pass filter set to 0.1 Hz and a low-pass filter set to 1000 Hz. These measures were taken during a 10 minute period during which subjects were sitting quietly, and not speaking. ECG was recorded with disposable electrodes placed on the participant's chest in a triangular configuration. Respiration depth and frequency were measured by a latex rubber pneumatic bellows girth sensor fitted around the participant's chest. All physiological signals were fed into an A/D interface box and stored on an IBM-compatible computer. The sampling rate was 1000 Hz for all channels. Data analysis was implemented with the James Long Company PHY General Physiology Analysis System software, which permits visual inspection and manual editing of artifacts. Approximately 1% of data were edited for artifacts using interpolation of adjacent points. RSA was assessed on the basis of the ECG and respiration data. Interbeat intervals (IBIs) were calculated as the time in milliseconds between successive R-waves in the electrocardiogram, and the 'peak-to-valley' method (Grossman & Svebak, 1987) was used to derive RSA on the basis of these IBIs. This method computes the difference (in milliseconds) between the heart period between inspiration onset and expiration onset. For any particular episode of time, the sum of these 'peak-to-valley' measurements divided by the total number of breaths is calculated as an estimate of RSA for that episode. Peak-to-valley methods are widely used and show high correlations with other methods of assessing RSA (Grossman, van Beek, & Wientjes, 1990). Following standard practice, RSA values were logged before analysis in order to normalize their distribution.

## Results

Responses to the math and anger-recall tasks were highly correlated (mean  $r = .63$ ), and were therefore averaged to yield four composite response variables: anger reactivity, distress reactivity, anger recovery, and distress recovery. Reactivity scores were calculated as task-minus-baseline difference scores. Recovery scores were calculated as baseline minus post-task difference scores, so that more *effective* recovery (i.e., achieving post-task levels equal to or below baseline levels) was represented by *higher* recovery scores. All analyses of recovery included reactivity scores as covariates to control for the fact that it is generally more difficult to recover effectively from large reactive changes than small reactive changes, and all analyses of reactivity scores included baseline values as covariates. Summary statistics for all measures are presented in Table 1, stratified by experimental group. There were no differences between the experimental groups on reactivity, recovery, or baseline values. All regression analyses reported below are simultaneous regressions.

Table 2 presents correlations between attachment anxiety, avoidance, perceived security in current relationships, and RSA. Consistent with *H1*, individuals with high attachment anxiety had significantly *lower* resting RSA, and those perceiving high security in their current attachment relationships had significantly *higher* resting RSA. Given that both attachment anxiety and current security were associated with resting RSA, and given their significant association with one another (see Table 2), resting RSA was regressed on *both*

**TABLE 2**  
**Correlations among major variables**

Measure	1	2	3
1. Attachment Avoidance			
2. Attachment Anxiety	.14		
3. Perceived Security in Current Attachment Relationship	-.21 <sup>†</sup>	-.26*	
4. Vagal Tone (resting RSA)	-.03	-.24*	.29*

<sup>†</sup> $p < .10$ ; \* $p < .05$ .

attachment anxiety and perceived security in order to more clearly identify direct and indirect effects. In this model, perceived security remained highly statistically significant,  $t = 2.2$ ,  $p < .03$ , but the effect of anxiety was no longer significant,  $t = 1.6$ ,  $p = .12$ .

To assess whether attachment style and perceived security in current relationships were associated with responses to the emotion inductions ( $H2$ ), a series of regressions were performed in which the outcome measure of interest was regressed on attachment anxiety, avoidance, perceived security in current relationships, and romantic relationship status (i.e., single versus coupled). The results of each of these analyses are presented in Table 3. As displayed in Table 3, distress reactivity was positively associated with attachment anxiety,  $t = 2.52$ ,  $p < .02$  and distress recovery was negatively associated at the trend level with attachment avoidance,  $t = -1.70$ ,  $p < .10$ . Anger recovery was positively associated with current relationship security at the trend-level,  $t = 1.8$ ,  $p = .06$ , consistent with  $H2$ .

To test the potential mediating effect of RSA, the reactivity and recovery outcomes were first regressed on RSA and age (age was added as a covariate because RSA tends to be negatively associated with age). Following Baron and Kenny (1986), this step is necessary in order to determine whether RSA qualifies as a potential mediator between the recovery outcomes and the attachment variables. Table 2 and Table 3 confirm that the other requirements for mediation are met (i.e., significant associations between RSA and both attachment anxiety and current relationship security, and significant associations between attachment anxiety and distress reactivity and between anger recovery and current relationship security). The only outcome variable that was significantly associated with RSA was anger recovery,  $t = 2.90$ ,  $p < .01$ . When RSA and age were then added to the previous model including attachment style and current relationship security, RSA remained significantly associated with anger recovery,  $t = 2.33$ ,  $p < .03$ , but there was no longer a significant effect of current security. The results of this regression are presented in Table 3. A Sobel test found that this change (i.e., the addition of age and RSA) was significant at the trend level,  $\Delta R^2 = .04$ ,  $\Delta df = 2$ ,  $t = -1.74$ ,  $p < .08$ . Because changes in respiratory frequency can influence estimates of RSA (Grossman, Karemaker, & Wieling, 1991), all analyses involving RSA were recomputed after controlling for respiratory frequency (as in Berntson, Cacioppo, & Fieldstone, 1996). In no cases did this eliminate the reported effects, although as with the Berntson et al.'s study, some effects were smaller in magnitude, reflecting the extremely conservative nature of this correction approach.

We also conducted an ancillary test of an alternative model, in which the association between current security and vagal tone was mediated by anger

**TABLE 3**  
**Results of regressions predicting distress and anger reactivity and recovery from attachment anxiety, avoidance, security of current relationships, vagal tone, age, and romantic relationship status**

Dependent Variable	Step One Predictors	$\beta$		
Distress Reactivity	Attachment Avoidance	.01		
	Attachment Anxiety	.13*		
	Security of Current Attachment Relationship	.03		
	Romantic Relationship Status	.03		
	Baseline Distress	-.31*		
		$R^2 = .15, F(5,68) = 2.43^*$		
Distress Recovery	Attachment Avoidance	-.06 <sup>†</sup>		
	Attachment Anxiety	.01		
	Security of Current Attachment Relationship	.01		
	Romantic Relationship Status	-.05		
	Distress Reactivity	-.59**		
		$R^2 = .50, F(5,68) = 13.58^{**}$		
Anger Reactivity	Attachment Avoidance	-.07		
	Attachment Anxiety	.01		
	Security of Current Attachment Relationship	.01		
	Romantic Relationship Status	-.17		
	Baseline Anger	-.03		
		$R^2 = .03, F(5,68) = .35$		
	<b>Without Adding RSA</b>	$\beta$	<b>With RSA</b>	$\beta$
Anger Recovery	Attachment Avoidance	-.03		-.04
	Attachment Anxiety	-.03		-.01
	Security of Current Attachment Relationship	.02 <sup>†</sup>		.01
	Romantic Relationship Status	.07		.05
	Anger Reactivity	-.41**		-.41**
				Age
			Vagal Tone	.18*
				$\Delta R^2 = .04^{\dagger}, \Delta df = 2$
				Final Model: $R^2 = .47, F(7,65) = 8.37^{**}$

<sup>†</sup> $p < .10$ ; \* $p < .05$ ; \*\* $p < .01$ .

recovery (consistent with the aforementioned possibility that vagal tone predisposes some individuals to poor emotion regulation, leading such individuals to develop low-security relationships). First, current relationship security was regressed on age, baseline RSA, current relationship status, attachment anxiety, and attachment avoidance. There was a significant effect of baseline RSA,  $\beta = .25, p < .03$ . When anger recovery and anger reactivity were added to the model, they had no significant effects, and baseline RSA remained significant. Thus, emotion regulation (as indexed by anger recovery) does not appear to mediate the association between vagal tone and current relationship security.

*H4* predicted that the aforementioned associations between attachment insecurity and poor emotion regulation would be more pronounced when

individuals are in the presence of their romantic partners than when they are either alone or with a friend. This hypothesis was not confirmed. Not only was experimental group not significantly related to any of the outcome measures, as noted earlier, but it did not interact with any of the significant effects noted in Table 3. Analyses were repeated after controlling for ethnicity and also after deleting ethnic-minority respondents, and none of the results were altered. To examine whether the lack of a 'partner presence' effect was attributable to the fact that some individuals reported low security with their partners, we also repeated the analyses including only individuals who were above the sample median on perceived relationship security to their partner. Again, the results were unchanged.

## Discussion

The present research investigated associations among young men's responses to experimental inductions of anger and anxiety, their attachment style, their perceptions of security in current, specific attachment relationships, and their vagal tone, an index of parasympathetic nervous system functioning (indexed by resting respiratory sinus arrhythmia, or RSA) that has been associated with effective emotion regulation in prior research (Fabes & Eisenberg, 1997; Friedman & Thayer, 1998; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). As predicted, we found that vagal tone is positively associated with their perceptions of emotional security in current attachment relationships and negatively associated with their overall attachment anxiety. This finding is consistent with prior theory and research suggesting that attachment histories and current attachment experiences shape individuals' emotion regulation capacities (Mikulincer et al., 2003). Furthermore, men with higher perceptions of security in their current relationships showed more effective recovery from a laboratory-based anger induction (i.e., faster return to baseline levels of anger), and vagal tone was found to mediate this association. This suggests a potential biological mechanism through which attachment security shapes the regulation of negative emotions and the attendant mental health consequences of emotion regulation capacities and strategies (Cooper et al., 1998; Mickelson et al., 1997).

We found that the silent presence of an attachment figure had no effect on responses to the emotion inductions – nor did the silent presence of an opposite-sex friend. Thus, although adults might unconsciously *associate* proximity with distress-alleviation (Mikulincer, Birnbaum, Woddis, & Nachmias, 2000), proximity in and of itself does not necessarily facilitate the reduction of distress in adults. Also, contrary to expectation, the presence of one's romantic partner did not moderate the aforementioned associations between attachment security and emotion regulation. One possible explanation for this finding is the fact that we attempted to isolate 'presence' from 'support' by constraining the behavior of romantic partners (and friends) so that they did not actually interact with participants during the assessed recovery period. As noted earlier, the basis for expecting a moderating effect was the notion that partner presence would increase the immediate salience

of insecure individuals' negative expectations of their partners' availability and supportiveness. Yet perhaps we inadvertently *decreased* the salience of these expectations by placing clear-cut constraints on partners' behavior, such that individuals knew that their partners could not act in a supportive fashion even if they wanted to. Thus, future research on this topic might profit by permitting more naturalistic post-stressor interactions.

### **Limitations, strengths, and future directions**

Importantly, the effects we detected were relatively small, and the hypothesized mediated effect of vagal tone was found only for anger, and not for distress. Thus, future research should seek not only to replicate these effects, but to examine whether (given their small size) they have appreciable implications for day-to-day emotional functioning. Thus, an important 'next step' for research on this topic is to examine individuals' responses to real-life emotional experiences, using daily diaries, ambulatory measures of physiological functioning (such as Carels, Blumenthal, & Sherwood, 2000), and ideally observational and behavioral data on individuals' current relationships.

It is also worth noting that the hypothesized mediating effect of vagal tone was found only for anger, and not for distress. This might be attributable to the fact that our laboratory tasks may have served as stronger anger manipulations than distress manipulations. Future research should, therefore, replicate these findings with laboratory manipulations specifically designed to elicit maximal anxiety, as well as other intense emotional experiences. Such research will help to develop a more comprehensive profile of the association between attachment security and emotion regulation.

Finally, because this study involved only male participants, the extent to which the findings are gender-specific remains unknown. Previous research has detected gender differences in the links between attachment style and relationship experiences (Kirkpatrick & Davis, 1994; Kirkpatrick & Hazan, 1994), and it is possible that these gender differences have physiological manifestations. Future research should directly compare men and women in order to investigate this possibility.

These limitations, however, are outweighed by the strengths of the present study. One such strength, clearly, is its integration of measures of physiological processes related to emotion regulation. Although Bowlby (1973) conceptualized the attachment system as playing a fundamental role in maintaining *physiological* as well as emotional homeostasis, scant research has investigated this aspect of the attachment system in adults. Studies such as this one are important for specifying the *processes* through which attachment experiences shape emotional regulation capacities and strategies, which has been identified as a priority for future attachment research (Mikulincer & Shaver, 2004).

Another strength of this study is its assessment of *both* attachment style *and* perceptions of security in current relationships, given that most research on adult attachment focuses on the former rather than the latter. The fact that current relationship security remained associated with vagal tone even after controlling for attachment anxiety demonstrates the

importance of assessing both of these dimensions. Of course, a key area for future study involves assessing associations between vagal tone and current perceptions of relationship security *longitudinally*, during the formation and development of new attachment relationships. The results of the mediational analyses in the present study suggest that experiences of emotional security in current relationships can enhance vagal functioning, and it is important to confirm this causal pathway by tracking changes in both of these domains – as well as global attachment style – over time.

Of course, given that the study relied exclusively on a self-report measure of current perceptions of security in attachment relationships, it is impossible to definitively determine the degree to which individuals' responses on this measure reflect factors specific to the relationship versus their global attachment orientations. As noted earlier, the two phenomena undoubtedly influence one another, and thus it would be inappropriate to interpret self-reports of security in current relationships as the 'truth' of a particular relationship while interpreting attachment styles as trans-situational biases that function independently of these 'truths.' It is for this reason that future research would profit by integrating *behavioral* data (e.g., on interpersonal interactions revolving around comfort, support, empathy) in order to begin identifying the independent and joint contributions of attachment-related expectations and attachment-related experiences to emotion regulation. Finally, the use of controlled laboratory inductions of anger and anxiety and the comparison of participants' responses with and without attachment figures present is another strength of the study, given that most prior research on attachment and emotion regulation has relied on self-reports of emotional experience or emotional memories, and has assessed individuals' emotional experiences while they are alone (with some notable exceptions, such as Carpenter & Kirkpatrick, 1996; Rholes et al., 1999).

## **Conclusion**

Effective modulation of negative emotional experiences is fundamentally important to both mental and physical health. The present research demonstrates that this process is associated with an individual's experiences of security within attachment relationships, and that this association is mediated by parasympathetic nervous system functioning. These findings open up a host of provocative questions regarding the basic biopsychology of the attachment system and the multiple ways in which interpersonal experiences with attachment figures become integrated, over time, into psychological, behavioral, and biological patterns of emotion regulation. Future research on these issues is important for integrating the increasingly sophisticated bodies of knowledge on social relationships and physiological functioning that have developed within the social-psychological, developmental, and behavioral medicine traditions. Such integration is critical for elucidating how and why humans' most intimate and important relationships shape both mental and physical health over the life course.

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