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Preliminary Evidence of Attenuated Blood Pressure Reactivity to Acute Stress in Adults Following a Recent Marital Separation

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Abstract

OBJECTIVE: This study explores cardiovascular reactivity during an acute-stress task in a sample of recently separated adults.

DESIGN: In a cross-sectional design, we examined the association between adults' subjective separation-related distress and changes in heart rate and blood pressure across the acute-stress laboratory paradigm in a sample of 133 ($n = 49$ men) recently separated adults.

MAIN OUTCOME MEASURES: Heart rate (HR) and Blood pressure (BP) were recorded across a resting baseline period, a math stressor task, and a recovery period.

RESULTS: Multilevel analyses revealed that adults who reported greater separation-related distress exhibited higher initial BP and a slower linear increase in BP across the study period. In addition, adults reporting greater separation-related distress evidenced significantly slower declines in diastolic blood pressure (DBP) following the acute stress task. HR reactivity was not moderated by separation-related distress.

CONCLUSIONS: In recently separated adults, preliminary evidence suggests that the context of the stressors may reveal differential patterns of problematic reactivity (exaggerated or blunted responding). Greater emotional intrusion and hyperactivity symptoms may index increased risk for blunted cardiovascular reactivity to general stressors. This pattern of reactivity is consistent with models of allostatic load that emphasise the deleterious effect of *hyporesponsivity* to environmental demands.

Keywords

Marital separation; divorce; blunted cardiovascular reactivity; blood pressure; health outcomes

Roughly 40% of first marriages in the United States end in divorce and approximately 2.5 million adults experience marriage dissolution each year (Kreider & Ellis, 2011; Arias, 2007). Despite the fact that rates have remained stable over the past few decades, divorce continues to be a common and stressful life event that is associated with declines in both mental and physical health (Amato, 2010). The combination of high prevalence and increased risk for negative, stress-induced consequences makes divorce an important topic for psychological investigation; illuminating causal—or, potentially causal— pathways

between marital dissolution and negative health outcomes is of considerable public health importance (see Sbarra, Hasselmo, & Bourassa, 2015).

Although divorce is often rated as a highly stressful life event, it does not necessarily lead to poor outcomes for all adults. Demographic variables, including age, personality, gender, and premorbid functioning moderate the relationship between marital termination and health (Sbarra, Law, Lee, & Mason, 2009; Mason & Sbarra, 2012; Shor, Roelfs, Bugyi & Schwartz, 2012). The body of evidence in this area suggests that divorce confers risk of maladjustment for only a subset of adults and the majority of people are resilient following relationship termination (Amato, 2010; Sbarra et al., 2015). Importantly, people at greatest risk evidence poor outcomes across a range of functioning, including impaired immune (Kiecolt-Glaser et al., 1987) and neuroendocrine responses (Powell et al., 2002), as well as risk for a range of poor physical health outcomes (Sbarra & Coan, 2017). Divorce is associated with increased risk for contracting disease, as well as poor outcomes for those already health-compromised (Bjorkestam, Hallqvist, Dalman & Ljung, 2013; Floud et al., 2014). Further, recent meta-analyses reflecting a median of 6.5 years of follow-up data indicate that divorced or separated adults, on average, are at a 20–30% increased risk for early death when compared to married adults (Shor et al., 2012; Sbarra et al., 2011). Correlational data clearly demonstrate an inverse relationship between divorce and health; however, less is known about the physiological mechanisms that mediate this association and may explain long-term health endpoints.

Stress-related cardiovascular reactivity (CVR) is one proposed mechanism that may explain the association between divorce and poor health outcomes. The reactivity hypothesis stipulates that heightened CVR in the face of stressors increases risk for the development of cardiovascular disease such as hypertension, atherosclerosis, and other cardiovascular pathology (Carrol et al., 2001; Barnett et al., 1997 Triber et al., 2003; Chida & Steptoe, 2010). Consistent with this model, adults who are high in attachment anxiety, which is associated with risk of poor adjustment following divorce, tend to use physiologically *hyperactivating* coping strategies to regulate emotion (Lee, Sbarra, Mason & Law, 2011), which in turn is associated with increased blood pressure responses when people are prompted to think about their separation. Similarly, individual differences in heart rate variability, as indexed by respiratory sinus arrhythmia, moderated a prospective, positive association between baseline scores of separation-related distress and blood pressure reactivity several months later in a sample of recently separated and divorced adults (Bourassa, Hasselmo, & Sbarra, 2016).

Although considerable evidence suggests excessive CVR is associated with negative outcomes, there is a growing body of literature suggesting that the true nature of the relationship between reactivity and negative outcome is curvilinear; both heightened *and* blunted reactivity to stress is associated with poor prognostic effects (Phillips, Ginty, & Hughes, 2013). Attenuated physiological reactions to stressors are observed in adults with depression, obesity, substance abuse, and personality traits associated with adverse health outcomes such as neuroticism (Phillips, 2011; Phillips et al., 2013 Salomon, Clift, Karlsottir & Rottenberg, 2009; Schwerdtfeger & Rosenkaimer, 2011). There is some evidence that attenuated reactivity is also observed in adults who perceive their lives as stressful but are

otherwise free of pathology. Ginty and Conklin (2011), for example, examined the association between perceived stress and cardiovascular reactivity during a laboratory stressor. Adults who perceived their lives as highly stressful had blunted reactivity during a math stressor relative to adults who reported moderate to low levels of perceived life stress, indicating that the perception of stress may have negative prognostic effects in otherwise healthy adults. For adults experiencing separation and divorce, it is plausible that high levels of separation-related distress may, like other life stressors (e.g. depression, obesity, perceived life stress), be associated with differential physiological responses across different contexts (e.g. a separation- stress task vs. a generalised laboratory stress task).

In the general stress and coping literature, many studies of distressed adults show evidence of heightened cardiovascular reactivity, whereas others find evidence of blunted cardiovascular reactivity, to a range of general stressors (Allen, Bocek, & Burch, 2011; Carroll, Phillips, Hunt, & Dur, 2007; Carroll et al., 2001; Chida & Steptoe, 2010). In the separation and divorce literature, current evidence documents strong relations between heightened CVR in response to *separation-specific laboratory stressors* and a variety of individual differences, including attachment anxiety, resting respiratory sinus arrhythmia, and perceived separation-related distress (Bourassa et al., 2016; Lee et al., 2011; Sbarra et al., 2009). The current study extends this literature by exploring the emotional impact of relationship termination on physiological reactivity in a *general, acute-stress laboratory paradigm*. This extension is a crucial addition as it tracks stress sensitivity more generally in adults following marital separation. It may be that separation/divorce-specific stressors equivalently probe stress responses in adults who experience acute distress only when reminded of their separation and in adults experiencing a more global difficulty regulating stress in daily activities. Exploring the effects of a general, acute-stress paradigm improves our ability to differentiate these two patterns that may have differential long-term implications for health. Further, we believe the use of this general paradigm improves the external validity of a separation-related stress effect on health, as these adults are likely to encounter a greater number of general stressors relative to separation/divorce-specific stressors in daily life. Based on previous literature examining normative physiological reactions to acute laboratory stressors (Dickerson & Kemeny, 2004; Kirschbaum, Pirke, & Hellhammer, 1993; Rutledge, Linden, & Paul, 2000), we expected to observe a curvilinear relationship between adults' physiological reactivity and time. We hypothesized [H1] that separation-related distress would be associated with adults' physiological responses, but we were agnostic about the direction of this association. Evidence from the separation-specific and general CVR literatures would suggest heightened reactivity; other work reviewed above, however, suggests we might expect blunted responses. Therefore, we made no a priori predictions about the direction of the association between separation-related distress and physiological reactivity as measured by heart rate (HR) and blood pressure (BP) in our general, acute stress task.

Method

Participants

Participants were 133 community dwelling adults ($n = 49$ men), recruited via newspaper advertisements, divorce recovery support groups, and conciliation court. On average, participants were 40.7 years old (standard deviation (SD) = 9.8), were in romantic relationships for 13.6 years ($SD = 8.3$ years), and had been separated from their partner for 3.8 months ($SD = 1.9$ months). The majority, 75.4%, of participants self-identified as white, with 13% Hispanic, 1.4% Asian, 1.4% African American and the remainder choosing not to self-identify ethnicity. The majority of participants (53%) reported making <\$30,000 annually.

Procedure

Details of the procedures are described elsewhere (see Sbarra et al., 2009; Sbarra & Borelli, 2013). Recently separated adults were recruited to participate in a study with the stated purpose of investigating ‘how adults adjust to marital separation and the ways in which your body responds when you think about and reflect on your separation experience’. Interested participants were screened across several domains to determine eligibility. Interested participants who were younger than 60 years of age with self-reported good health (i.e. no history of hypertension or uncontrolled medical conditions within the previous three months) were deemed eligible to participate. Exclusionary criteria included: current pregnancy, history of psychotic or manic symptoms, history substance abuse or dependence within the previous four months, active suicidal ideation, and any condition that would impede one’s ability to give informed consent or travel to the laboratory.

Participants were mailed a baseline questionnaire and were asked to refrain from caffeine and tobacco products at least 4 hours prior to the laboratory visit. Laboratory visits were scheduled at all times of the day to accommodate participants’ work schedules and childcare availability. During the laboratory visit, participants first participated in a stream-of-consciousness task which asked them to reflect on their separation experience, and then speak continuously about their marriage and separation history for four minutes. Next, participants were seated in a physiological measurement chamber that included one speaker and two video cameras to allow participants to communicate with a research assistant in the next room. After equipment set-up, participants watched a 4-minute nature video, and then engaged in a 5-minute serial subtraction math stressor task followed by a 3-minute recovery period (see Cacioppo et al., 1995). The last two minutes of the nature video served as the baseline period and BP responses across the ten-minute study period constituted the primary outcomes for the current analysis. The serial subtraction task was designed to maintain a high degree of difficulty and task engagement as a function of participants’ mental math acumen. All participants began with a minuend of 297 and a subtrahend of 3 for the first minute; each minute, the minuend changed based on participants’ correct responses. For example, if participants correctly answered between 25–36 responses in minute 1, the minuend in minute 2 shifted to 688 with a subtrahend of 8. A research assistant probed the participant to go faster during minutes 3, 4, and 5 of the serial subtraction task to increase the level of stress.

Measures

Impact of events scale revised (IES-R)—The Impact of Events Scale-Revised (IES-R; Creamer, Bell & Failla, 2003) is a commonly used 22-item questionnaire that assesses emotional reactions to stressful events across three constructs typically associated with, but not specific to, posttraumatic stress disorder (PTSD). The combined emotional intrusion and hyper-arousal subscale was used for the present study (e.g., ‘Any reminders brought back feelings about it;’ ‘I was jumpy and easily startled;’ and ‘Reminders of it caused me to have physical reactions, such as sweating, trouble breathing, nausea, or a pounding heart’). Higher scores reflected greater self-reported emotional intrusion and somatic hyper-arousal in relation to participants’ separation experience. In the present study, the IES-R showed strong internal consistency ($\alpha = 0.93$).

Heart Rate (HR)—Heart rate data were collected using the Biopac MP100 system and electrocardiograph (ECG) amplifier. Signals were recorded using a standard lead configuration, including the right clavicle and pre-cordial site V6, using EL505Ag/AgCl electrodes (Biopac Technologies, Santa Barbara, CA). ECG signals were digitized at 1000 samples per second and amplified using a Biopac 100C system with a gain of 1000. Signals were stored on a computer running Biopac’s Acqknowledge physiological data acquisition software (see Sbarra and Borelli, 2013). Heart rate was calculated as the arithmetic mean beats per minute across 1-minute epochs.

Blood Pressure (BP)—Blood pressure was assessed using a non-invasive tonometry device (Vasotrac AMP 205, Medware Inc., Arden Hills, Minnesota) over the radial artery to provide frequent, real-time updates of systolic and diastolic BP (SBP and DBP, respective). The tonometry device was placed on participants’ non-dominant arm, and participants placed their arm on a table in front of them during the physiological measurement portion of the laboratory visit. BP data were analysed using post processing software (BP 2.6, Mindware Technology, Westerville, Ohio). Minute-by-minute means were calculated for SBP and DBP across the main study periods. The current analyses focus on ten minutes, which is comprised of the final two minutes of the resting baseline period, five minutes of math stressor and three minutes of recovery.

Covariates—The potential influence of demographic and health status variables on BP was accounted for by the inclusion of participants’ sex, age, tobacco use, exercise frequency, body mass index, status as initiator or non-initiator of the separation, scores on the Beck Depression Inventory (BDI; Beck, Steer, & Garbin, 1998), history of high blood pressure, and relationship length (prior to the separation) in all models.

Data Analysis

Data were analysed using the linear and nonlinear mixed effects (nlme) modelling package in R (Pinheiro, Bates, DebRoy & Sarkar, 2012). This method accounts for the nonindependence of time-varying data nested within individuals and permits the modelling of linear and non-linear trends. This method also accounts for initial levels of the outcome variable when modelling linear and quadric trends across time. To capture changes in physiological responses and the interaction between physiological responses and separation-

related distress, time was treated as a level-1 variable, IES-R and covariates were treated as level-2 variables, and physiological measures were specified as outcome variables with 10 (1-minute averaged) observations across the study period.

Results

Figure 1 illustrates the pattern of HR, SBP and DBP, respectively, across 10 minutes of the study. The models examined change in HR and BP across baseline, math stressor, and recovery study periods, while accounting for relevant covariates and score on IES-R. Prior to full model specification, we compared a series of unconditional growth models to examine linear change and curvilinear change over time for HR, SBP and DBP. Model comparisons revealed significantly better fit for those models that specified both linear and quadratic effects of time ($p < .01$).

After determining the functional form of the data, we ran full multilevel models examining the interaction between IES-R and linear and quadratic change in HR over time. We observed significant main effects of linear ($b = 2.81, p < .001$) and quadratic ($b = -0.33, p < 0.001$) time. There was no significant main effect of IES-R ($b = -2.02, p = .16$) suggesting separation-related distress did not impact baseline measures of HR. The interaction terms IES-R $\times$ time and IES-R $\times$ time² were not significant.

Next, we examined the interaction between IES-R and linear and quadratic change in BP over time. As shown in Table 1, we observed a significant effect of IES-R scores on the SBP intercept, such that adults who reported higher scores on the IES-R started the serial subtraction lab stressor task with higher baseline values of SBP ($b = 6.69, p = .01$), as compared to individuals who reported lower scores on the IES-R. This finding may reflect that adults with higher IES-R scores entered the study with elevated SBP or exhibited a stronger physiological reaction to the prior stream-of-consciousness task, relative to individuals who reported lower separation-related distress. Above and beyond these observed baseline differences, the average systematic increase in SBP was 4.45 mm HG per minute across the math task. The observed increase in SBP amounted to a large effect size (within-person $d = .52$) from baseline to peak SBP at minute 3 of the math task. These linear changes were offset by a significant quadratic effect of time ($b = -0.60, p < .001$) suggesting that, on average, adults' SBP slowed across the time period at a rate of .60 mmHG per minute. The linear increase in SBP over time was moderated by scores on the IES-R such that those with higher scores on the IES-R demonstrated a *slower* linear increase across the assessment period, as compared to adults with lower scores on the IES-R ($b = -1.73, p = .03$).

We observed a similar effect for DBP, a significant intercept effect for the IES-R, indicating that higher scores on this measure were associated with higher initial DBP values ($b = 5.32, p = .01$). Participants who reported higher scores on the IES-R started the lab stressor task with higher baseline values of DBP, as compared to individuals who reported lower scores on the IES-R. Above and beyond these observed baseline differences, the average systematic increase in DBP over time was 2.87 mm HG per minute. The observed increase in DBP amounted to a medium effect size (within-person $d = .30$) from baseline to peak DBP at

minute 2 of the math task. The linear increase in DBP was moderated by scores on the IES-R such that, like SBP, those with higher scores on the IES-R demonstrated a slower linear increase across the assessment period as compared to adults with lower scores on the IES-R ($b = -1.69, p < .001$). The overall linear change was offset by a significant quadratic effect of time ($b = -0.41, p < .001$) suggesting that, on average, adults DBP slowed across the time period at a rate of 0.41 mm HG per minute. This slowing was also moderated by scores on the IES-R such that those high on the IES-R showed decreased rates of slowing and subsequent recovery across the assessment period as compared to adults with low scores on the IES-R ($b = .19, p = 0.01$).

Discussion

The current study examined blood pressure and heart rate reactivity of recently separated adults in the context of a standardised, acute stress math task. Consistent with a prior report from this sample (using a different laboratory task), we observed that adults reporting greater separation-related distress evidenced higher blood pressure levels at the start of the acute-stress math task (see Sbarra et al., 2009). Accounting for these individual differences, we observed curvilinear reactivity to the stress task, and this effect differed as a function of subjective, separation-related distress. Adults who reported greater separation-related distress showed a less rapid increase in both SBP and DBP across the laboratory stressor. Additionally, these participants also exhibited slower DBP recovery, as compared to adults reporting less separation-related distress. Thus, adults who endorsed greater separation-related distress displayed a blunted pattern of blood pressure reactivity to the math stressor, as well as a slower rate of recovery for DBP. This conditional effect of separation-related distress on reactivity was not reflected in adults' HR during the math task. This is the first study to examine separated and divorcing adults' responses to an acute laboratory challenge task that is *not* specific to their separation, and, to our knowledge, this report is also the first to document slower DBP recovery among participants reporting more emotional intrusion and hyperarousal following their separation.

This finding is of particular clinical interest given the large body of literature linking physiological responses to acute stressors and distal prognostic outcomes (e.g., Barnett et al., 1997; Cohen, Janicki-Deverts, & Miller, 2007; Phillips et al., 2013). Although adults reporting recent marital separation are likely to experience reminders of their relationship (e.g. on-going litigation, custody exchanges, and shifts in social networks; Sbarra et al., 2011), the majority of their time is likely spent dealing with common, day-to-day stressors. As such, adults with poorer adjustment to marital separation may be experiencing maladaptive physiological responses to both marital-specific stressors (Sbarra et al., 2009) and general life stressors, a pattern, that if sustained over time, would place them at increased risk for poor health outcomes.

Although adults reporting higher separation-related distress exhibited slowed increases in both SBP and DBP across the laboratory stressor, this effect must be understood in light of the significant intercept effect—i.e., adults reporting higher separation-related distress evidence higher BP levels at the onset of the physiological portion of the study. Given the significant difference in intercepts, what may look like blunted reactivity to a generalised

stressor may actually be a carry-over effect from the initial stream-of-consciousness task (in which participants were asked to reflect on their separation experience) occurring earlier in the study, prior to the physiological assessment. In fact, adults reporting higher separation-related distress rated the stream-of-consciousness task as more stressful than their less distressed counterparts ($b = .55$, $S.E. = .38$, $p < .001$). Although we did not have physiological measures of distress during the stream-of-consciousness task, the significant association between subjective ratings of distress following the stream-of-consciousness task and separation-related-distress suggests adults reporting high levels of separation-related distress may have also exhibited a strong physiological reaction to the stream-of-consciousness task and, potentially, had not returned to baseline prior to commencing the acute stress paradigm. The possibility of this type of carry-over effect is intriguing, and to our knowledge, not yet reported in the literature.

The significant BP effects also have to be considered in light of the null HR results. One possible explanation for this null HR effect is that participants completed a paced breathing task as part of the baseline physiological measurement period. As such, participant's HR may have slowed as a result of the paced breathing task while their BP may have remained elevated from the stream-of-consciousness task. This observed discrepancy is in line with previous studies that have reported discrepant BP and HR findings within the context of a laboratory stressor (Salomon et al., 2009). One possible physiological explanation of this discrepancy is that HR is under both sympathetic and parasympathetic control and responds almost immediately to parasympathetic influence, such as a paced breathing task (Levy, Yang, & Wallick, 1993). It should be noted the interaction effect of IES by time for SBP and DBP and IES by time² for DBP remained statistically significant after adding HR as a covariate to the overall model (see Table 1).

An alternative explanation is that the significant difference in intercepts captures a chronic dysregulation in the stress-response system for highly-distressed participants, which is consistent with conceptual models of allostatic load (McEwen & Stellar, 1993; McEwen, 1998). In general, the way adults perceive stressful life events affects their ability to habituate to subsequent stressors. Most adults, in the face of a stressful event, mount an adaptive allostatic response wherein the body activates the sympathetic nervous system and hypothalamic-pituitary-adrenal (HPA) axis to prepare the body to combat the stressor. Removal of the stressor returns the system to baseline. However, if the allostatic response remains active, or if the inactivation is inefficient, it is associated with a variety of negative health outcomes including declines in cognitive and physical functioning and increased risk for cardiovascular disease (Karlamanla, Singer, McEwen, Rowe & Seeman, 2002; Seeman, Singer, Rowe, Horwitz & McEwen, 1997). As described by McEwen (1998), failure to mount an adaptive response in the face of a stressor is one dimension of allostatic load and consistent with the blunted BP findings observed among highly-distressed adults. Although the majority of adults exhibit resilience following divorce (Sbarra et al., 2015), blunted responding to acute stressors may be one way in which the emotional distress of marital separation becomes health relevant. In the current study, adults endorsing high levels of separation-related distress may have entered into the study with relatively high levels of tonic blood pressure, resulting in an overall observable pattern of blunted blood pressure reactivity during the math stressor task. This pattern may in actuality represent a ceiling

effect, as their stress-response system was already activated from a prior task and therefore lacked the physiological resources to exhibit a reaction to the stressor.

Unfortunately, the absence of a true baseline measurement of blood pressure in the current study precluded us from determining if the relationship between blunted cardiovascular reactivity and separation-related distress is a product of generally elevated blood pressure (e.g., presence of allostatic load) or, alternatively, heightened blood pressure in response to the stream-of-consciousness task occurring prior to physiological measurement. This would be an ideal addition for future studies on this topic.

Independent of the BP effects at baseline, we also observed that separation-related distress interacted with time to predict DBP recovery; in particular, people reporting greater emotional difficulty around their separation evidenced *slower* recovery to the acute math stressor task. This finding is particularly relevant in light of a recent meta-analysis which found that poor recovery from laboratory stressors, both physical and psychological, is predictive of detrimental cardiovascular outcomes (Panaite, Salomon, Jin, & Rottenberg, 2015). Investigation of CV recovery is increasingly recognised as an integral component to elucidating comprehensive health-relevant effects of acute stressors, as it independently and additively predicts variance in health outcomes, relative to CV reactivity (Panaite, et al., 2015; Chida & Steptoe, 2010; Moseley & Linden, 2006). Moreover, some argue that the duration of the stress-response system activation may be a stronger predictor of poor health consequences than the magnitude of reactivity to stressors (Glynn, Christenfeld, & Gerin, 2002; McEwen & Stellar, 1993).

It should be noted that although the quadratic effect of time was not found to significantly predict SBP recovery as a function of separation-related distress, the direction of this effect was congruent with the significant DBP recovery effect ($d = .17$, $d = .19$; SBP and DBP, respectively)

The current findings should be considered in light of several limitations. First, the study design did not allow for a true measure of baseline BP. As previously stated, prior to physiological hook-up, participants completed a 4-minute stream-of-consciousness (SOC) task during which they were asked to bring up mental images of their former partner and verbally reflect on their separation experience. Thus, physiological measures were not recorded during the SOC task, limiting our ability to tease apart the potential impact of reactivity during SOC on the current analyses. Inclusion of a true measure of baseline blood pressure in future studies will allow more precise conclusions about the influence of confounding variables on patterns of reactivity. Additionally, future studies should utilise longitudinal, prospective study designs to test the hypothesis that recently separated adults reporting high levels of separation-related distress exhibit physiological patterns indicative of allostatic load following marital dissolution. Second, the observation of slowed recovery in adults reporting higher separation-related distress was uniquely related to DBP although the effect for SBP was in the hypothesised direction. This discrepancy may be related to inadequate power, and thus, future studies should investigate these effects with larger sample sizes. Third, relative to the entire sample, women largely outnumbered men. Use of a more

balanced sample will allow investigations of the influence of gender, as overrepresentation of women in the current sample may have driven the observed effects.

Conclusion

The current study is the first of its kind to assess the physiological reactivity of recently separated adults and their separation-related distress in the context of a standardised laboratory stress task that is not focused on marital separation. After controlling for relevant covariates, adults reporting high levels of separation-related distress exhibited blunted blood pressure reactivity during a standardised, laboratory math stressor task. This pattern may be indicative of allostatic load, a physiological state associated with increased risk for developing future health problems. If replicated, these results have potential clinical implications for our ability to identify high-risk, recently separated adults. This information can be used by health professionals to connect these adults with early intervention efforts to mitigate the risk of developing adverse health outcomes.

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Abbreviations:

HR	Heart rate
BP	Blood pressure
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
IES-R	Impact of Events Scale-Revised.

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Figure 1.

Change in heart rate and blood pressure across the study period. Panel A illustrates change in heart rate (HR), Panel B for systolic blood pressure (SBP), and Panel C for diastolic blood pressure (DBP). Time 0 = baseline heart rate/blood pressure; HR = heart rate; DBP = diastolic blood pressure; SBP = systolic blood pressure; low IES-R = -1 SD; med IES-R = mean; high IES-R = +1 SD.

Table 1

Unstandardised parameter estimates from multilevel model predicting systolic (SBP), diastolic (DBP) blood pressure, and heart rate (HR) across three time periods (recovery, math stressor, recovery).

Variable	Estimate	SE	t	P	95% CI
SBP					
Intercept	136.04	1.74	77.99		132.64, 139.44
Time	1.90	0.62	3.04	<.01	0.68, 3.11
Time ²	−0.23	0.07	−3.14	<.01	−0.37, −0.09
IES-R	7.17	2.74	2.62	0.01 **	1.78, 12.56
BMI	0.29	0.38	0.76	0.45	−0.09, 0.98
Age	0.54	0.22	2.42	0.02	0.09, 0.99
Sex	4.58	1.82	2.52	0.01 **	0.99, 8.17
Tobacco	−5.06	4.07	−1.24	0.22	−13.08, 2.95
Exercise	0.50	0.51	0.97	0.33	−0.51, 1.51
Length	−0.02	0.02	−1.05	0.30	−0.07, 0.02
Initiator status	1.72	1.57	1.10	0.27	−1.36, 4.81
BPHx	0.71	1.64	0.43	0.67	−2.52, 3.95
BDI	−0.28	0.24	−1.19	0.24	−0.75, 0.19
Math Appraisal	1.15	1.24	0.93	0.36	−1.29, 3.59
Heart Rate	0.41	0.05	7.59	<.01	0.30, 0.51
Time x IES-R	−1.62	0.70	−2.32	0.02	−2.98, −0.26
Time ² x IES-R	0.16	0.08	1.95	0.05	−0.00, 0.32
<i>Random Effects</i>					
Intercept	16.70				14.34, 19.46
Time	5.39				4.48, 6.48
Time ²	0.64				0.53, 0.76
DBP					
Intercept	77.25	1.24	62.17	<.01	74.83, 79.67
Time	1.15	0.45	2.56	0.01 **	0.28, 2.02
Time ²	−0.16	0.05	−3.21	<.01	−0.26, −0.06
IES-R	5.78	1.87	3.10	<.01	2.11, 9.46
BMI	0.16	0.25	0.66	0.51	−0.32, 0.65
Age	0.32	0.14	2.22	0.03	0.04, 0.60
Sex	3.41	1.18	2.88	<.01	1.08, 5.74
Tobacco	−4.09	2.64	−1.55	0.12	−9.28, 1.10
Exercise	0.50	0.33	1.55	0.13	−0.15, 1.15
Length	−0.03	0.02	−2.01	0.05	−0.06, −0.00
Initiator status	0.73	1.08	0.68	0.50	−1.39, 2.85
BPHx	0.42	1.06	0.39	0.70	−1.67, 2.50
BDI	−0.17	0.15	−1.07	0.29	−0.47, 0.14
Math Appraisal	1.24	0.80	1.55	0.12	−0.33, 2.82

Variable	Estimate	SE	t	P	95% CI
Heart Rate	0.33	0.04	7.77	<.01	0.24, 0.41
Time x IES-R	-1.36	0.50	-2.72	<.01	-2.33, -0.39
Time ² x IES-R	0.13	0.06	2.24	0.02	0.02, 0.24
<i>Random Effects</i>					
Intercept	11.76				9.43, 14.65
Time	3.72				2.65, 5.24
Time ²	0.43				0.33, 0.55
HR					
Intercept	70.77	0.93	76.08	< 0.01	68.96, 72.59
Time	2.81	0.28	10.01	< 0.01	2.27, 3.36
Time ²	-0.33	0.03	-11.97	< 0.01	-0.39, -0.28
IES-R	-2.02	1.44	-1.40	0.16	-4.86, 0.82
BMI	0.20	0.18	1.12	0.26	-0.15, 0.56
Age	-0.12	0.12	-1.01	0.31	-0.35, 0.11
Sex	-0.64	0.95	-0.68	0.50	-2.51, 1.22
Tobacco	-2.68	2.21	-1.22	0.23	-7.03, 1.66
Exercise	0.16	0.28	0.56	0.58	-0.40, 0.72
Length	0.02	0.01	1.98	0.05	0.00, 0.05
Initiator status	-1.32	0.84	-1.57	0.12	-2.97, 0.33
BPHx	-1.33	0.91	-1.45	0.15	-3.13, 0.47
BDI	0.11	0.12	0.89	0.38	-0.13, 0.35
Math Appraisal	-0.19	0.67	-0.28	0.78	-1.51, 1.14
Time x IES-R	0.07	0.31	0.22	0.83	-0.54, 0.68
Time ² x IES-R	0.01	0.03	0.34	0.73	-0.05, 0.07
<i>Random Effects</i>					
Intercept	9.53				8.26, 10.99
Time	2.61				2.19, 3.12
Time ²	0.25				0.21, 0.30

Note. Estimate = unstandardised parameter estimate of fixed effects, standard deviation estimate of random effects; SE = standard error; Time = minutes into task (coded 0–9); IES-R = Impact of Events Scale – Revised; BMI = body mass index (weight in kg/height in meters²); Age = age at study entry, in years; Sex (0 = male, 1 = female); Tobacco = current use of tobacco (1 = no, 2 = yes); Exercise = average days per week of exercise; Length = relationship length in months prior to separation; Initiator status = participant report of who initiated the separation (1 = participant, 2 = participant's ex-partner); BPHx = self-report of historical diagnosis of high blood pressure (1 = no, 2 = yes); BDI = Beck Depression Inventory. Random effects not included for SBP as the model did not converge with random effects of time and time².

* $p < .05$.

** $p < .01$.