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BRIEF REPORT

Affective Reactivity, Resting Heart Rate Variability, and Marital Quality: A 10-Year Longitudinal Study of U.S. Adults

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Increasing evidence suggests that heightened affective reactivity to daily stressors has implications for mental and physical health, yet little is known about the long-term repercussions of day-to-day stress reactivity for marital quality. This study examined associations between affective reactivity and two indicators of marital well-being (marital satisfaction and marital risk) over a 10-year period. An additional aim was to investigate the potential role of resting high-frequency heart rate variability (HF-HRV), an index of cardiac vagal regulation, in moderating the association between affective reactivity and marital quality. These relationships were examined using data from 344 married adults in the Midlife in the United States (MIDUS II and III) study. Respondents completed daily telephone interviews and longitudinal reports of stressors, affect, and marital quality. HF-HRV was measured at rest. Greater affective reactivity to daily stressors predicted lower marital satisfaction and higher marital risk 10 years later. These associations remained after adjustments for potential confounders, including demographics, physical and behavioral factors, and psychological characteristics. In addition, HF-HRV moderated the associations between affective reactivity and marital quality. Results are consistent with a buffering effect, in which high levels of HF-HRV offset the inverse association between affective reactivity and marital quality.

Keywords: affective reactivity, heart rate variability, HF-HRV, marital quality

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A growing body of literature has used daily process designs to develop indices of affect regulation in the context of naturally occurring stressors. Bolger and Zuckerman (1995) defined *affective reactivity* with respect to individuals' within-person associations between daily stressors and mood. Following this definition, a highly reactive individual would have a strong positive relationship between daily stress and negative affect. Since Bolger and Zuckerman's (1995) seminal paper, interest in affective reactivity as a dynamic personality process variable has steadily increased. Notably, empirical work has demonstrated that increased affective reactivity is a unique vulnerability factor for subsequent affective disorders (Charles, Piazza, Mogle, Sliwinski, & Almeida, 2013), chronic health conditions (Piazza, Charles, Sliwinski, Mogle, & Almeida, 2013), impaired sleep (Ong et al., 2013), diminished well-being (Selcuk, Gunaydin, Ong, & Almeida, 2016), inflammation (Sin, Graham-Engeland, Ong, & Almeida, 2015), and even mortality (Stanton, Selcuk, Farrell, Slatcher, & Ong, 2019). Given the documented breadth of correlates, it is plausible that affective reactivity would be associated with marital outcomes as well.

The present study sought to fill several conceptual and empirical gaps in the literature on affective reactivity and well-being. First, to our knowledge, no studies have directly tested the prediction that affective reactivity to naturally occurring daily stressors predicts future marital quality. In their seminal vulnerability-stress-adaptation model of marriage, Karney and Bradbury (1995) argued that individual vulnerabilities (e.g., high affective reactivity) predict the longitudinal course of marriage. Spouses who are espe-

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cially reactive to external stressors may find it more difficult to engage in constructive relationship maintenance behaviors and risk experiencing a deterioration of marital satisfaction (Neff & Karney, 2017). Indirect evidence consistent with this prediction can be drawn from individual differences studies showing that those who use more adaptive stress management strategies report lower emotional reactivity (Gunaydin, Selcuk, & Ong, 2016), more positive appraisals of criticism from romantic partners (Klein, Renshaw, & Curby, 2016), and higher marital quality (Finkel, Slotter, Luchies, Walton, & Gross, 2013). Additional evidence from laboratory studies suggests that individuals who are able to downregulate negative affect and successfully disengage during conflictual interactions experience greater relationship satisfaction (Bloch, Haase, & Levenson, 2014; Salvatore, Kuo, Steele, Simpson, & Collins, 2011). Thus, although both theory and research have assumed that individuals' abilities to regulate affective responses to daily stressors should influence subsequent marital outcomes, this assumption has rarely been directly tested.

Second, existing research has not considered the possibility that individuals differ systematically in how much they are affected by daily stress processes. In recent years, resting *heart rate variability* (HRV), defined as the variation in the time interval between heartbeats at rest, has been posited as a promising index of behavioral flexibility (Appelhans & Luecken, 2006). Previous research has revealed that individual differences in resting HRV are affected by variations and changes in the quality of one's marriage (Donoho, Seeman, Sloan, & Crimmins, 2015; Smith et al., 2011) and may play a protective role in the links between stressor exposure, psychological distress, and physical health problems (Curtis, Fuller-Rowell, Hinnant, Kaeppler, & Doan, 2017; El-Sheikh, Harger, & Whitson, 2001; McLaughlin, Rith-Najarian, Dirks, & Sheridan, 2015). Moreover, reviews of the HRV literature suggest that high resting HRV may confer regulatory control of the autonomic nervous system via the parasympathetic vagus nerve, which is understood to play an essential role in regulating cardiac activity (Porges, 2007). Greater vagally mediated responding, as operationalized by HRV, is thought to allow for greater capacity to respond to physically and socioemotionally challenging situations (Balzarotti, Biassoni, Colombo, & Ciceri, 2017; Thayer, Hansen, Saus-Rose, & Johnsen, 2009). Thus, it is reasonable to suggest that resting HRV could alter or potentially buffer the effects of affective reactivity on marital quality.

To our knowledge, no studies to date have investigated resting HRV as a moderator of the link between affective reactivity to daily stressors and marital outcomes. However, there is supporting evidence to suggest that higher resting HRV is related to downregulation of negative affect (Fabes & Eisenberg, 1997; Sin, Sloan, McKinley, & Almeida, 2016; Sloan et al., 2017), more effective recruitment of calming and engagement coping strategies in negative emotional situations (Calkins, 1997; Geisler, Kubiak, Siewert, & Weber, 2013), and greater emotional control in response to interpersonal conflicts (Geisler & Schröder-Abé, 2015; Gyurak & Ayduk, 2008). Together, this research suggests that HRV is a resource that may afford individuals increased capacity for flexible parasympathetic responses to day-to-day challenges and hence may mitigate the effect of enduring vulnerabilities such as affective reactivity on marital well-being. Alternatively, affective reactivity may have enduring effects over time (Charles et al., 2013; Piazza et al., 2013) that are largely independent of resting levels of HRV. It thus remains an open question whether the effects of affective reactivity on marital outcomes are relatively fixed or moderated by key intrapersonal resources.

In the present study, we address two questions: First, does affective reactivity predict marital quality over time? Assessing marital quality is crucial to understanding how marriage confers lasting effects on physical health (Robles, Slatcher, Trombello, & McGinn, 2014). Historically, research on marital quality has focused on a single dimension of the marital relationship. Examining both positive and negative marital characteristics may aid in our understanding of the breadth and specificity of marital outcomes that are impacted by affective reactivity and HRV (Kiecolt-Glaser & Newton, 2001; Slatcher & Selcuk, 2017). Extending prior work demonstrating an association between affective reactivity and later health, we hypothesized that married individuals who experienced higher levels of affective reactivity (increases in negative affect in response to daily stressors) would evince lower levels of marital satisfaction and higher levels of marital risk a decade later. Second, is the effect of affective reactivity moderated by resting HRV? Although a number of studies have linked stress reactivity and negative emotional states to reduced resting HRV (Sin et al., 2016; Sloan et al., 2017), little attention has been given to the protective benefits of resting HRV on marital outcomes. Informed by research showing that resting high-frequency HRV (HF-HRV) plays a significant role in marital well-being (Donoho et al., 2015; Smith et al., 2011), we tested the hypothesis that high levels of resting HRV would offset the association between affective reactivity and marital quality.

Method

Sample and Procedures

Data for the current study came from the second and third waves of the Midlife in the United States (MIDUS) survey and the second wave of the National Study of Daily Experiences (NSDE). Participants from MIDUS II (2004–2006) were 4,963 noninstitutionalized, English-speaking adults aged 38 to 86 years. Of these, a random subsample of 2,022 was selected to participate in NSDE II (2004–2009), an 8-day diary study that assessed participants' affect and daily stressors. Of the 2,022 randomly selected participants, 1,001 agreed to participate in the MIDUS Biomarker Project, during which they were assessed for physical health and provided comprehensive biological assessments. We restrict our analyses to respondents who progressed through the MIDUS II, NSDE II, Biomarker Project, and MIDUS III (2013–2014).

We further limit the primary analyses to respondents who remained married to the same partner at both MIDUS waves and who had complete data on all variables ($n = 344$). We repeated our analyses using multiple imputation of missing data ($n = 413$). Participants with complete data did not differ from participants with missing data in terms of age, $t(411) = -1.50$, $p = .13$; income, $\chi^2(1, N = 402) = 0.56$, $p = .45$; HRV, $t(411) = -0.16$, $p = .87$; or affective reactivity, $t(411) = 0.77$, $p = .44$. Because the pattern of results did not differ between these two groups, analyses testing our main hypotheses were conducted on the sample with the most complete data. Of the 344 participants with complete data, 179 were women and 165 were men. The majority were White (95%) and ranged in age from 34 to 81 years old (M = 54.64, SD = 10.24).

All study procedures were reviewed and approved by the Education and Social/Behavioral Sciences and the Health Sciences Institutional Review Boards at the University of Wisconsin-Madison. Data and documentation for MIDUS are publicly available from the Interuniversity Consortium for Political and Social Research (https://www.icpsr.umich.edu/icpsrweb).

Measures

Daily stressors and affective reactivity. Daily stressors and negative affect were assessed each evening in NSDE II. Participants reported whether they experienced six different types of stressors: conflict, avoided conflict, stressor at work or school, stressor at home, discrimination, and network stressors (a stressful event that occurred in the participant's social network that affected the participant). Participants also reported the frequency of 14 negative emotions (restless or fidgety, nervous, worthless, so sad nothing could cheer you up, everything was an effort, hopeless, lonely, afraid, jittery, irritable, ashamed, upset, angry, and frustrated) using a 5-point scale ranging from 0 (*none of the time*) to 4 (*all of the time*). Affective reactivity to stress was defined as the difference in an individual's level of negative affect on stressor versus nonstressor days. Following procedures established in prior daily stress research (Charles et al., 2013; Piazza et al., 2013; Sin et al., 2015), affective reactivity scores were computed for each participant using a two-level multilevel model in which the occurrence of a daily stressor (yes/no) was entered as a predictor of negative affect on day d for person i:

Level 1 (day-level):

$$\text{Negative Affect}_{di} = a_{0i} + a_{1i}(\text{Stressor Day}_{di}) + e_{di}$$

Level 2 (person-level):

$$a_{0i} = \beta_{00} + u_{0j}$$

$$a_{1i} = \beta_{10} + u_{1j}$$

At Level 1, a_{0i} is the intercept representing negative affect on nonstressor days, a_{1i} is the slope representing person i's change in negative affect on stressor days, and e_{di} is the residual representing day-to-day variability in negative affect for person i. At Level 2, β_{00} and β_{10} represent the sample average levels of negative affect and negative affective reactivity, respectively, and u_{0j} and u_{1j} are the variances reflecting person i's deviations from the sample average levels of negative affect and negative affective reactivity. Each person therefore has unique regression parameters, representing their own relationship between stress and affect. For some people, reactivity coefficients will be larger and for others smaller, or even near zero. As an example, a person with a negative affect reactivity coefficient of 0.19 (the sample mean) had an increase of 0.19 (on a 0–4 scale) in negative affect on stress days compared with nonstress days. Deviation scores were outputted from the multilevel model to calculate each person's affective reactivity slopes. The slopes were subsequently entered as predictors of marital quality in linear regression models for the primary analyses.

Marital quality. Marital quality was assessed in MIDUS II and MIDUS III with a set of measures indicating marital satisfaction and marital risk. Global marital satisfaction was measured with a single item: How would you rate your marriage these days (0 = *worst*, 10 = *best*)? The measure of marital risk was composed of two items (coefficient alphas = .71 at MIDUS II and MIDUS III) assessing how often participants thought their relationship was in trouble over the preceding year (1 = *never*, 5 = *all the time*) and the chances that the participant and their partner would eventually separate (1 = *very likely*, 4 = *not at all likely*; reverse-scored). Ratings were summed across the two items, with higher scores indicating greater marital risk.

Resting HF-HRV. Measures of resting HF-HRV were collected in the Biomarker Project using an ECG recording obtained during an 11-min seated resting period. Power spectral density of HRV was calculated using the fast Fourier transform, with high-frequency spectral power classified between .15 and .4 Hz. The mean value of HF-HRV from the two baseline 300-s epochs was computed, with the last 60 s excluded from analysis. A detailed description of the Biomarker Project is provided elsewhere (Love, Seeman, Weinstein, & Ryff, 2010).

Covariates. Demographic factors, health behaviors, and psychological characteristics were included in models to account for potential confounds. Specifically, age, gender (Ref: female), race (White vs. non-White), household income (in quintiles), stressor frequency (% stressor days), body mass index (BMI; in kg/m^2, taken by clinic staff), self-reported number of chronic conditions, exercise (dichotomized as yes vs. no to engaging in regular exercise), and subjective sleep quality (1 = *very good*, 4 = *very bad*) were included in analyses as covariates. Three psychological characteristics (neuroticism, negative affect, and perceived stress) at MIDUS II were also included. Neuroticism was measured using a 4-item (moody, nervous, worrying, calm [reversed]; α = .74) adjective-rating scale (1 = *not at all*, 4 = *a lot*). Negative affect during the last 30 days was measured with 5 items (afraid, jittery, irritable, ashamed, upset; α = .80). Responses to the 5-point scale (1 = *all of the time*, 5 = *none of the time*) were reverse-coded such that higher scores indicated higher levels of negative affect. At the clinic visit for the biomarker assessment, perceived stress in the past month was measured using the 10-item (α = .86) Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983).

Results

Descriptive statistics for the sample are reported in Supplementary Table S1 in the online supplemental material. At baseline, our measures of marital quality were moderately correlated (r = −.46). Results of the regression analyses are displayed in Tables 1 and 2. The first model (Model 1) assessed the prospective association between affective reactivity and MIDUS III marital quality, adjusting for stressor frequency, HF-HRV, and MIDUS II marital quality scores. As hypothesized, greater affective reactivity was associated with higher marital risk (B = 2.07, 95% confidence interval [CI] [.66, 3.48], p = .004) and lower marital satisfaction (B = −2.14, 95% CI [−3.75, −.53], p = .009) a decade later. Importantly, the main effects were qualified by significant interactions between affective reactivity and HF-HRV (Model 2) in the prediction of marital risk (B = −1.54, 95% CI [−2.73, −0.35], p = .010) and marital satisfaction (B = 2.64, 95% CI [1.30, 3.98], p = .0001), respectively. Adding demographics (Model 3), physical health and behavioral covariates (Model 4), and psychological

Table 1
Coefficients From Models Predicting Marital Risk 10 Years Later

Variable B	Model 1 B [95% CI]	Model 2 B [95% CI]	Model 3 B [95% CI]	Model 4 B [95% CI]	Model 5 B [95% CI]
Baseline marital risk	.49*** [.35, .58]	.45*** [.33, .57]	.40*** [.29, .52]	.39*** [.27, .51]	.38*** [.26, .50]
Stressor frequency	.01 [−.61, .62]	.01 [−.60, .62]	−.09 [−.69, .51]	−.15 [−.76, .45]	−.28 [−.89, .33]
Affective reactivity	2.07** [.66, 3.48]	1.77* [.35, 3.19]	1.40* [.01, 2.80]	1.42* [.07, 2.72]	1.08 [−.41, 2.58]
HF-HRV	−.11† [−.22, .00]	−.12* [−.22, .00]	−.20*** [−.32, −.08]	−.20*** [−.32, −.08]	−.20*** [−.32, −.08]
Affective Reactivity × HF-HRV		−1.54* [−2.73, −.35]	−1.67** [−2.83, −.50]	−1.61** [−2.78, −.44]	−1.70** [−2.89, −.52]
Age			.02*** [−.04, −.01]	.02*** [−.04, −.01]	.03*** [−.04, −.01]
Female			−.01 [−.27, .24]	−.03 [−.30, .22]	−.04 [−.31, .23]
White race			.23 [−.35, .83]	.26 [−.34, .86]	.21 [−.38, .82]
Income quintile			−.13* [−.22, −.04]	−.13* [−.22, −.03]	−.11* [−.21, −.02]
Physical health					
BMI				.00 [−.01, .03]	.00 [−.02, .03]
Chronic conditions				.01 [−.05, .09]	.02 [−.05, .09]
Exercise				−.08 [−.42, .25]	−.11 [−.45, .22]
Sleep quality				.14 [−.07, .36]	.11 [−.10, .34]
Psychological characteristics					
Neuroticism					−.14 [−.43, .13]
Perceived stress					.03* [.00, .06]
Trait negative affect					−.09 [−.51, .31]
R^2	.19	.21	.26	.27	.28

Note. HF-HRV = high-frequency heart rate variability; CI = confidence interval; BMI = body mass index.
† $p = .05$. * $p < .05$. ** $p < .01$. *** $p < .001$.

characteristics (Model 5) did not alter these results. The final model accounted for 28% and 38% of the variance in marital risk and marital satisfaction scores, respectively.

Fitted interaction plots are presented in Figures 1 and 2. Simple slope analyses indicated that the association of affective reactivity and marital risk was significant and positive for participants with an HF-HRV level 1 *SD* below the mean ($b = 3.08$, 95% CI [1.27, 4.89], $p = .001$). In contrast, the association between affective reactivity and marital risk was not significant for participants with a HF-HRV level 1 *SD* above the mean ($b = -0.91$, 95% CI [−3.16, 1.34], $p = .43$; see Figure 1). Supplementary analyses revealed that the interactions between affective reactivity and HF-HRV were not moderated by demographic factors (see Supplementary Note S1 in the online supplemental material). The Johnson-Neyman analysis identified the region of significance for the association between affective reactivity and marital risk as including individuals scoring below −0.22 on Z-scored HF-HRV, which was equivalent to the bottom 43.0% of HF-HRV values in this sample. Likewise, estimates of simple slopes showed that higher affective reactivity was associated with lower subsequent marital satisfaction for participants at 1 *SD* below the mean in HF-HRV ($b = -4.49$, 95% CI [−6.55, −2.43], $p = .0001$) but not

Table 2
Coefficients From Models Predicting Marital Satisfaction 10 Years Later

Variable	Model 1 B [95% CI]	Model 2 B [95% CI]	Model 3 B [95% CI]	Model 4 B [95% CI]	Model 5 B [95% CI]
Baseline marital satisfaction	.61*** [.51, .72]	.59*** [.48, .70]	.55*** [.44, .66]	.55*** [.44, .66]	.55*** [.44, .66]
Stressor frequency	−.39 [−1.10, .30]	−.40 [−1.09, .28]	−.30 [−.98, .38]	−.29 [−.98, .40]	−.15 [−.85, 54]
Affective reactivity	−2.14** [−3.75, −.53]	−1.63* [−3.23, −.03]	1.58* [−2.98, −.18]	1.49* [−2.99, −.19]	1.12 [−2.83, .57]
HF-HRV	.06 [−.06, .19]	.06 [−.05, .19]	.15* [.01, .29]	.15* [.01, .29]	.15* [.01, .29]
Affective Reactivity × HF-HRV		2.64*** [1.30, 3.98]	2.77*** [1.45, 4.09]	2.79*** [1.45, 4.13]	2.87*** [1.52, 4.22]
Age			.02* [.00, .04]	.02* [.00, .04]	.02* [.00, .04]
Female			−.25 [−.55, .04]	−.24 [−.55, .05]	−.21 [−.55, .08]
White race			−.51 [−1.19, .16]	−.51 [−1.19, .18]	−.44 [−1.13, .24]
Income quintile			.11* [.01, .22]	.11* [.00, .22]	.10† [−.00, −21]
Physical health					
BMI				.00 [−.02, .03]	.00 [−.02, .03]
Chronic conditions				−.01 [−.10, .06]	−.02 [−.11, .06]
Exercise				−.01 [−.39, .37]	.02 [−.35, .41]
Sleep quality				.00 [−.24, .25]	.03 [−.21, .29]
Psychological characteristics					
Neuroticism					.04 [−.27, .37]
Perceived stress					−.04* [−.07, −.01]
Trait negative affect					.32 [−.14, .79]
R^2	.31	.34	.37	.37	.38

Note. HF-HRV = high-frequency heart rate variability; CI = confidence interval; BMI = body mass index.
† $p = .05$. * $p < .05$. ** $p < .01$. *** $p < .001$.

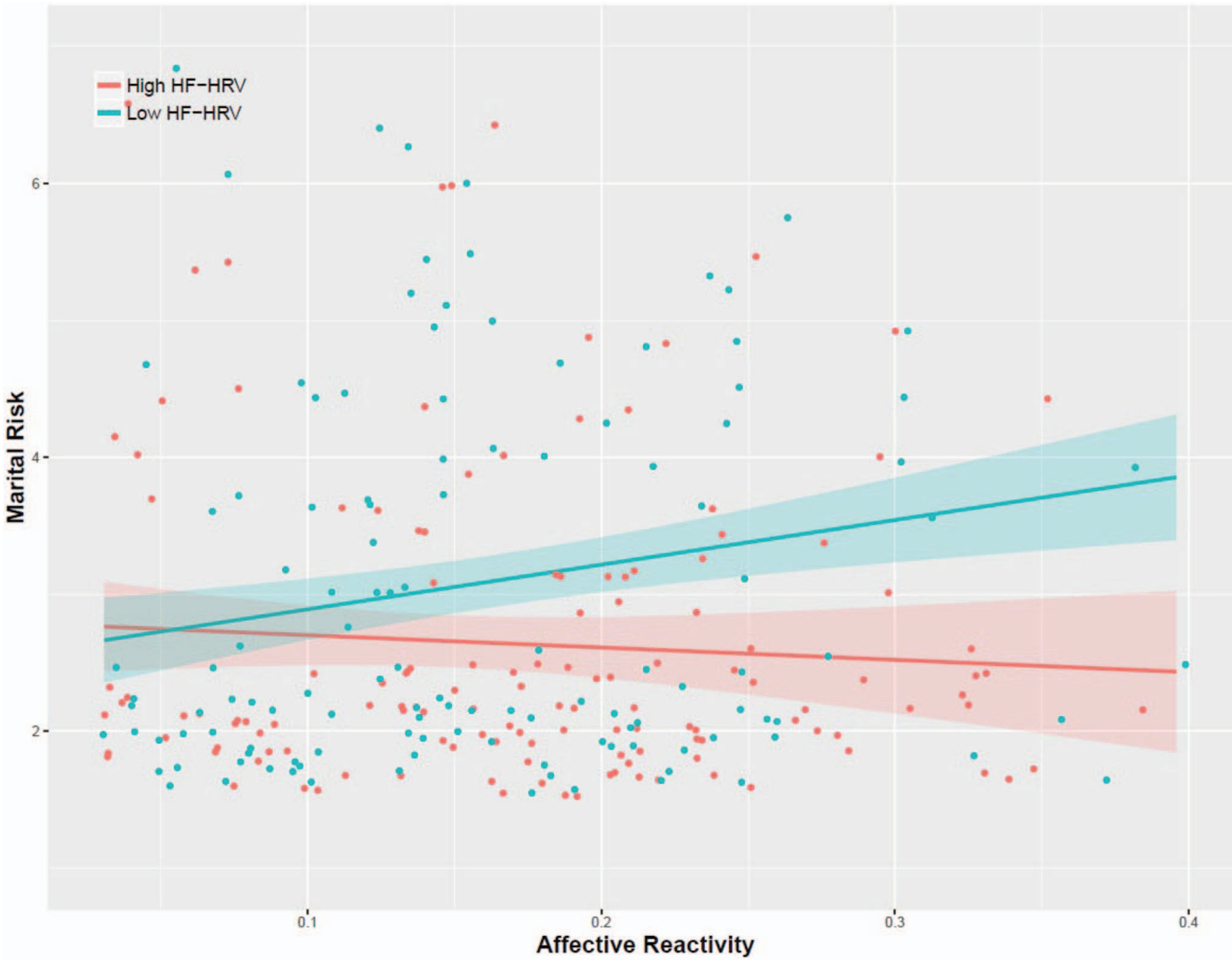

Figure 1. Association between affective reactivity and marital risk at low (−1 *SD*) and high (+1 *SD*) levels of high-frequency heart rate variability (HF-HRV), with 95% confidence bands shown in color. See the online article for the color version of this figure.

for those at 1 *SD* above the mean in HF-HRV ($b = 2.24$, 95% CI [−0.32, 4.79], $p = .09$; see Figure 2). The region of significance for the association between affective reactivity and marital satisfaction included values of −0.18 or lower on HF-HRV (Z-scored), which was equivalent to the bottom 43.8% of HF-HRV values in this sample. We also report the region of significance on affectivity reactivity (see Roisman et al., 2012 for a discussion), which reveals the range of affective reactivity values for which HF-HRV is significantly associated with marital outcomes (see Supplementary Note S2 in the online supplemental material).

Discussion

This study is among the first to examine prospective associations between daily affective reactivity and marital quality. Higher levels of affective reactivity to daily stressors were associated with greater declines in marital satisfaction and increases in marital risk over a 10-year follow-up. Associations remained while adjusting for a range of potential confounders. These findings add to the robust literature on daily stress processes and well-being (Charles et al., 2013; Stanton et al., 2019) by demonstrating that heightened affective reactivity may also forecast deterioration in marital quality over time. To our knowledge, this study is the first to report an interaction between affective reactivity and HF-HRV in the marital quality literature. The results indicated that increased affective reactivity predicted higher marital risk and lower marital satisfaction but only among individuals low in resting levels of HF-HRV. These results are consistent with an emerging literature suggesting that vagally mediated HRV can act as a buffer against the detrimental effects of stress on mental and physical health (Curtis et al., 2017; El-Sheikh et al., 2001; McLaughlin et al., 2015).

Future research should replicate these findings by adopting dyadic designs that afford insight into the extent to which the observed results reflect stable intrapersonal characteristics, dynamic interpersonal processes, or a combination of these phenomena (Diamond, Hicks, & Otter-Henderson, 2011; Randall & Bodenmann, 2009). In addition, our data do not speak to the

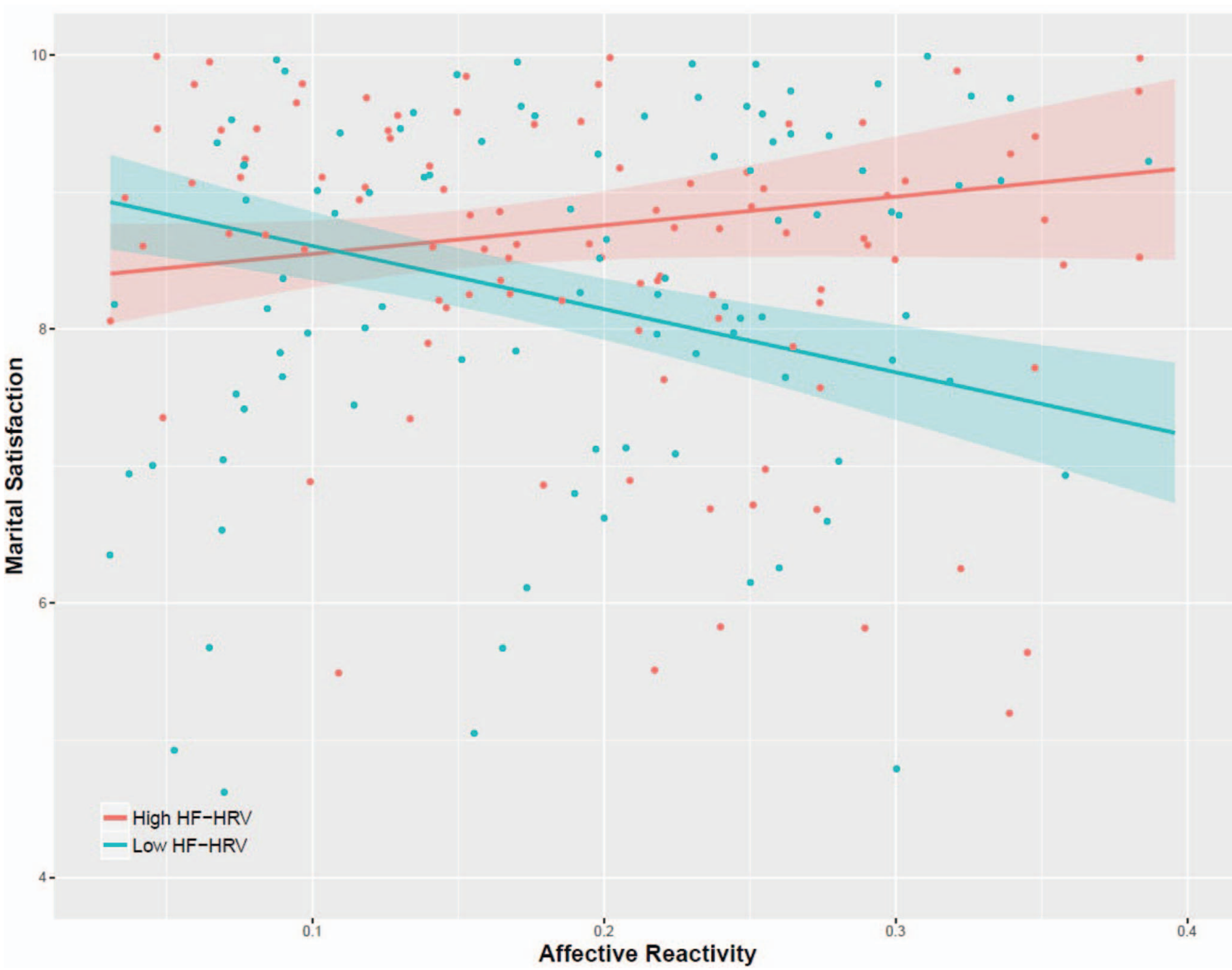

Figure 2. Association between affective reactivity and marital satisfaction at low (−1 *SD*) and high (+1 *SD*) levels of high-frequency heart rate variability (HF-HRV), with 95% confidence bands shown in color. See the online article for the color version of this figure.

underlying mechanisms. Affective reactivity may act to disrupt restorative processes like sleep (Ong et al., 2013), which, in turn, may be linked to marital quality (Hasler & Troxel, 2010). Alternatively, it may be that interpersonal factors such as marital quality are among the key mediating pathways linking affective reactivity to downstream physical health outcomes. Negative aspects of marriage (e.g., conflict, hostility) are known to increase risk for subsequent health problems (Robles et al., 2014; Slatcher & Selcuk, 2017). These hypothesized processes have yet to be empirically investigated. Finally, our analyses focused on resting HF-HRV as a moderator of the link between affective reactivity and marital quality; however, future work would benefit from including other indices of cardiac vagal regulation (e.g., HF-HRV responses to stressor tasks). Despite these limitations, this study contributes to the existing literature, as it is the first to use a prospective design and nationally representative sample to examine the direct and moderating effects of affective reactivity and resting HF-HRV on marital quality.

Conclusion

The present findings advance understanding of the ways in which long-term marital outcomes are a joint consequence of individual vulnerabilities and strengths. Our results support the notion that affective reactivity may be an enduring vulnerability factor that can shape marital processes over time. However, we also found that resting HF-HRV may be a resource that serves as a buffer against excessive affective reactivity to daily stressors. While statistically modest (see Supplementary Note S3 in the online supplemental material for a discussion of effect size computation), the observed interaction effects were not trivial, especially given that the dependent measures were assessed approximately 10 years after the assessment of HF-HRV and affective reactivity. Overall, these findings show how distinct indicators of emotion regulation capacity may interact to shape marital satisfaction and risk over time. Future research should focus on developing intervention programs aimed at improving and sustaining emotion regulation skills of married individuals under stress.

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