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Resting Respiratory Sinus Arrhythmia Buffers Against Rejection Sensitivity via Emotion Control

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Emerging evidence suggests that high resting heart rate variability in the respiratory frequency band, or respiratory sinus arrhythmia (RSA) may capture individual differences in the capacity to engage in situationally appropriate regulation of affect and behavior. The authors therefore hypothesized that high RSA may act as a protective factor against difficulties controlling negative affect and hostile behaviors in conflicts with romantic partners in highly rejection-sensitive individuals—a population otherwise vulnerable to these responses. Results were consistent with this hypothesis such that highly rejection-sensitive participants reported less emotion control and more hostility in conflicts only if they were also low in RSA. Furthermore, emotion control mediated the joint effect of rejection-sensitivity and RSA on hostile conflict behavior. These results are consistent with the argument that resting RSA is a marker of flexible responding in the context of highly emotional situations, and further suggest that it may serve as a protective factor particularly in vulnerable populations.

Keywords: respiratory sinus arrhythmia, self-regulation, emotion control, hostility, rejection sensitivity

No romantic relationship is impervious to conflict. Topics of argument can take many forms, ranging from small spats about household chores to heavy conversations about sex, loyalty, and the future (Eaker, Sullivan, Kelly-Hayes, D'Agostino, & Benjamin, 2007). Nevertheless, it is apparent that not all couples that argue are necessarily unhappy (Cramer, 2002; Heavey, Layne, & Christensen, 1993). Research shows that it is not the mere presence or absence of conflicts that undermines relationships; instead it is the way partners behave and handle themselves during a conflict that has consequences for the health of the relationship, as well as of individual members (Eaker et al., 2007; Filsinger & Thoma, 1988; McGonagle, Kessler, & Gotlib, 1993; Smith, & Uchino, 2006). For example, constructive behaviors such as partner perspective-taking and problem-solving facilitate effective resolution of conflicts, potentially turning them into contexts in which relationships are validated rather than undermined (Arriaga & Rusbult, 1998; Heavey et al., 1993). In contrast, use of negative conflict tactics, such as criticism, withdrawal, stonewalling, and expression of hostility reduces general relationship satisfaction and can eventually lead to the dissolution of the bond (Arriaga & Rusbult, 1998; Clements, Cordova, Markman, & Laurenceau, 1997; Gottman, Coan, Carrere, & Swanson, 1998; Levenson & Gottman, 1983).

An important question then is exactly what enables people to refrain from using destructive behaviors in conflicts? In line with common wisdom, growing evidence from multiple areas in psychology suggest that successful conflict negotiation in close relationships hinges on individuals' ability to down-regulate negative emotions and to resist enactment of prepotent responses in emotionally charged situations. Several lines of research support the notion that individual differences in self-regulatory capacity may successfully attenuate reactivity to interpersonal stressors particularly in vulnerable populations, such as those with heightened sensitivity to detect rejection, borderline personality disorder, or low self-esteem (e.g., Ayduk et al., 2000; Eisenberg et al., 1997; Gyurak & Ayduk, 2007; Linehan, 1995; Rothbart, & Bates, 1998; Wolff & Ollendick, 2006). Whereas most of this literature has examined mechanisms related to self-regulation using questionnaires and behavioral assessments (e.g., preschool delay of gratification paradigm, reaction time performance on interference tasks), relatively less emphasis has been paid to physiological mechanisms associated with effective regulation of affect and behavior in interpersonal conflicts.

Researchers recently proposed that individual differences in resting heart-rate variability in the respiratory frequency band, or respiratory sinus arrhythmia (RSA) marks flexibility and efficiency in responding to the changing demands of situations, particularly those critical for social relationships (Appelhans & Luecken, 2006; Grossman & Taylor, 2007; Porges, 1995; Thayer & Lane, 2000). Thus, the present study investigated the protective effect of resting RSA on the dysfunctional conflict behavior of an interpersonally vulnerable group—people high in rejection sensitivity (RS) —a population otherwise prone to both aggression and withdrawal in conflict situations (see Pietrzak, Downey, & Ayduk, 2005 for review).

Resting RSA as an Index of Physiological Self-Regulatory Capacity

Resting RSA, the periodic slowing and speeding up of the heart rate with the respiratory cycle, results from a dynamic relationship between the sympathetic and parasympathetic branches of the autonomic nervous system on the heart (Berntson et al., 1997).

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Two prominent theories on RSA, Porges' Polyvagal Theory (Porges, 1995) and Thayer's Model of Neurovisceral Integration (Thayer & Lane, 2000) suggest that the parasympathetic autonomic nervous system, channeled through the vagus nerve and the heart, evolved to support highly flexible and environmentally contingent mammalian behavior. These authors argue that in safe situations, the "vagal brake" functions to slow the heart rate by increasing parasympathetic influence on the heart, which in turn results in increased ability to attend to the environment. This increased vagal influence corresponds to acute increases in RSA (more variable heart rate). In contrast, in challenging or threatening situations, the vagal brake is withdrawn. This leads to sympathetic branch dominance, which supports increased metabolic output in order to energetically and effectively respond to the situation. Vagal withdrawal is reflected in acute RSA decreases. Based on the foregoing analysis, Thayer and Lane (2000) suggested that resting RSA, a measure of variability of the heart rate at rest, provides a marker of the chronic efficiency and flexibility of the central-peripheral feedback system in responding to challenging situations. Additionally, both Thayer and Porges (Porges, 1995; Thayer & Lane, 2000) hypothesize that resting RSA indexes flexibility of the vagal brake, with the implication that higher levels should be related to better regulation.

These theoretical accounts exist in the backdrop of controversy about the exact nature of high RSA in the human species, in particular about the psychological processes underlying RSA (Grossman & Taylor, 2007). In addition, it is unclear at this point whether high RSA is the cause or the outcome of better regulation. Based on the empirical evidence we review next, however, there is growing consensus in the literature that resting RSA can at least be conceptualized as a *marker* for self-regulatory capacity (e.g., Porges, 1995; Grossman & Taylor, 2007).

Individual differences in resting RSA show reasonable temporal stability (Sloan, Shapiro, Bagiella & Gorman, 1995), with low levels having been linked to psychopathology characterized by affect-regulatory problems especially in anxiety (Friedman, 2007) and depression spectrum disorders (Chambers & Allen, 2007; Rottenberg, 2007). In nonclinical samples, higher resting RSA has been associated with a number of potential indicators of situationally appropriate responding, including more effective coping during periods of stress (Fabes & Eisenberg, 1997), better impulse control (Allen, Matthews, & Kenyon, 2000), and more effective recruitment of calming strategies in negative emotional situations in toddlers (Calkins, 1997). Furthermore, resting RSA has been related to longer persistence and performance on demanding, boring tasks (Segerstrom & Nes, 2007), better performance on executive cognitive tasks, and higher attentional capacity (Hansen, Johnsen, & Thayer, 2003; Porges, 1992).

Resting RSA does not seem to be related to emotional reactivity under low to moderate levels of daily stress (Fabes & Eisenberg, 1997), or in situations when powerful emotional responses are not warranted (Demaree, Pu, Robinson, Schmeichel, & Everhart, 2006). However, recent studies suggest that individuals with higher resting RSA may show stronger emotional responses in situations that specifically call for them (Butler, Wilhelm, & Gross, 2006; Demaree, Robinson, Everhart, & Schmeichel, 2004). For example, in a healthy college student population, higher resting RSA was related to more expressed disgust when participants were explicitly instructed to up-regulate their responses to a disgust-eliciting situation (Demaree et al., 2004). Similarly, women with higher resting RSA showed more intense negative reactions in response to watching a provocative 11-min-long documentary about the atrocities of Hiroshima and Nagasaki (Butler et al., 2006). These findings paint a more nuanced, situationally dependent picture between resting RSA and strength of emotional responding. It appears that in circumstances that normatively call for powerful emotions, higher RSA might actually be related to more engagement and therefore greater intensity of responses.

Against the backdrop of some controversy about how specific resting RSA is to mammalian species, and its exact nature in humans (e.g., Grossman & Taylor, 2007), the existing literature, taken together, suggests that resting RSA may be a marker of situationally adaptive and flexible behavioral engagement, which includes both effective regulation of inappropriate emotional reactivity and the expression of strong emotions when appropriate. Based on this literature, the present study examined the protective effect of high RSA for individuals high in RS who have been shown to respond in maladaptive ways to interpersonal conflicts.

RS—Enhanced Vulnerability for Maladaptive Relationship Behaviors

RS captures individual differences in anxious expectations of rejection that develop out of early experiences of rejection and neglect (Downey & Feldman, 1996; Downey, Khouri, & Feldman, 1997). People who are high in RS are anxious of and expect rejection, whereas low RS people are minimally concerned about interpersonal rejection and have high expectations of acceptance. Once anxious expectations of rejection develop, they become activated in situations that give rise to the possibility of interpersonal rejection, and increase high RS individuals' readiness to perceive rejection in subsequent relationships (Downey & Feldman, 1996). These perceptions in turn can trigger affective and behavioral overreactions, which ironically serve to elicit actual rejection from significant others. This cycle describes the operation of a self-fulfilling prophecy in maintaining high RS dynamics (Downey, Freitas, Michaelis, & Khouri, 1998).

The process through which RS impacts subsequent interactions are thought to be mediated by heightened threat activation. Specifically, situations that set off high RS people's fears and expectations of rejection also activate their defensive motivational system (Downey, Mougios, Ayduk, London, & Shoda, 2004). This in turn triggers defensive responses such as hostility, aggression, or withdrawal in high RS people. For example in a laboratory discussion of relationship conflicts—a situation that typically activates concerns about and perceptions of rejection, women displayed more verbal and nonverbal signs of anger toward their romantic partners, to the extent that they were high in RS (Downey et al., 1998). Paralleling these findings in women, high RS men also reported being more physically aggressive toward their partners if they were highly invested in the relationship (Downey, Feldman, & Ayduk, 2000). Additionally, recent studies generated findings for higher prevalence of withdrawal and self-silencing, two dysfunctional conflict strategies (Eaker et al., 2007; Rusbult, 1993) in romantic relationships among high RS people. Ayduk and colleagues (Ayduk, May, Downey, & Higgins, 2003) found that both high RS men and women, as compared with low RS men and women, report greater self-silencing in order to prevent rejection

from occurring, while also withdrawing love and support in conflict situations when they sensed that rejection was happening.

Self-Regulation as a Buffer Against Interpersonal Vulnerabilities

Taken together, the research reviewed above paints a rather bleak picture of RS dynamics; early experiences of rejection that lead to maladaptive relationship behaviors in later relationships, and culminate in actual instances of rejection from peers and partners. However, recent evidence suggests that self-regulatory capacity can buffer the potentially negative consequences of dispositional vulnerabilities, such as high RS. For example, the ability to delay gratification in early childhood has been associated with less susceptibility to negative outcomes among high RS individuals, including low self-worth, academic difficulties, and borderline personality symptoms in adulthood (Ayduk et al., 2000, 2008b). Attentional control (i.e., the ability to effortfully focus and shift attention) has also been found to buffer people low in self-esteem, another dispositional vulnerability, against the activation of the defensive motivational system to scenes of social rejection, in an emotion-modulated startle paradigm (Gyurak & Ayduk, 2007).

Consistent with these findings, the literature on developmental psychopathology suggests that psychological disorders and conduct problems develop as a joint effect of heightened reactivity and difficulties with self-regulation. For example research on the etiology of problem behaviors in children (Eisenberg et al., 1997), anxiety disorders (Beauchaine, 2001), suicidality (Crowell et al., 2005), and borderline personality disorder (Linehan, 1995) indicate that reactivity differences due to temperament or life history of abuse co-occur with poor regulation in clinical populations.

The Present Study

In summary, there is growing evidence suggesting that vulnerability factors for heightened reactivity are less likely to be associated with maladaptive outcomes in the presence of personality correlates that mark effective functioning of self-regulatory mechanisms. Less is known about whether physiological markers of self-regulation show a similar protective effect. Because resting RSA is a relatively simple and noninvasive physiological measure of self-regulatory capacity that potentially can be trained and improved (Lehrer et al., 1997; Nolan et al., 2005; Sandercock, Bromley, & Brodie, 2005), the present research sought to establish the moderating role of RSA on the relationship between RS and conflict hostility.

Specifically, we investigated the moderating role of RSA and RS in the context of interpersonal conflicts. According to interdependence theory proposed by Kelley and Thibaut (1978; see also Rusbult, 1993) relationship conflicts constitute a regulatory dilemma. Members of the couple have to weigh the benefits of engaging in hostile and retaliatory behavior that may satisfy short-term self-interest (e.g., taking revenge) against behaving in accordance with longer-term relationship maintenance goals that require regulation. People with better self-regulatory abilities may have an advantage in being able to resolve such a dilemma in favor of long-term goals because they may be better able to inhibit the urge to retaliate and instead engage in more constructive behaviors. A second, related outcome variable of interest was emotion control in conflicts which we conceptualized as the ability to down-regulate negative arousal (e.g., being able to stay calm) and to exert higher order cognitive control on one's emotions (e.g., being able to respond with reason, taking into account partner's perspective; Arriaga & Rusbult, 1998).

In addressing these questions, we investigated the statistical interaction between RS and RSA on both dependent variables with the following more specific hypotheses:

Hypothesis 1: Relationship of RS to conflict hostility and emotion control among high and low RSA individuals. Among individuals low in resting RSA, we expected RS to show a positive relationship to conflict hostility but a negative relationship to the ability to control emotions. In contrast, we expected these relationships to be attenuated or eliminated among individuals high in resting RSA, based on the premise that high RSA functions as a protective factor primarily for individuals who are threatened by conflicts.

Hypothesis 2: Relationship of RSA to conflict hostility and emotion control among low and high RS individuals. Among high RS individuals, we expected resting RSA to be negatively associated with conflict hostility but positively associated with emotion control. In other words, we hypothesized that high RS individuals also high in RSA would report lower conflict hostility and better emotion control compared to their low RSA counterparts.

Based on the foregoing reasoning, we did not expect RSA to be diagnostic of low RS individuals' behavior and emotion control during conflicts. First, there is extensive evidence showing that because low RS people are not particularly fearful of rejection, conflicts with partners are not as stressful for them as they are for high RS individuals (e.g., Ayduk, Gyurak, & Luerssen, 2008a; Downey et al., 1998, 2004). Second, prior evidence suggests that RSA is related to down-regulation of emotional and behavioral reactivity only under high stress (Fabes & Eisenberg, 1997). Together, these findings suggest that RSA should not be significantly associated with hostility or emotion control among individuals low in RS, because conflicts are not high stress situations for them—a pattern also consistent with previous research in which self-regulation ability (i.e., attentional control, ability to delay gratification) was not predictive of low RS individuals' interpersonal behavior and adjustment (e.g., aggression, self-worth, borderline personality symptoms; Ayduk et al., 2000, 2008b).

Hypothesis 3: Role of emotion control as a mediator of the RS × RSA interaction on hostility. Because high RSA is assumed to promote adaptive behavior partly by enabling situationally appropriate regulation of emotion, we also investigated whether emotion control during conflicts explained the hypothesized buffering effect of RSA against high RS individuals' tendency to engage in hostile conflict behavior. We conducted mediated moderation analysis to address this issue.

Method

Sample and Procedure

Undergraduates ($N = 41$; 32 female, 9 male) completed the study in exchange for course credit ($M_{age} = 21.41$, $SD_{age} = 4.20$). The ethnic composition of the sample was 36.59% Asian, 24.39% Caucasian, 9.76% Hispanic, 4.88% Black, and 24.39% mixed or other ethnicities. This study reports previously unpublished

findings from a larger study (Gyurak & Ayduk, 2007). Because we were interested in assessing conflict behaviors in the context of an ongoing relationship, we focus on data from participants who reported being in a relationship at the time.

Participants completed the study individually in a sound-attenuated experimental room. Upon arrival, they gave informed consent and were then attached to physiological sensors measuring heart-rate, skin conductance, and muscle activity on the face. Following this, participants were seated in front of a computer, while physiological responses were continuously recorded for 5 minutes. After completing several tasks that were not the focus of the current study, participants filled out several questionnaire measures (described under Measures) on the computer. Finally, participants were fully debriefed and thanked.

Measures

Rejection sensitivity. RS was measured by Downey and Feldman's (1996) Rejection Sensitivity Questionnaire (RSQ). The RSQ consists of 18 hypothetical scenarios commonly experienced by college students (e.g., "You ask your boyfriend/girlfriend to move in with you"). Participants indicate the level of concern they would feel over the situation (1: Very unconcerned, 6: Very concerned) and likelihood of acceptance (1: Very unlikely, 6: Very likely). Acceptance ratings are reverse scored to index rejection expectations and multiplied by the anxiety ratings to derive a score for each scenario. These scores are then averaged to compute an overall RS score ($\alpha = .84$, $M = 7.82$, $SD = 2.94$).

Hostile conflict behaviors. Modeled loosely after the Conflict Tactics Scale (Straus, Hamby, Boney-McCoy, & Sugarman, 1996), we created a seven-item self-report scale that taps into various forms of maladaptive conflict behaviors. Participants indicated how often (1: hardly ever, 5: very often) they engaged in the following behaviors during the most recent conflict they had with their current romantic partner: "Yelled, insulted and/or swore at the other one," "Sulked and/or refused to talk about it," "Stomped off and left the scene," "Did or said something to spite the other one," "Acted cold and distant," "Blamed the other person," or "Withdrew and became less communicative." Responses were averaged to create a composite conflict hostility score ($\alpha = .82$, $M = 2.57$, $SD = .82$).

Emotion control. Participants were asked to rate the degree to which the following items described their emotion regulatory behavior the last time they were in a confrontation with their current romantic partner (1: Not at all descriptive, 7: Very descriptive): "I used and responded to reason even though I was feeling very upset," "I felt like I was not in control of my emotional reactions," "I was able to make myself see the other person's side of the issue," or "I was able to remain calm in spite of my hurt or anger." Responses were averaged to create a composite emotion control score ($\alpha = .77$, $M = 4.5$, $SD = 1.37$).

Heart Rate Recording

Participants were seated in a sound-attenuated experimental room and were instructed to relax quietly for 5 minutes to obtain baseline values. Electrocardiograph (EKG) data were recorded using two disposable, pregelled Ag-AgCl electrodes, placed on the inner sides of the right arm, and the left leg (Biopac Systems, Inc, Santa Barbara, CA). EKG data were sampled at 1000 Hz and recorded for 5 minutes continuously. Additional sensors were placed on the face and on the fingers to record physiological signals that are not discussed in this paper.

Physiological Data Processing

Frequency domain analyses were performed on digitally derived inter-beat-interval series using Mindware RSA package (Mindware Inc., Ghanna, OH) following procedures outlined in Berntson et al. (1997). Artifacts were identified by the algorithm of Berntson, Quigley, Jang, and Boysen (1990), and manually edited. One participant's recording contained numerous movement artifacts that rendered 7.7% of the heartbeats unanalyzable, and therefore, his or her data were excluded from the data analysis. This reduced the overall sample size to $N = 40$. A 4-Hz time series was then derived by interpolation (Berntson, Cacioppo, & Quigley, 1995), and the series was detrended by a second-order polynomial to minimize nonstationaries in the data. The residual series was then tapered with a Hamming window and submitted to a Fast Fourier Transform to derive the spectral frequency distribution. RSA was quantified as the integral power within the respiratory frequency band (0.12 to 0.40 Hz).

Construct Validation of the Hostile Conflict Behavior Scale

To support the construct validity of the hostile conflict behavior scale we used in the present study, we examined its relationship to observed conflict behavior in a separate sample of dating couples who participated in a larger study on personality and interpersonal adjustment (Ayduk et al., 2008a). Specifically, 53 monogamous, nonmarried, English-speaking dating couples were recruited from the University of California at Berkeley campus for monetary compensation. On average, couples had been in relationships for over 16 months. Both members of the couple completed an online questionnaire battery that contained the self-report hostile conflict behavior measure among other instruments. Items were slightly reworded for this version to better separate double-barreled questions. Specifically, participants indicated how descriptive (1: not at all, 7: extremely) the following items were of their behavior during the most recent distressing conflict with their current romantic partner: "Yelled," "Insulted or swore at the other person," "Sulked," "Refused to talk about the issue," "Stormed off," "Did or said something to spite the other person," "Blamed the other person," or "Acted cold and distant." Responses were averaged to create a composite score ($\alpha = .84$, $M = 3.16$, $SD = 1.36$).

After completion of the questionnaire packet the couple was scheduled for a laboratory session modeled after standard marital interaction paradigms (e.g., Heyman, Weiss, & Eddy, 1995) designed to elicit strong naturalistic conflict behaviors that predict important relationship indexes, such as the quality and longevity of the relationship (e.g., Gottman et al., 1998). During this lab session, participants were asked to rate how much stress or challenge a list of possible relationship conflicts posed for their relationship, and how important each of these was to them. Based on the ratings, the experimenter identified a mutually conflictual and important area and instructed the couple to discuss the problem for 15 min to try to reach a solution.

Conflict discussions were videotaped and later rated (1: presence vs. 0: absence) for positive and negative behavior codes by trained coders following the Rapid Marital Interaction Coding System (Heyman & Vivian, 1997). On 25% of the videos, which were double coded by independent judges, the interjudge agreement was 87.7%. For the purposes of the current study, an *observed conflict hostility* index was calculated by averaging ratings' across negative behavior codes, including psychological abuse, distress maintaining attributions, hostility, dysphoric affect, and withdrawal ($M = .41$, $SD = .71$). For a detailed description of these constructs and codes see Heyman and Vivian (1997).

Given the dyadic, interdependent nature of the data, the relationship between self-reported and observed conflict hostility was examined in a mixed procedure in the SAS package (Version 9.1), modeling at the level of the couple to account for autodependency. Self-reported and observed conflict hostility showed a significant positive relationship, $F(1, 51) = 5.34$, $\beta = .14$, $p < .05$, lending support to the construct validity of the conflict hostility measure used in the present study.

Results

Statistical analyses were conducted using the SAS package (Version 9.1). All predictors were centered on their means and used as continuous variables in testing for interactions as recommended by Aiken and West (1991).[1,2]

Zero-Order Correlations

Pearson correlations were calculated first to examine zero-order correlations among key variables. RS and RSA did not have a significant relationship, $r(38) = .24$, $p = .13$, suggesting that there was reasonable power to test for an interaction between these predictors. Furthermore, RS was significantly related to conflict hostility, $r(38) = .33$, $p < .03$, but not to emotion control, even though the relationship was in the theoretically expected direction, $r(38) = -.18$, $p = .26$. In contrast, RSA did not have significant zero-order relationship with conflict hostility, $r(38) = .07$, $p = .65$, or emotion control, $r(38) = .02$, $p = .91$. Finally, although emotion control was significantly correlated with conflict hostility, $r(38) = .61$, $p < .0001$, they shared only 37% of their variance, suggesting they are related yet distinct constructs.

Does RSA Moderate the Positive Relationship Between RS and Hostile Conflict Behaviors?

Our central question of interest was the moderating effect of RSA between RS and hostile conflict behaviors. We examined this hypothesis using the General Linear Models procedure in SAS, where hostile conflict behavior composite served as the dependent variable, and RS, RSA, and their interaction term, served as continuous predictors (see Table 1 for all parameter estimates).[3]

As predicted, we found a significant RSA × RS interaction in predicting conflict hostility, $F(1, 36) = 6.92$, $p = .01$. Figure 1 illustrates these results. To probe the pattern of this interaction, follow-up simple slopes analyses were conducted at 1 *SD* below and above the respective means of the predictors. These analyses revealed that among low RSA people, RS was positively related to conflict hostility $t(36) = 3.50$, $\beta = .86$, $p = .001$. The slope of RS was not statistically significant among high RSA people ($t < 1$, $\beta = .05$). These findings supported Hypothesis 1. Furthermore, consistent with Hypothesis 2, among high RS people, RSA was negatively related to conflict hostility, $t(36) = -2.03$, $\beta = -.46$, $p = .05$. However, among low RS people, high RSA was related to marginally more hostile conflict behaviors than low RSA $t(36) = 1.75$, $\beta = .35$, $p = .08$. We return to this unexpected finding in the discussion.

Is RSA Related to Emotion Control Among High RS People?

Next, we examined the moderating effects of RSA × RS interaction on emotion control in conflict situations in a General Linear Models procedure, where emotion control served as the dependent variable, and RS, RSA, and their interaction term served as predictors (see Table 1). Our results indicated a significant RSA × RS

[1] Given the strong relationship between RSA and depression spectrum symptomatology (Beauchaine, 2001), depression was assessed with the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) in which participants rated their experience of affective, cognitive, and behavioral symptoms of depression on a 4-point scale (0-3). Ratings were summed to create a composite score ($M = 6.93$, $SD = 5.40$). In preliminary analyses, controlling for depression scores did not change the findings reported. Therefore, these results are not discussed in the main text.

[2] Although there is little power to assess sex and race differences, given the small sample size and low frequency of participants in certain categories (e.g., we had 9 men and 2 African American participants in our pool), in preliminary analyses, we tested whether the results reported held when controlling for age, sex, and race. None of the covariates explained significant variance in either conflict hostility or emotion control (all Fs $<$ 1.91). Furthermore, controlling for these covariates, the RS × RSA interaction remained significant for conflict hostility ($p = .04$) and was slightly attenuated for emotion control ($p = .06$). When we tested whether race or ethnicity moderated the RS × RSA interaction, neither the RS × RSA × race nor the RS × RSA × sex interaction was significant in explaining hostility or emotion control (Fs < 2.08). Together, these suggest that the RSA × RS interaction on outcome variables operated similarly across sex and race.

[3] The conflict hostility measure included items that tapped into maladaptive behavior that included both active and passive hostility. To explore whether the pattern of results was similar to these two types of behavior, we created theoretically derived active and passive hostility indices based on the face validity of the items. The passive hostility index included "acting cold and distant," "withdrew and became less communicative," "stomped off and left the scene," and "sulked and refused to talk about it." The active hostility index included items "Yelled, insulted and/or swore at the other one," "Did or said something to spite the other one," and "Blamed the other person." Ratings on these indices were highly correlated ($r = .58$, $p < .0001$) and both showed the expected relationship to RS, active hostility $r(38) = .36$, $p = .02$; passive hostility $r(38) = .26$, $p = .09$. Furthermore, the RSA × RS interaction term was significant for passive hostility, $F(3, 36) = 8.80$, $p < .01$. The interaction was not significant but was in the theoretically expected direction for active hostility, $F(3, 36) = 1.97$, $p = .16$. When we examined whether the effect of the RSA × RS interaction was statistically different, depending on the type of hostility, the 3-way interaction between RSA × RS and type of hostility (2: passive vs. active; within-subjects factor) was not significant, $F(1, 36) = 2.23$, $p = .14$, suggesting that overall the results reported in the main text are not different as a function of hostility type.

Table 1
Standardized Parameter Estimates and Effect Sizes in Predicting Conflict Hostility and Emotion Control from Rejection Sensitivity, Resting RSA, and the Interaction Between Them

Dependent variables	Predictors			Effect size (sr^2)	R^2 for the
	RS	RSA	RS × RSA	RS × RSA	model
Conflict hostility	.45**	−.05	−.39**	.14	.25*
Emotion control	−.31†	.11	.41**	.15	.19*

Note. Effect sizes reported are squared semi-partial correlations between the RS × RSA interaction and each dependent variable.
** $p \leq .01$. * $p \leq .05$. † $p \leq .06$.

interaction on emotion control, $F(1, 36) = 6.83$, $p < .05$. Figure 2 illustrates these results. Supporting Hypothesis 1, simple slopes analyses conducted at 1 *SD* above and below the mean of the predictors revealed that whereas RS was negatively related to emotion control among low RSA people $t(36) = -2.86$, $\beta = -.74$, $p < .05$, this relationship was not statistically significant among those high in RSA ($t < 1$).

Furthermore, consistent with Hypothesis 2, among high RS people, higher RSA was associated with greater emotion control, $t(36) = 2.25$, $\beta = .53$, $p < .05$. This relationship was not significant among low RS people, $t(36) = -1.48$, $\beta = -.31$, $p = .15$.

Emotion Control as a Mediator Between RSA × RS and Hostile Conflict Behaviors

Our final question of interest was to evaluate the mediational role of emotion control on the RSA × RS interaction (Hypothesis 3). We followed Shrout and Bolger's (2002) approach for assessing mediation, which involves demonstrating the following four effects in order: (1) the predictor variable (i.e., RS × RSA interaction) significantly affects the outcome variable (conflict hostility); (2) the predictor (i.e., RS × RSA interaction) significantly affects the mediator (i.e., emotion control); (3) the effect of the mediator on the outcome variable is significant, controlling for the direct effect of the predictor variable (and main effects), on the outcome variable; and, (4) the mediated path from the predictor variable through the mediator to the outcome variable is significant, as indicated by a bootstrap test (Preacher, Rucker, & Hayes, 2007). Bootstrapping is a method that resamples from an original sample to derive a more accurate estimate of relationships between variables. Bootstrapping has been recommended when testing for mediation in small samples ($n < 400$; for reviews see: Preacher et al., 2007; Shrout & Bolger, 2002). In the current study, bootstrapping (with 1,000 resamples) was conducted using the SAS macro created by Preacher and colleagues (2007).

The first two steps required for establishing mediation were supported in the analyses reported above. To recap, in General Linear Models analyses the RSA × RS interaction was significant in predicting both the outcome variable, hostile conflict behaviors $t(36) = -2.63$, $\beta = -.39$, $p = .01$, and the mediator, emotion control during conflicts, $t(36) = 2.61$, $\beta = .41$, $p = .01$. In the third step of testing for mediation, we conducted General Linear Models analyses on conflict hostility including, RS, RSA, and their interaction, as well as emotion control, as predictors. This analysis revealed that the mediator, emotion control, showed a significant

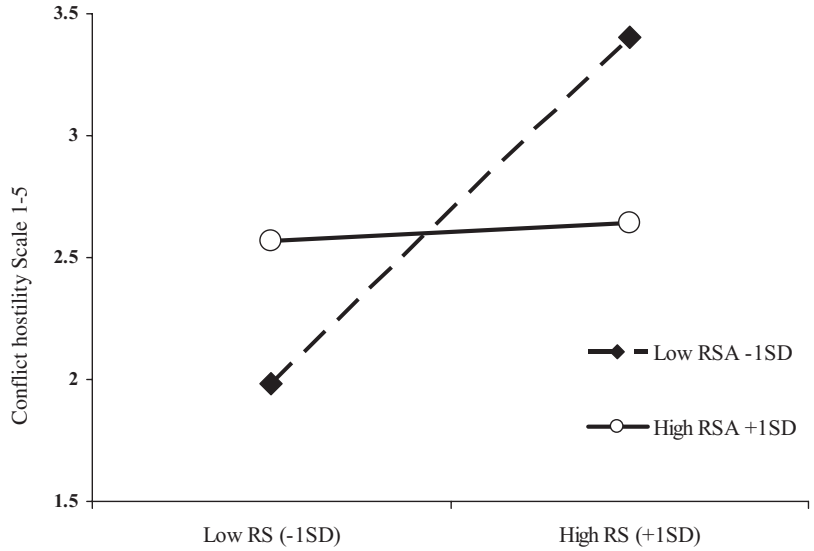

Figure 1. Hostile conflict behaviors as a function of RS and RSA. Higher numbers indicate more hostile conflict behaviors.

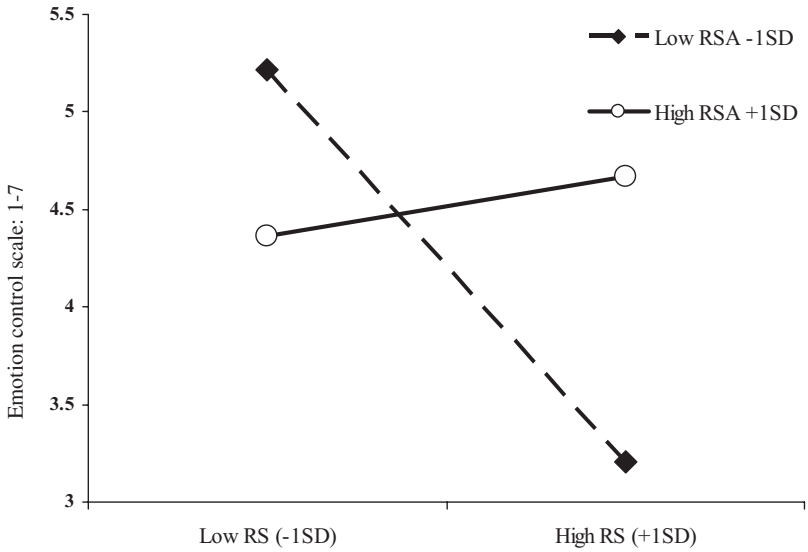

Figure 2. Emotion control during conflicts as a function of RS and RSA. Higher numbers indicate more emotion control.

negative association with the outcome variable, conflict hostility, $t(36) = -3.76$, $\beta = -.51$, $p = .0006$, while the direct effect of RSA × RS after controlling for emotion control dropped to a nonsignificant level, $t(36) = -1.32$, $\beta = -.18$, $p = .20$. In the final step of establishing mediation, the mediated path from RS × RSA interaction through emotion control to conflict hostility was significant at $p < .05$ since the 95% confidence interval $\{-0.11$ to $-0.01\}$ estimated for the mediated path by bootstrapping fell outside of 0.

Discussion

Relationship conflicts pose a regulatory dilemma in which people have to weigh short-term, potentially negative responses, such as retaliation and hostility against long-term relationship maintenance considerations (Rusbult, 1993). The success of this process, whether someone lashes out on the partner, or regulates and responds constructively, has far-reaching consequences for maintenance of the bond. Previously, high RS has been related to a greater tendency to behave destructively in conflict situations that negatively impact relationship quality (Pietrzak et al., 2005). Consistent with this research, we found that high RS people reported using more destructive conflict strategies than their low RS counterparts. Although self-regulatory ability assessed through behavioral paradigms has been shown to moderate this relationship, no research, thus far, has examined the role of physiological markers of regulatory ability in interpersonal conflicts. In this study, an important finding was that destructive tendencies were moderated by high RSA, such that high RS–high RSA people reported less conflict hostility than their high RS–low RSA counterparts. These findings corroborate our previous studies demonstrating a buffering effect of regulatory capacity against the maladaptive dynamics of high RS (Ayduk et al., 2000) and low self-esteem (Gyurak, & Ayduk, 2007). Although the exact nature of the psychological functions of resting RSA is still unclear (e.g., Grossman & Taylor, 2007), there is growing convergence that RSA might be a marker of physiological and psychological regulatory capacity and flexible responding. Our results were consistent with this interpretation. Nevertheless, it is important to caution against a singular interpretation of RSA, because biological markers such as RSA are complex, multilevel, and interacting. The mere association of a biological marker with a given outcome does not imply causation nor necessarily indicate underlying mediators. Further research is necessary to establish causation, for example by experimentally manipulating RSA (i.e., with aerobic exercise regiment; Sandercock et al., 2005) or RSA feedback training (Lehrer et al., 1997; Nolan et al., 2005) which have been shown to improve it.

We also found that participants' self-reported ability to control their emotions during conflicts showed a pattern that paralleled their level of conflict hostility. That is, high RS individuals reported lower emotion control than low RS individuals if they were also low in RSA. However, RS was not related to emotion control among those high in RSA. Furthermore, mediation analysis showed these differences in emotion control mediated the buffering effect of high RSA against high RS individuals' heightened tendency to engage in conflict hostility.

However, because mediation models require that all variables be statistically related to one another and because in cross-sectional studies, direction of causality is ambiguous, the role of emotion control as the underlying mechanism that explains the joint effect of RSA and RS on hostile conflict behaviors needs to be interpreted with caution. In cross-sectional designs, differentiation of predictors from mediators must be guided by theory (Baron & Kenny, 1986). Consistent with the literature on aggression and self-regulation (e.g., Dodge, Bates, & Pettit, 1990), our theoretical assumption was that the ability to use reason to overcome the pull of negative emotions should precede the enactment of hostile behaviors. Moreover, we tried to limit inflating the expected relationship between these constructs by minimizing item overlap in their measurement. However, to the extent that people infer their underlying motivations and emotions by observing their own be-

havior (Bem, 1972), it is also plausible for hostile behavior to mediate the effect of RS and RSA interaction on emotion control. We therefore, also tested the reverse mediation with bootstrapping, and similar to the theoretically derived model reported in the results section, this model was statistically significant at $p < .05$. Although most existing theory and research on aggression is more consistent with our theoretically derived model, the reverse mediation is also consistent with the notion that relationship between emotion control and hostility may be highly dynamic, with each one feeding into the other.

Despite the clarity of the protective effect high RSA had among high RS people, other aspects of the findings require further discussion. Although RSA showed the expected positive relationship to emotion control among high RS individuals as we hypothesized, in correlation analysis, we did not find a significant relationship between RSA and emotion control in the whole sample. The same was true for conflict hostility. The lack of direct relationship between RSA and these outcomes may seem unexpected at first. However, Fabes and Eisenberg (1997) reported that high RSA's protective effects were only manifested during highly emotional situations. Thus, the protective effects of high RSA against conflict hostility might only be apparent among individuals for whom conflicts are particularly threatening and stressful. Similar findings have been reported in the broader literature on self-regulation. For example, aggressive children act aggressively when peers provoke or tease them, but not when they are approached positively in bids to play (Shoda, Mischel, & Wright, 1993; Wright & Mischel, 1987). Together these findings are consistent with the notion that the relationship between RSA and emotion control (and subsequent expressions of reactivity) may be complex, and emerge more clearly in person by situation interactions (Mischel & Shoda, 1995).

Another aspect of the findings that require further discussion is the marginally significant negative relationship between RSA and conflict hostility observed among low RS people. The pattern was similar for emotion control though statistically not significant ($p = .15$). Recently, Butler and colleagues (Butler et al., 2006) have shown that in healthy adult women, resting RSA was associated with greater (not lower) emotional reactivity to a documentary film about the bombing of Hiroshima and Nagasaki. Because feeling anger, sadness, and disgust, when it comes to such atrocities of war is an appropriate response, Butler and colleagues interpreted their finding in support of the notion that RSA levels are indicative of physiological flexibility in responding. Drawing from these findings, we speculate that RSA's positive relationship with conflict hostility in low RS individuals may reflect a similar flexibility in responding. We know from prior research that conflicts occur in low RS people's relationships as frequently as they do in high RS people's (Ayduk et al., 2003; Downey et al., 1998); however, conflicts do not negatively impact either low RS people's self-concept (Ayduk et al., 2008a) or their partners' satisfaction with the relationship (Downey et al., 1998) to the same degree as when they occur in the context of better functioning relationships. It can be argued therefore that, to a certain degree, expressions of hostility and letting go of emotions during conflicts in low RS people's well-functioning relationships may reflect greater engagement with the situation and serve a more adaptive function (e.g., standing one's ground, and articulating one's views and feelings) especially since overall level of hostility reported by low RS people was relatively low. Although necessarily post hoc, the possibility of RSA predicting reactivity in the opposite direction in low and high RS individuals is an intriguing possibility that should be investigated in greater depth in future research.

An additional aspect of the findings that require further discussion is the nonsignificant trend toward a positive relationship we observed between RS and RSA. The sample in the current study was drawn from a larger sample (Gyurak & Ayduk, 2007) and constituted those who were involved in an ongoing romantic relationship at the time of the study. In this larger sample, the correlation between RS and RSA $r(72) = -.01$, *ns*. We examined this relationship among those who were not involved in a romantic relationship ($n = 34$), RSA and RS were correlated with each other in the expected direction, $r(33) = -.32$, $p = .07$. Given that the RSA–RS relationship was in the opposite direction for the two groups, we tested formally whether the association between RS and RSA was moderated by relationship status. This analysis indeed yielded a significant RS $\times$ relationship status interaction, $t(70) = 2.45$, $p < .02$. We also ran complimentary analysis to explore whether RS and RSA in interaction predicted relationship status. Logistic regression analysis on relationship status (in a relationship vs. not in a relationship) indicated that RS and RSA jointly predicted whether participants were involved in a relationship or not ($\chi^2 = 4.81$, $p < .03$) with high RS participants' likelihood of being involved in a relationship increasing with their level of RSA. Because high RS individuals have difficulty establishing and maintaining long-term relationships (Downey et al., 1998), these findings suggest that high RSA among high RS individuals may be associated with overcoming these difficulties. To the extent that high RS people with higher levels of RSA are overrepresented among those who are involved, these findings also help explain the trend-level positive relationship between RS and RSA found in the current sample.

Caveats and Conclusions

As with any research, there are several possible potential areas of improvements that need to be addressed. First, we used retrospective self-reports to assess conflict behaviors and emotion control in conflict situations. It will be important for future research to further validate these self-report findings in the context of observational studies, for example using diary methodologies or laboratory-based conflict discussions.

Self-regulatory competency was assessed physiologically by measuring resting RSA derived from a continuous EKG signal recorded for 5 minutes. Although this measure is believed to capture RSA in resting situations, Grossman and colleagues (Grossman & Kollai, 1993; Grossman, Stemmler, & Meinhardt, 1990; Grossman & Taylor, 2007) argue that measuring respiratory rate and depth, in addition to EKG, is critical for correct RSA calculation, particularly during active states when there is a possibility of movement. However, several authors (Allen, Chambers, & Towers, 2007; Denver, Reed, & Porges, 2007) demonstrated high convergence between RSA measured with and without respiration during resting states, as in our design. Because our participants were stationary during collection of the 5-min resting baseline recording and were specifically instructed to relax during data collection, these concerns were minimized. Nonetheless, it will be important for future research to use paced breathing and to

simultaneously collect respiration signal as recommended by Grossman and colleagues (Grossman & Kollai, 1993; Grossman & Taylor, 2007; Grossman et al., 1990).

Although the relationship between individual differences in resting RSA and the amount of phasic RSA changes during emotion regulation is poorly understood, there is evidence both from children (e.g., Bazhenova, Plonskaia, & Porges, 2001; Calkins, 1997) and adults (Butler et al., 2006) suggesting that phasic changes in RSA reactivity during goal engagement may serve a similar regulatory function. The current study design cannot speak to this issue, and future studies that measure phasic RSA changes during conflict engagement are necessary to address it properly.

Taken together our findings present a dynamic picture of vulnerabilities and protection as correlates of high RS and low RSA. These results argue that dispositional vulnerability, such as high RS, is multiply determined by the confluence of interpersonal tendencies to overreact to perceived signs of rejection, and by self- and emotion-regulatory ability, as indexed by RSA. Furthermore, as it has been shown that resting RSA can be improved by behavioral interventions such as a physical exercise regimen (for review see Sandercock, Bromley, & Brodie, 2005) or biofeedback (Lehrer et al., 1997; Nolan et al., 2005), our results allude to the possibility that with targeted interventions that increase resting RSA, high RS and similar interpersonally problematic behavioral tendencies may be countered. Our findings raise an interesting starting point for intervention studies and offer a great deal of promise in alleviating the negative outcomes associated with high RS and other interpersonal vulnerabilities.

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