Cardiovascular Reactivity, Stress, and Personal Emotional Salience: Choose Your Tasks Carefully

Kyle J. Bourassa[1,2] & David A. Sbarra[3]

[1] Duke University Medical Center, Center for the Study of Aging and Human Development

[2] Durham VA Health Care System, Geriatrics Research, Education, and Clinical Center

[3] University of Arizona, Department of Psychology

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Abstract

Both greater cardiovascular reactivity and lesser reactivity ("blunting") to laboratory stressors are linked to poor health outcomes, including among people who have a history of traumatic experiences. In a sample of recently separated and divorced adults (*N* = 96), this study examined whether differences in cardiovascular reactivity might be explained by differences in the personal emotional salience of the tasks and trauma history. Participants were assessed for trauma history, current distress related to their marital dissolution, and cardiovascular reactivity during two tasks, a serial subtraction math stressor task and a divorce-recall task. Participants with a greater trauma history evidenced less blood pressure reactivity to the serial subtraction task (a low personal emotional salience task) when compared to participants with less trauma history. In contrast, participants with a greater trauma history evidenced higher blood pressure reactivity to the divorce-recall task, but only if they also reported more divorce-related distress (high personal emotional salience). These associations were not significant for heart rate reactivity. Among people with a history of more traumatic experiences, a task with low personal salience was associated with a lower blood pressure response, whereas a task with higher personal emotional salience was associated with a higher blood pressure response. Future studies examining cardiovascular reactivity would benefit from determining the personal emotional salience of tasks, particularly for groups that have experienced stressful life events or trauma.

Keywords: Cardiovascular reactivity, emotional salience, divorce, trauma, stressful life events

1. Introduction

Psychological stress and exposure to stressful life events are consistently associated with poor health and health-relevant biomarkers (Bourassa, 2021; Cohen & Williamson, 1991; Cohen, Janicki-Deverts, & Miller, 2007; Glaser, Rabin, Chesney, Cohen, & Natelson, 1999; Noelke & Avendano, 2015; Philips et al., 2001; Russ et al., 2012). Considerable research effort has been dedicated to disentangling the exact mechanisms that might explain how stressful life events influence health (Epel et al., 2018; Shields & Slavich, 2017). For example, physiological reactions to stress have identified people at greater risk of poor health following stressful life events (Shields & Slavich, 2017; Turner et al., 2020). Greater cardiovascular reactivity to laboratory stressors is theorized to characterize people who react more strongly to chronic and acute real-world stressors, leading to wear-and-tear on the cardiovascular system and poorer health over time (Manuck, 1994; Treiber et al., 2003). Termed the cardiovascular reactivity hypothesis (Blascovich & Katkin, 1993; Manuck, 1994; Treiber et al., 2003), this model arose in response to observed associations between exaggerated reactivity and the development of cardiovascular disease states (Manuck, 1994). This model is supported by studies linking greater reactivity to cardiovascular disease outcomes (Treiber et al., 2003) and all-cause mortality (Carroll et al., 2012), as well as by meta-analytic evidence linking greater reactivity to cardiovascular health risk (Chida & Steptoe, 2010). Conceptually, this model matches how trauma and other stressful life events are thought to lead to exaggerated physiological hyperarousal (APA, 2013), and empirical evidence links distress following stressful life events to exaggerated cardiovascular reactivity in the form of higher blood pressure (Bourassa, Hasselmo & Sbarra, 2016; Park et al., 2017) and heart rate (Bourassa et al., 2020; Park et al., 2017; Pole, 2007).

Although the cardiovascular reactivity hypothesis has proven generative, a puzzling pattern of cardiovascular responding has appeared in the literature over the past two decades that does not align with the traditional reactivity hypothesis (Allen, 2013; Carroll, Phillips, Hunt, & Der, 2007). Rather than exaggerated reactivity, a subset of studies has found poorer health is associated with *lower* cardiovascular reactivity in the form of blood pressure and heart rate (Carroll, Lovallo, & Phillips, 2009; Phillips, 2011). This evidence led to the development of a blunting model of cardiovascular reactivity in which lower reactivity is theorized to assess motivational dysregulation (Carroll et al., 2017; Ginty et al., 2013). This dysregulation is believed to contribute to poorer health via indirect routes, such as changes in health behavior or increased depressive symptoms (Phillips et al., 2013).

Recent studies have sought to determine whether the traditional cardiovascular reactivity and blunting models are competing or complementary (Bourassa et al., 2021; Hase, Aan Het Rot, de Miranda Azevedo, & Freeman, 2020). For example, it is plausible either extreme of response style—i.e., very low *or* very high reactivity—could be associated with poorer health. Alternatively, it is possible that one model will show more consistent associations over time and come to represent the primary model linking cardiovascular reactivity and poor health. However, an alternative explanation is that differences in study design may shape patterns of cardiovascular reactivity and explain seemingly contradictory findings. For example, a recent study drawing on two longitudinal cohorts measured over several decades found consistent associations between blunted cardiovascular reactivity to cognitive stressors (as assessed by blood pressure and heart rate) and poorer health (Bourassa et al., 2021). These associations were attenuated when accounting for individual differences in characteristics that might influence how people engage with a cognitive stressor, including cognitive ability, depressive symptoms, and conscientiousness. Although this study replicated associations between blunted reactivity and poor health across two cohorts, it is possible the *types of tasks* used were responsible for this pattern of responding. If cognitive stressors elicit a certain set of cardiovascular cause they have little emotional salience, then it would be necessary to instead compare and contrast people's reactivity to multiple types of laboratory tasks that vary in their personal emotional salience.

1.1 Might Laboratory Task Type Shape or Constrain Cardiovascular Reactivity?

How might the type of task used when assessing cardiovascular activity influence cardiovascular responses? Self-reported task stressfulness and difficultly do not explain differences in blunted or exaggerated blood pressure and heart rate reactivity to three common types of stressor tasks—mental arithmetic, cold pressor, and exercise tasks (Brindle, Whittaker, Bibbey, Carroll, & Ginty, 2017). Cognitive stressors, such as mental arithmetic or Stroop tasks, are intentionally designed to have low personal emotional salience. For such tasks, low reactivity might align better with findings from the cardiovascular blunting literature that find lower reactivity characterizes people with low behavioral motivation who find it hard to engage in such tasks, such as people with a history of childhood adversity and trauma (Bourassa et al., 2021; Ginty, Masters, Nelson, Kaye, & Conklin, 2017; McLaughlin et al., 2014; Murali & Chen, 2005; Voellmin et al., 2015). Notably, among these five studies showing an association between childhood adversity and lower physiological reactivity, tasks were largely comprised of two types, cognitive challenges involving a math or Stroop task (Bourassa et al., 2021; Ginty et al., 2017; McLaughlin et al., 2014; Voellmin et al., 2015) and/or performance tasks involving speeches (McLaughlin et al., 2014; Murali & Chen, 2005; Voellmin et al., 2015). Social evaluative performance tasks and cognitive stressors are presumed to be similarly stressful, however, it is possible that among people with a history of adversity, different types of stressors may result in different patterns of reactivity. For example, there is heterogeneity in the responses for different stressful tasks when examining the association between socioeconomic status (SES) and cardiovascular reactivity—lower SES is associated with *greater* reactivity to cognitive stressors, *lower* reactivity to tasks that combine cognitive, interpersonal, and physical challenges, and is not associated with reactivity to interpersonal stressors (Boylan, Cundiff, & Matthews, 2018).

In contrast, tasks asking people to recall a difficult experience, such as a recent divorce or trauma, might be personally emotionally salient in a way that cognitive or performance stressors are not and better align with more traditional cardiovascular reactivity findings. Importantly, the emotional salience for such recall tasks would be expected to vary based on the extent to which asking someone to reflect on and recall aspect of the event is, in fact, distressing to them personally. From this perspective, we expect that people who are more distressed by their divorce experience will react more strongly than people reporting less distress about their divorce (Bourassa et al., 2016). Indeed, a large body of previous empirical work supports this possibility—people who rate stressful events as more distressing evidence greater blood pressure and heart rate reactivity when recalling those stressors (Bourassa et al., 2016; Bourassa et al., 2020; Ginty, Masters, Nelson, Kaye, & Conklin, 2017; Park et al., 2017; Pole, 2007). There is also experimental evidence that exaggerated reactivity observed when people recall their traumas is reduced by efficacious treatment; active-duty soldiers who complete exposure therapy show decreased heart rate reactivity when recalling their trauma compared to waitlist controls (Bourassa et al., 2020). Notably, this pattern extends to childhood adversity as well. One study finding an association between socioeconomic disadvantage and *greater* blood pressure reactivity to a “mental stress task” used personally-relevant and emotionally salient anger and sadness recalls as laboratory stressors to elicit reactivity (Williams et al., 2008), though there was no such association for heart rate reactivity. Testing two tasks—one that is *less* personally emotionally salient and another that varies in its salience—in the same laboratory study could help contextualize the discrepancy between the blunting and traditional cardiovascular reactivity literatures.

1.2 Present Study

The current study used a sample of recently divorced adults (*N* = 96) to examine whether individual differences in participants’ trauma histories and divorce-related distress were associated with their laboratory-based cardiovascular reactivity, as well as whether this association varied based on the type of task used to evoke reactivity. The study protocol included a less personally emotionally salient serial subtraction math task and a divorce-recall task that was expected to vary in emotional salience by participants’ distress related to their divorce. Based on prior studies of trauma and reactivity to cognitive stressors (Bourassa et al., 2021; Ginty et al., 2017; McLaughlin et al., 2014), we expected that the serial subtraction task would result in a "blunting" effect for people with more trauma history, such that a greater history of trauma would be associated with lower cardiovascular reactivity. We expected a different pattern of association for the divorce-recall task, such that people who reported higher levels of divorce-related distress (i.e., the people for whom the task would be more personally emotionally salient) would show higher levels of cardiovascular reactivity to the divorce-recall task. In addition, we hypothesized that there would be a positive association between divorce-related stress and cardiovascular reactivity, and this association would be stronger among people with greater trauma history (i.e., a significant Trauma History × Divorce-related Distress interaction).

2. Method

2.1 Participants

As previously described (Borelli & Sbarra, 2011; Bourassa, Allen, Mehl, & Sbarra, 2017; Sbarra, Boals, Mason, Larson, & Mehl, 2013), a sample of 109 recently separated or divorced adults—described as divorced in the current study[1] (mean time since the date of physical separation = 3.8 months, *SD* = 1.4)—were recruited from the community for an expressive writing intervention study. Eligible participants physically separated from their partner within the past five months and cohabitated with their former partner for at least two years. Prior to randomization and intervention, participants completed a baseline psychophysiological assessment, as well as a number of self-report measures. The current study used data from participants who completed the psychophysiological assessment and reported on their trauma histories (*N* = 96) during the baseline assessment. The 13 participants not included in the study either were not provided the trauma history measure (*n* = first 11 participants) or

[1] The study sample was comprised of people who experienced marital dissolution, which included both people who were legally divorced as well as those who were physically separated (i.e., separated and divorced). In this study, we used "divorce" as a term encompassing this group of people who experienced marital dissolution broadly, which is a process that can unfold over months and even years.

did not complete the measure (n = 2). These participants did not significantly differ from those included in the study in terms of their age, sex, or time since divorce, all ds < .52, all ps > .12.

2.2 Procedure

As previously described (Bourassa et al., 2017; Sbarra et al., 2013), recently-divorced adults completed a baseline assessment prior to being randomized to an expressive writing condition. The University of Arizona Institutional Review Board approved the study protocol. All participants signed an informed consent form prior to study participation. Participants were mailed a questionnaire packet prior to their first laboratory visit and were asked to avoid consuming caffeine and tobacco for at least 4 hours prior to the visit. In the laboratory, participants completed a psychophysiological battery that included six tasks across 24 minutes of assessment: a resting baseline, a serial subtraction math stressor, a recovery period, a mundane event recall, a divorce-recall task, and a second recovery period (see Sbarra et al., 2013). For the resting baseline, participants were asked to sit without speaking and relax while watching a nature video for 4-minutes. Following this video, participants engaged in a 5-minute serial subtraction math task (see Cacioppo et al., 1995). 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 increases the level of stress (Grinberg, O'Hara, & Sbarra, 2018). After a 3-minute recovery period and 4-minute mundane events recall, participants completed a 7-minute divorce-recall task (Borelli & Sbarra, 2011; Bourassa, Hasselmo, & Sbarra, 2016). Participants were asked to think about themselves and their partner in a variety of situations and let any relevant thoughts, feelings, or images come to mind when viewing upcoming questions. Seven questions related to the marital dissolution were provided during the divorce-recall task for 1 minute each. Examples included, "Please think about how you and your partner met," and "When did you first realize you and your partner were headed toward divorce. What was that time like?" Following the divorce-recall, there was a recovery period. Participants provided self-reported appraisals of the serial subtraction task, the divorce-recall task, and the mundane event recall as a vanilla baseline (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992). Previous research using these appraisals are presented elsewhere (Sbarra, Law, Lee, & Mason, 2009).

2.3 Measures

2.3.1 Cardiovascular reactivity. As previously described (Bourassa et al., 2017; Sbarra et al., 2013), cardiovascular physiology was assessed during study tasks and included blood pressure and heart rate. Blood pressure was assessed using a noninvasive tonometry device on the wrist covering the radial artery. The device was placed on participants' nondominant arm, and produces real time blood pressure (BP) readings (Vasotrac AMP 205, Medwave Inc., Arden Hills, MN). The Vasotrac system detects arterial pressures using ongoing compression and decompression of the radial artery, and are measured every 12 to 15 beats. BP was scored using the Mindware Technology BP 2.6 post-processing software. Minute-by-minute mean scores were created and averaged to create the task averages. Baseline blood pressure was assessed using the resting baseline task mean. Reactivity to the two tasks were created for systolic and diastolic blood pressure by subtracting the resting baseline task mean from each task mean.

For heart rate, electrocardiograph (ECG) data was collected using the Biopac MP100 system and ECG amplifier, and 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. Post-processing artifact detection and data cleaning of ECG interbeat interval signals was conducted using the MindWare Technologies HRV 2.60 application (Mindwaretech, Westerville, OH). Heart rate was calculated as beats per minute, and baseline heart rate and heart rate reactivity to the two tasks was calculated in the same manner as for blood pressure.

2.3.2 Trauma history. Trauma history was assessed using the 23-item Traumatic Life Events Questionnaire (Kubany et al., 2000). Participants reported whether they had experienced 23 traumatic events including a natural disaster, a serious motor vehicle accident, the death of a loved one, physical or sexual assault, and childhood physical, emotional, or sexual abuse. For each item, participants indicated how many times they experienced such events (never, once, 2-5 times, or more than 5 times). Scores for each item were summed such that higher scores represented more trauma history. Scores above 25 (n = 8, 8.3% of the sample, range 26 to 34) were windsorized to 25 to reduce positive skew.

2.3.3 Divorce-related distress. The Impact of Events Scale-Revised (IES-R; Weiss & Marmar, 1997) is a measure that assesses the degree to which people are experiencing ongoing avoidance, emotional intrusion, and somatic hyperarousal related to a specific stressful event. As described elsewhere (Bourassa et al., 2016), this study modified the IES-R to specifically ask about the psychological distress participants were experiencing related to their recent marital dissolution over the past week. The scale has 22 questions using a five point Likert scale rating system with specific anchoring statements (0 = “Not at all,” 1 = “A little bit,” 2 = “Moderately,” 3 = “Quite a bit,” 4 = “Extremely”). Scores for each item were summed such that higher scores represented more divorce-related distress (range 0 to 66). The IES-R scale has demonstrated high internal consistency in a range of previous studies and showed high internal consistency in the current study (α = 0.93).

2.3.4 Task appraisals. Following the serial subtraction, divorce-recall, and mundane events tasks, participants were asked to appraise task difficulty using self-report. As described in more detail previously (Sbarra et al., 2009), three of the four appraisal items described in a previous study were averaged to create a composite scale assessing task difficulty (one item from the prior study was excluded as it was not assessed in the serial subtraction task). The three items asked how much effort each task required, how much bodily tension/anxiety participants felt during each task, and how emotionally upsetting each task was, with higher scores representing more task difficulty.

2.3.5 Study covariates. Study covariates were assessed using self-report and included sex, age, and time since divorce or separation from their ex-partner.

2.4 Data Analysis

Multiple regression models were used to examine the association between trauma history, divorce-related psychological distress, and cardiovascular reactivity to a serial subtraction math task (Grinberg et al., 2018) and a divorce-recall task (Borelli & Sbarra, 2011; Bourassa, Hasselmo, & Sbarra, 2016). The two tasks varied in their emotional salience—the serial subtraction task was not designed to have personal emotional salience, whereas the divorce-recall task was designed to be emotionally salient to recently divorced adults, specifically adults distressed by their divorce. The first models examined the association of trauma history and divorce-related distress with cardiovascular reactivity to the serial subtraction stressor and divorce-recall task. The next models tested whether divorce-related psychological distress moderated the association between trauma history and cardiovascular reactivity to the two tasks. All models predicting reactivity scores were adjusted for age, sex, time since divorce, and the relevant baseline cardiovascular activity. We used full information maximum likelihood in MPLUS version 8.3 (Muthén & Muthén, 2012) to account for missing data. This method incorporates all available data and produces estimates that outperform other missing data treatments when data are missing at random (Graham, 2009). Given our sample size and standard errors given our analytic approach, our models could detect standardized effects that were small to medium size ($\beta > 0.20$).

3. Results

The study sample was 61.5% female (n = 59), 40.8 years old on average (SD = 10.0), and reported being separated from their spouse an average of 3.6 months prior to the study visit (SD = 1.7). The sample was 75.0% non-Hispanic white (n = 72), 13.5% Hispanic (n = 13), and 11.5% (n = 11) indicated another race or ethnicity, and 52.1% (n = 50) of participants reported earning less than $30,000 per year. Table 1 shows descriptive data and bivariate correlations among the study variables Study participants' depressive symptoms were correlated with trauma history, but not the measures of reactivity to the serial subtraction or divorce recall tasks (Supplemental Analysis 1). Table 2 shows mean cardiovascular activity levels across the study tasks.

In terms of cardiovascular activity during and following the serial subtraction task, a repeated measures ANOVA showed a significant increase from baseline to the serial subtraction task across measures (heart rate mean difference = 6.23, 95% CI [4.67, 7.79], $p < .001$; systolic BP mean difference = 8.12, 95% CI [5.88, 10.37], $p < .001$; diastolic BP mean difference = 5.21, 95% CI [3.54, 6.87], $p < .001$). Cardiovascular activity then returned to resting activity levels, as shown when comparing mean levels during the baseline and serial subtraction recovery period (heart rate mean difference = 0.21, 95% CI [-1.24, 1.65], $p = .78$; systolic BP mean difference = 0.30, 95% CI [-1.83, 2.35], $p = .81$; diastolic BP mean difference = -0.99, 95% CI [-2.65, 0.67], $p = .24$).

3.1 Trauma History and Cardiovascular Reactivity

To test our main hypotheses, we first examined the association between trauma history and cardiovascular reactivity to the serial subtraction and divorce-recall tasks. Consistent with our first hypothesis, greater trauma history was associated with less systolic, β = -0.44, 95% CI [-0.62, -0.25], $p < .001$, and diastolic blood pressure reactivity, β = -0.39 [-0.58, -0.20], $p < .001$, to the serial subtraction task. Trauma history was not associated with heart rate reactivity to the serial subtraction task at a $p < .05$ level, β = -0.18, 95% CI [-0.39, 0.02], $p = .078$). Trauma history was not associated with blood pressure or heart rate reactivity to the divorce-recall task (Table 3). Figure 1 illustrates trauma history and systolic blood pressure reactivity to the serial subtraction task.

3.2 Divorce-related Distress and Cardiovascular Reactivity

We next reproduced an analysis of the association between divorce-related distress and cardiovascular reactivity to the two tasks, which is reported elsewhere (Bourassa et al., 2016). Greater divorce-related distress was associated with higher systolic, β = 0.24, 95% CI [0.05, 0.43], p = .015, and diastolic blood pressure reactivity to the divorce-recall task, β = 0.26, 95% CI [0.07, 0.44], p = .006. Trauma history was not associated with heart rate reactivity to the serial subtraction task at a $p < .05$ level, β = 0.19, 95% CI [-0.00, 0.38], p = .054). Divorce-related distress was not associated with blood pressure or heart rate reactivity to the serial subtraction task (Table 3). Figure 2 illustrates divorce-related distress and blood pressure reactivity to the serial subtraction task.

3.3. Moderation by Divorce-related Distress

Finally, we examined whether the association between trauma history and reactivity to the divorce-recall task might depend on the emotional salience of the task, as assessed by divorce-related distress. Consistent with our third hypothesis, divorce-related distress moderated the association between participants' trauma history and systolic, β = 0.25, 95% CI [0.08, 0.43], *p* = .005, and diastolic, β = 0.18, 95% CI [0.01, 0.35], *p* = .046, blood pressure reactivity to the divorce-recall task. There was a positive association between trauma history and blood pressure reactivity to the divorce-recall task for participants reporting greater divorce-related distress; whereas we observed a negative association between trauma history and blood pressure reactivity for participants reported less divorce-related distress. For example, participants with lower distress (1 *SD* below the mean, i.e., people for whom the divorce-recall was less personally emotionally salient), trauma history was associated with lower systolic blood pressure reactivity, β = -0.37, 95% CI [-0.65, -0.08], *p* = .013, in a manner that approximated the association between trauma history and lower systolic blood pressure observed in the less personally emotionally salient serial subtraction stressor (Table 3; β = -0.44, 95% CI [-0.62, -0.25], $p < .001$). Divorce-related distress did not moderate the association between participants' trauma history and heart rate reactivity, β = 0.05, 95% CI [-0.13, 0.24], *p* = .578. Divorce-related distress did not moderate the association between trauma history and blood pressure or heart rate reactivity to the serial subtraction task (Table 3). Figure 2 illustrates systolic blood pressure reactivity to the tasks based on divorce-related distress and trauma history.

3.4 Secondary Analysis: Examining Task Appraisals.

We next examined how participants' appraisals of task difficulty varied across for the serial subtraction, divorce-recall, and mundane events recall tasks. We also tested whether task difficulty was associated with divorce-related distress. As shown in Figure 3, both the serial subtraction and divorce-recall tasks were appraised as stressful compared to a vanilla baseline. We next examined associations for the item asking about the math and divorce-recall task's level of emotional difficulty. On average, participants rated the divorce-recall task as more emotionally difficult than the serial subtraction task, $d = 0.52$, 95% CI [0.30, 0.73], $p < .001$. This item also showed specificity such that greater divorce-related distress was associated with higher appraisals of emotional difficulty for the divorce-recall task when controlling for serial subtraction task difficulty ($r = .39$, $p < .001$), and this effect replicated when controlling for the main study covariates. We founds no such association in the serial subtraction task appraisals of emotional difficultly, which were not correlated with divorce-related distress when controlling for divorce-recall task difficulty ($r = .12$, $p = .244$), or main study covariates.

3.5 Sensitivity Analysis: Windsorizing Reactivity Scores.

To examine whether extreme reactivity scores might account for the observed associations, we conducted our primary analyses while windsorizing the reactivity scores. The results from these analyses replicated those reported in the main findings (see Supplemental Table 1), suggesting the associations were not due to outliers.

4. Discussion

In the current study, we used a sample of 96 recently separated and divorced adults to examine associations between trauma history and cardiovascular reactivity to laboratory stressors with varying personal emotional salience. Consistent with prior literature on physiological blunting (Allen, 2013; Carroll et al., 2007; Carroll et al., 2009; Phillips, 2011), a greater history of trauma was associated with lower cardiovascular reactivity to the serial subtraction math task, which we assumed to have little personal emotional salience to the study participants. In addition, divorce-related distress was associated with greater reactivity to the divorce-recall task, which we assumed to have high personal emotional salience for participants distressed by their divorce. For the divorce-recall task, there was a significant interaction between divorce-related distress and trauma history when predicting blood pressure reactivity. As illustrated in Figure 2, people with greater trauma history who were distressed by the end of their marriage showed exaggerated reactivity to the divorce-recall task. This was in contrast to people with greater trauma history reporting relatively less divorce-related distress—for whom the divorce-recall task was presumably less personally emotionally salient—who showed lower levels of reactivity to the divorce-recall task. If replicated, these results suggest that the personal emotional salience of laboratory task may influence the cardiovascular reactivity observed in a given study, particularly among those who have experienced stressful life events and trauma.

The present findings are relevant to interpreting apparent discrepancies between the traditional and blunted cardiovascular reactivity models. These two literatures have found that both higher *and* lower cardiovascular reactivity are empirically associated with poor health. Notably, each model implicates separate biopsychosocial pathways that lead to poor health. Greater reactivity is hypothesized to increase wear-and-tear on the cardiovascular system directly over time (Blascovich & Katkin, 1993; Manuck, 1994; Treiber et al., 2003), whereas blunted reactivity is theorized to be associated with poor health via behaviors associated with dysregulated behavioral motivation, such as poorer health behaviors (Carroll et al., 2017; Ginty et al., 2013; Phillips et al., 2013). Although it is possible that reactivity has a non-linear association with health—such that average reactivity levels are health protective and high and low reactivity independently affect health in different ways—this type of non-linear effect was not borne out empirically in a recent study using multiple longitudinal cohorts (Bourassa et al., 2021). Importantly, studies using both models have generally focused on direct associations between participants' characteristics or experiences and higher or lower cardiovascular reactivity, with less attention paid to accounting for the way individual differences might interact with the types of tasks used to influence reactivity.

The existing literature examining stressful life events, early childhood adversity, and trauma highlights the importance of investigating how study participants' characteristics and experiences might interact with different tasks to explain reactivity in the laboratory. Early life adversity and trauma are associated with *lower levels* of physiological reactivity across of a number of studies (Bourassa et al., 2021; Ginty et al., 2017; McLaughlin et al., 2014; McLaughlin et al., 2015; Murali & Chen, 2005; Voellmin et al., 2015). Experiencing early life adversity is theorized to result in a "freezing response" to general stress that could explain such findings (McLaughlin et al., 2015). This empirical evidence linking early life adversity and trauma to lower reactivity stands in contrast with well-established theory and empirical evidence showing that stressful life events, trauma, and the development of post-traumatic stress disorder (PTSD) are associated with *higher levels* of cardiovascular reactivity among adults (Bourassa et al., 2016; Park et al., 2017; Pole, 2007). For example, people with higher levels of PTSD symptoms evidence greater cardiovascular reactivity compared to healthy controls (Pole, 2007). Theoretically, these results align with hyperarousal and hypervigilance symptoms central to PTSD (APA, 2013). Notably, experimental evidence shows people who have experienced trauma and stressful life events show decreases in cardiovascular activity and reactivity after completing evidence-based empirical interventions (Bourassa, Hendrickson, Reger, & Norr, 2021). For example, recently divorced adults show improved cardiac functioning after completing a narrative expressive writing intervention (Bourassa et al., 2017) and active-duty soldiers with PTSD have shown reduced heart rate reactivity when thinking about their trauma following exposure therapy (Bourassa et al., 2020) compared to controls.

One possible explanation for reconciling these differences is the need to better account for the *types of tasks* used to assess cardiovascular reactivity in the context of trauma or adversity. Many studies have found that early child adversity is associated with lower reactivity to cognitive and/or performative stressors (Bourassa et al., 2021; Ginty et al., 2017; McLaughlin et al., 2014; McLaughlin et al., 2015; Murali & Chen, 2005; Voellmin et al., 2015). Studies of trauma and PTSD in adults, in contrast, often use trauma-recall tasks to elicit reactivity (Bourassa et al., 2016; Bourassa et al., 2021; Park et al., 2017; Pole, 2007). Notably, prior research finding childhood socioeconomic disadvantage is associated with *increased* cardiovascular reactivity used emotional recall tasks to elicit reactivity, rather than a cognitive or a performative stressor (Williams et al., 2008). In combination with the present findings, these associations highlight the importance of accounting for the personal emotional salience of laboratory tasks, particularly for people who have experienced stressful life events or trauma. Cognitive stressors could be expected to produce lower reactivity, whereas personally emotionally salient trauma-specific stressors would be expected to produce higher reactivity. This need for specificity also extends to the type of outcome. We found patterns of association for blood pressure, but not heart rate. It is possible this represents a meaningful difference in response to emotionally evocative stressors in the form of cardiovascular response in the peripheral vasculature, rather than sympathetic cardiac activation. Given the variety of outcomes used to assess cardiovascular reactivity, replication would be required before firm conclusions could be drawn. Alternatively, meta-analytic studies (cf. Boylan et al., 2018) aggregating published associations between types of laboratory tasks and cardiovascular reactivity could help provide additional evidence using the existing published literature.

It is unsurprising that the type of stressful task used in a psychophysiological reactivity protocol might influence the level or direction of cardiovascular reactivity observed in any given study. Exercise stressors, cold pressors, Trier-social stress tests, and mental arithmetic vary in the method of eliciting "stress," but often the results of such studies are interpreted through a general lens of stress reactivity.

Our findings, however, systematically link a task characteristic (personal emotional salience) and an individual difference (history of traumatic experiences) to different patterns of cardiovascular reactivity; these differences may help explain discrepancies between the exaggerated and blunted cardiovascular reactivity literature, particularly studies of early childhood adversity, trauma, and stressful life events. These results add to existing literature that has investigated cardiovascular responses to multiple types of stressors to better understand patterns of physiological reactivity (Brindle et al., 2017). Future studies would benefit from expanding these results to new samples, other types of reactivity tasks, and recovery from stressful tasks, particularly given that physiological recovery following a stressful task has been shown to predict future mortality (Panaite, Salomon, Jin, & Rottenberg, 2015). Evidence of differences in cardiovascular recovery after to recalling an emotionally salient event that varied based on trauma history could provide additional context to how such reactivity might influence long-term health. Observed associations were also strongest among people who were the most distressed about their divorce. It is possible that future study using samples that focused on people distressed by their divorce might result in stronger associations between trauma history and cardiovascular reactivity to a divorce-recall task. Samples showing the highest levels of distress would also match better conceptually with studies of PTSD and trauma, which generally require a certain threshold of PTSD symptoms for inclusion. If our results are replicated, these findings have the potential to help reconcile several decades of apparent discrepancies in cardiovascular reactivity research and influence we interpret studies using such reactivity protocols in the past, present, and future.

The results of the current study should be interpreted within the context of important limitations. First, this is a relatively small sample of recently divorced adults (N = 96) drawn from a larger intervention that was not specifically collected for the purposes of this study. The results of this study should be tested in different populations with larger samples to ensure the current results can be replicated. Second, the current study was cross-sectional and cannot determine whether lower or higher reactivity to tasks that vary in personal emotional salience might vary over time, or whether reactivity to more or less emotionally salient tasks are more or less relevant to subsequent health outcomes. Similarly, it is possible that unmeasured variables, such as health behaviors, might have explained observed associations. Third, the study tasks were presented in the same order for all participants, which may have resulted in differential responses to the different tasks. Fourth, the measure of trauma history used in this study does not allow us to determine whether reported traumas might have been perpetrated by an ex-spouse, which may have influenced the observed associations. Fifth, the divorce-recall task did not result in increased reactivity across the sample as a whole, only among people with higher levels of distress related to their divorce. Although these results fit with the expectation that those most affected by their divorce might show the greatest response to the divorce-recall task, it is possible the task as a whole is not operating as a stressful task in a way that is comparable to the serial subtraction task. Finally, this study did not experimentally manipulate personal emotional salience, and naturally occurring differences were used to test our hypotheses. Future studies that experimentally manipulate emotional salience in the future would be valuable.

4.1 Conclusions

In the current study, we found that the emotional salience of two tasks used in a psychophysiological protocol produced different patterns of cardiovascular reactivity among recently divorced adults. People with greater history of trauma evidenced a blunted reactivity response to a low emotional salience serial subtraction task, but evidenced an exaggerated cardiovascular reactivity response to a divorce-recall task if they also reported higher levels of distress related to their divorce and higher emotional salience as a result. These results suggest the importance of considering the personal emotional salience of tasks and the characteristics of the people completing them when using cardiovascular reactivity to investigate stress and health.

References

Allen, M. T. (2013). Integrative commentary: Implications of blunted reactivity. *International Journal of Psychophysiology*, *90*(2), 95-98. https://doi.org/10.1016/j.ijpsycho.2013.07.012

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Blascovich, J. J., & Katkin, E. S. (Eds.). (1993). APA Science Vols. *Cardiovascular reactivity to psychological stress & disease*. American Psychological Association.

Borelli, J. L., & Sbarra, D. A. (2011). Trauma history and linguistic self-focus moderate the course of psychological adjustment to divorce. *Journal of Social and Clinical Psychology*, *30*(7), 667-698. https://doi.org/10.1521/jscp.2011.30.7.667

Bourassa, K. J. (2021). Financial stressors during the Great Recession and subsequent risk of early mortality. *Psychosomatic Medicine*, *83*(5), 457-462. https://doi.org/10.1097/PSY.0000000000000943

Bourassa, K. J., Allen, J. J., Mehl, M. R., & Sbarra, D. A. (2017). The impact of narrative expressive writing on heart rate, heart rate variability, and blood pressure following marital separation. *Psychosomatic Medicine*, *79*(6), 697-705. https://doi.org/10.1097/PSY.0000000000000475

Bourassa, K. J., Moffitt, T. E., Harrington, H., Houts, R., Poulton, R., Ramrakha, S., & Caspi, A. (2021). Lower cardiovascular reactivity is associated with more childhood adversity and poorer midlife health: Replicated findings from the Dunedin and MIDUS cohorts. *Clinical Psychological Science*. Advanced online publication. https://doi.org/10.1177/2167702621993900

Bourassa, K. J., Hasselmo, K., & Sbarra, D. A. (2016). Heart rate variability moderates the association between separation-related psychological distress and blood pressure reactivity over time. *Psychological Science*, *27*(8), 1123-1135. https://doi.org/10.1177/0956797616651972

Bourassa, K. J., Hasselmo, K., & Sbarra, D. A. (2019). After the end: Linguistic predictors of psychological distress 4 years after marital separation. *Journal of Social and Personal Relationships*, *36*(6), 1872-1891. https://doi.org/10.1177/0265407518774428

Bourassa, K. J., Hendrickson, R. C., Reger, G. M., & Norr, A. M. (2021). PTSD treatment effects on cardiovascular physiology: A systematic review and research agenda. *Journal of Traumatic Stress*, *34*(2), 384-393. https://doi.org/10.1002/jts.22637

Bourassa, K. J., Manvelian, A., Boals, A., Mehl, M. R., & Sbarra, D. A. (2017). Tell me a story: The creation of narrative as a mechanism of psychological recovery following marital separation. *Journal of Social and Clinical Psychology*, *36*(5), 359-379. https://doi.org/10.1521/jscp.2017.36.5.359

Bourassa, K. J., Tackman, A. M., Mehl, M. R., & Sbarra, D. A. (2019). Psychological overinvolvement, emotional distress, and daily affect following marital dissolution. *Collabra: Psychology*, *5*(1). http://doi.org/10.1525/collabra.184

Bourassa, K. J., Stevens, E. S., Katz, A. C., Rothbaum, B. O., Reger, G. M., & Norr, A. M. (2020). The impact of exposure therapy on resting heart rate and heart rate reactivity among active-duty soldiers with posttraumatic stress disorder. *Psychosomatic Medicine*, *82*(1), 108-114.

Boylan, J. M., Cundiff, J. M., & Matthews, K. A. (2018). Socioeconomic status and cardiovascular responses to standardized stressors: a systematic review and meta-analysis. *Psychosomatic medicine*, *80*(3), 278-293. https://doi.org/10.1097/PSY.0000000000000561

Brindle, R. C., Whittaker, A. C., Bibbey, A., Carroll, D., & Ginty, A. T. (2017). Exploring the possible mechanisms of blunted cardiac reactivity to acute psychological stress. *International Journal of Psychophysiology*, *113*, 1-7. https://doi.org/10.1016/j.ijpsycho.2016.12.011

Cacioppo, J. T., Malarkey, W. B., Kiecolt-Glaser, J. K., Uchino, B. N., Sgoutas-Emch, S. A., Sheridan, J. F., Berntson, G. G., & Glaser, R. (1995). Heterogeneity in neuroendocrine and immune responses to brief psychological stressors as a function of autonomic cardiac activation. *Psychosomatic Medicine*, *57*(2), 154–164. https://doi.org/10.1097/00006842-199503000-00008

Carroll, D., Ginty, A. T., Der, G., Hunt, K., Benzeval, M., & Phillips, A. C. (2012). Increased blood pressure reactions to acute mental stress are associated with 16-year cardiovascular disease mortality. *Psychophysiology*, *49*(10), 1444-1448. https://doi.org/10.1111/j.1469-8986.2012.01463.x

Carroll, D., Ginty, A. T., Whittaker, A. C., Lovallo, W. R., & de Rooij, S. R. (2017). The behavioural, cognitive, and neural corollaries of blunted cardiovascular and cortisol reactions to acute psychological stress. *Neuroscience & Biobehavioral Reviews*, *77*, 74-86. https://doi.org/10.1016/j.neubiorev.2017.02.025

Carroll, D., Lovallo, W. R., & Phillips, A. C. (2009). Are large physiological reactions to acute psychological stress always bad for health?. *Social and Personality Psychology Compass*, *3*(5), 725-743. https://doi.org/10.1111/j.1751-9004.2009.00205.x

Carroll, D., Phillips, A. C., & Lovallo, W. R. (2012). *The behavioral and health corollaries of blunted physiological reactions to acute psychological stress: Revising the reactivity hypothesis.* In R. A. Wright & G. H. E. Gendolla (Eds.), How motivation affects cardiovascular response: Mechanisms and applications (p. 243–263). https://doi.org/10.1037/13090-012

Carroll, D., Phillips, A. C., Hunt, K., & Der, G. (2007). Symptoms of depression and cardiovascular reactions to acute psychological stress: Evidence from a population study. *Biological Psychology, 75,* 68–74. https://doi.org/10.1016/j.biopsycho.2006.12.002

Chida, Y., & Steptoe, A. (2010). Greater cardiovascular responses to laboratory mental stress are associated with poor subsequent cardiovascular risk status: a meta-analysis of prospective evidence. *Hypertension*, *55*(4), 1026-1032. https://doi.org/10.1161/HYPERTENSIONAHA.109.146621

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *JAMA*, 298(14), 1685-1687. https://doi.org/10.1001/jama.298.14.1685

Cohen, S., & Williamson, G. M. (1991). Stress and infectious disease in humans. *Psychological Bulletin*, *109*(1), 5-24. https://doi.org/10.1146/10.1037/0033-2909.109.1.5

Epel, E. S., Crosswell, A. D., Mayer, S. E., Prather, A. A., Slavich, G. M., Puterman, E., & Mendes, W. B.

(2018). More than a feeling: A unified view of stress measurement for population science. *Frontiers in Neuroendocrinology*, *49*, 146-169. https://doi.org/10.1016/j.yfrne.2018.03.001

Ginty, A. T., Gianaros, P. J., Derbyshire, S. W., Phillips, A. C., & Carroll, D. (2013). Blunted cardiac stress reactivity relates to neural hypoactivation. *Psychophysiology*, *50*(3), 219-229. https://doi.org/10.1111/psyp.12017

Ginty, A. T., Masters, N. A., Nelson, E. B., Kaye, K. T., & Conklin, S. M. (2017). Cardiovascular reactions to psychological stress and abuse history: The role of occurrence, frequency, and type of abuse. *Anxiety, Stress, & Coping*, *30*(2), 155-162. https://doi.org/10.1080/10615806.2016.1210791

Glaser, R., Rabin, B., Chesney, M., Cohen, S., & Natelson, B. (1999). Stress-induced immunomodulation: implications for infectious diseases?. *JAMA*, *281*(24), 2268-2270. doi:10.1207/10.1001/jama.281.24.2268

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, *60*, 549-576. https://doi.org/10.1146/annurev.psych.58.110405.085530

Grinberg, A. M., O'Hara, K. L., & Sbarra, D. A. (2018). Preliminary evidence of attenuated blood pressure reactivity to acute stress in adults following a recent marital separation. *Psychology & Health*, *33*(3), 430-444. https://doi.org/10.1080/08870446.2017.1373111

Hase, A., Aan Het Rot, M., de Miranda Azevedo, R., & Freeman, P. (2020). Threat-related motivational disengagement: Integrating blunted cardiovascular reactivity to stress into the biopsychosocial model of challenge and threat. *Anxiety, Stress, & Coping*, *33*(4), 355-369. https://doi.org/10.1080/10615806.2020.1755819

Jennings, J. R., Kamarck, T., Stewart, C., Eddy, M., & Johnson, P. (1992). Alternate cardiovascular baseline assessment techniques: vanilla or resting baseline. *Psychophysiology*, *29*(6), 742–750. https://doi.org/10.1111/j.1469-8986.1992.tb02052.x

Kubany, E. S., Leisen, M. B., Kaplan, A. S., Watson, S. B., Haynes, S. N., Owens, J. A., & Burns, K. (2000).

Development and preliminary validation of a brief broad-spectrum measure of trauma exposure: the Traumatic Life Events Questionnaire. *Psychological Assessment*, *12*(2), 210-224. https://doi.org/10.1037/1040-3590.12.2.210

Manuck, S. B. (1994). Cardiovascular reactivity in cardiovascular disease: "Once more unto the breach". *International Journal of Behavioral Medicine*, *1*(1), 4-31. https://doi.org/10.1207/s15327558ijbm0101_2

McLaughlin, K. A., Sheridan, M. A., Alves, S., & Mendes, W. B. (2014). Child maltreatment and autonomic nervous system reactivity: Identifying dysregulated stress reactivity patterns using the biopsychosocial model of challenge and threat. *Psychosomatic Medicine*, *76*(7), 538-546. 10.1097/PSY.0000000000000098

McLaughlin, K. A., Sheridan, M. A., Tibu, F., Fox, N. A., Zeanah, C. H., & Nelson, C. A. (2015). Causal effects of the early caregiving environment on stress response system development in children. *Proceedings of the National Academy of Sciences, 112*, 5637-5642. https://doi.org/10.1073/pnas.1423363112

Murali, R., & Chen, E. (2005). Exposure to violence and cardiovascular and neuroendocrine measures in adolescents. *Annals of Behavioral Medicine*, *30*(2), 155-163. https://doi.org/10.1207/s15324796abm3002_8

Muthén LK, and Muthén BO. Mplus User's Guide. Seventh Edition. Los Angeles, CA: Muthén & Muthén; 1998-2012

Noelke C, Avendano M. Who suffers during recessions? Economic downturns, job loss, and cardiovascular disease in older Americans. Am J Epidemiol 2015;182(10):873-82. https://doi.org/10.1093/aje/kwv094

Panaite, V., Salomon, K., Jin, A., & Rottenberg, J. (2015). Cardiovascular recovery from psychological and physiological challenge and risk for adverse cardiovascular outcomes and all-cause mortality. *Psychosomatic Medicine*, *77*(3), 215-226.

https://doi.org/10.1097/PSY.0000000000000171

Park, J., Marvar, P. J., Liao, P., Kankam, M. L., Norrholm, S. D., Downey, R. M., ... & Rothbaum, B. O. (2017). Baroreflex dysfunction and augmented sympathetic nerve responses during mental stress in veterans with post-traumatic stress disorder. *The Journal of Physiology*, *595*(14), 4893-4908. https://doi.org/10.1113/JP274269

Phillips, A. C. (2011). Blunted cardiovascular reactivity relates to depression, obesity, and self-reported health. *Biological Psychology*, *86*(2), 106-113. https://doi.org/10.1016/j.biopsycho.2010.03.016

Phillips, A. C., Ginty, A. T., & Hughes, B. M. (2013). The other side of the coin: Blunted cardiovascular and cortisol reactivity are associated with negative health outcomes. *International Journal of Psychophysiology*, *90*(1), 1-7. https://doi.org/10.1016/j.ijpsycho.2013.02.002

Phillips, D. P., Liu, G. C., Kwok, K., Jarvinen, J. R., Zhang, W., & Abramson, I. S. (2001). The Hound of the Baskervilles effect: natural experiment on the influence of psychological stress on timing of death. *BMJ*, *323*(7327), 1443-1446. https://doi.org/10.1136/bmj.323.7327.1443

Pole, N. (2007). The psychophysiology of posttraumatic stress disorder: a meta-analysis. *Psychological Bulletin*, *133*(5), 725-746. https://doi.org/10.1037/0033-2909.133.5.725

Russ, T. C., Stamatakis, E., Hamer, M., Starr, J. M., Kivimäki, M., & Batty, G. D. (2012). Association between psychological distress and mortality: Individual participant pooled analysis of 10 prospective cohort studies. *BMJ*, *345,* e4933. https://doi.org/10.1136/bmj.j108

Sbarra, D. A., Boals, A., Mason, A. E., Larson, G. M., & Mehl, M. R. (2013). Expressive writing can impede emotional recovery following marital separation. *Clinical Psychological Science*, *1*(2), 120-134. https://doi.org/10.1177/2167702612469801

Sbarra, D. A., Law, R. W., Lee, L. A., & Mason, A. E. (2009). Marital dissolution and blood pressure reactivity: evidence for the specificity of emotional intrusion-hyperarousal and task-rated emotional difficulty. *Psychosomatic Medicine*, *71*(5), 532–540. https://doi.org/10.1097/PSY.0b013e3181a23eee

Shields, G. S., & Slavich, G. M. (2017). Lifetime stress exposure and health: A review of contemporary assessment methods and biological mechanisms. *Social and Personality Psychology Compass*, *11*(8), e12335. https://doi.org/10.1111/spc3.12335

Treiber, F. A., Kamarck, T., Schneiderman, N., Sheffield, D., Kapuku, G., & Taylor, T. (2003). Cardiovascular reactivity and development of preclinical and clinical disease states. *Psychosomatic Medicine*, *65*(1), 46-62. https://doi.org/10.1097/00006842-200301000-00007

Turner, A. I., Smyth, N., Hall, S. J., Torres, S. J., Hussein, M., Jayasinghe, S. U., ... & Clow, A. J. (2020). Psychological stress reactivity and future health and disease outcomes: A systematic review of prospective evidence. *Psychoneuroendocrinology*, *114*, 104599. https://doi.org/10.1016/j.psyneuen.2020.104599

Voellmin, A., Winzeler, K., Hug, E., Wilhelm, F. H., Schaefer, V., Gaab, J., ... & Bader, K. (2015). Blunted endocrine and cardiovascular reactivity in young healthy women reporting a history of childhood adversity. *Psychoneuroendocrinology*, *51*, 58-67. https://doi.org/10.1016/j.psyneuen.2014.09.008

Williams, R. B., Marchuk, D. A., Siegler, I. C., Barefoot, J. C., Helms, M. J., Brummett, B. H., ... & Schanberg, S. M. (2008). Childhood socioeconomic status and serotonin transporter gene polymorphism enhance cardiovascular reactivity to mental stress. *Psychosomatic Medicine*, *70*(1), 32-39. https://doi.org/10.1097/PSY.0b013e31815f66c3

Table 1. *Descriptives and Bivariate Correlations among Study Variables*

N = 96	Mean ± *SD*	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Trauma history (1)	11.3 ± 7.0	1.0													
Divorce-related distress (2)	30.8 ± 15.2	.28*	1.0												
Baseline systolic BP (3)	138.4 ± 17.4	.14	.06	1.0											
Baseline diastolic BP (4)	80.3 ± 12.6	.14	.10	.94*	1.0										
Baseline heart rate (5)	71.0 ± 9.9	.04	-.11	.05	.05	1.0									
Systolic BP reactivity to serial subtraction (6)	7.9 ± 8.6	-.38*	-.14	.04	.03	.08	1.0								
Diastolic BP reactivity to serial subtraction (7)	5.0 ± 6.4	-.38*	-.19	-.02	-.08	.10	.94	1.0							
Heart rate reactivity to serial subtraction (8)	5.6 ± 4.6	-.13	.11	-.12	-.05	.01	.26*	.22*	1.0						
Systolic BP reactivity to divorce-recall (9)	2.8 ± 8.2	-.10	.19	-.29*	-.36*	-.10	-.09	-.07	.00	1.0					
Diastolic BP reactivity to divorce-recall (10)	1.0 ± 5.7	-.16	.17	-.27*	-.44*	-.03	-.05	.04	-.02	.90*	1.0				
Heart rate reactivity to divorce-recall (11)	0.3 ± 3.1	-.04	.22*	-.06	-.04	-.25*	.02	.02	.25*	.20	.17	1.0			
Years of age (12)	40.8 ± 10.0	-.14	-.07	.28	.19	-.01	-.02	-.02	-.14	.05	.04	-.09	1.0		
Percent female (13)	61.5%	.06	-.09	.07	.06	-.10	.04	-.03	.12	-.24*	-.26*	-.23*	-.04	1.0	
Months since separation (14)	3.6 ± 1.4	.16	.10	.07	.01	.04	.18	.14	.02	-.08	-.02	-.04	-.07	.09	1.0

Note: BP = blood pressure.
* = $p < .05$.

Table 2. *Cardiovascular Activity Study Task Means*

	Systolic blood pressure	Diastolic blood pressure	Heart rate
Baseline	138.4 ± 17.4	80.3 ± 12.6	70.8 ± 10.2
Serial subtraction	145.6 ± 20.4	84.5 ± 14.4	77.1 ± 11.1
Recovery	138.3 ± 18.2	78.6 ± 12.8	71.2 ± 10.2
Mundane event recall	139.5 ± 18.4	80.0 ± 12.6	71.3 ± 10.2
Divorce recall	139.9 ± 16.4	80.0 ± 11.4	71.2 ± 10.0
Recovery	139.6 ± 17.3	78.6 ± 12.6	71.3 ± 9.4

Note: All statistics are task means ± standard deviation units (*SD*s) derived from the full data available for study participants.

Table 3. *Association Between Trauma History and Cardiovascular Reactivity*

	Systolic blood pressure			Diastolic blood pressure			Heart rate		
(N = 96)	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*
Serial subtraction task reactivity									
Trauma history	**-0.44**	**[-0.62, -0.25]**	**<.001**	**-0.39**	**[-0.58, -0.20]**	**<.001**	-0.18	[-0.39, 0.02]	.078
Divorce-related distress	-0.04	[-0.24, 0.16]	.704	-0.11	[-0.31, 0.09]	.294	0.15	[-0.06, 0.36]	.166
Age	-0.06	[-0.26, 0.15]	.591	-0.05	[-0.25, 0.15]	.611	-0.20	[-0.39, -0.01]	.043
Sex	0.04	[-0.15, 0.24]	.655	-0.03	[-0.23, 0.17]	.772	0.02	[-0.18, 0.22]	.868
Time since divorce	**0.27**	**[0.06, 0.47]**	**.012**	**0.22**	**[0.01, 0.43]**	**.039**	-0.05	[-0.24, 0.15]	.641
Baseline cardiovascular activity	0.08	[-0.12, 0.28]	.438	-0.00	[-0.20, 0.20]	.988	-0.10	[-0.40, 0.20]	.528
Overall model R^2		**.232**			**.204**			**.091**	
Trauma × Divorce-related distress†	-0.01	[-0.20, 0.18]	.929	0.02	[-0.17, 0.22]	.824	-0.16	[-0.35, 0.03]	.097
Overall model R^2		**.236**			**.208**			**.113**	
Divorce-recall task reactivity									
Trauma history	-0.07	[-0.26, 0.12]	.497	-0.13	[-0.31, 0.06]	.192	-0.08	[-0.28, 0.11]	.415
Divorce-related distress	**0.24**	**[0.05, 0.43]**	**.015**	**0.26**	**[0.07, 0.44]**	**.006**	0.19	[-0.00, 0.38]	.054
Age	0.17	[-0.02, 0.37]	.082	0.17	[-0.01, 0.35]	.067	-0.09	[-0.28, 0.09]	.338
Sex	-0.16	[-0.35, 0.02]	.088	-0.11	[-0.29, 0.07]	.240	**-0.24**	**[-0.42, -0.06]**	**.011**
Time since divorce	-0.04	[-0.24, 0.16]	.672	-0.02	[-0.21, 0.17]	.833	-0.02	[-0.21, 0.17]	.820
Baseline cardiovascular activity	**-0.39**	**[-0.58, -0.20]**	**<.001**	**-0.47**	**[-0.64, -0.29]**	**<.001**	**-0.26**	**[-0.44, -0.08]**	**.006**
Overall model R^2		**.240**			**.301**			**.176**	
Trauma × Divorce-related Distress†	**0.25**	**[0.08, 0.43]**	**.005**	**0.18**	**[0.01, 0.35]**	**.046**	0.05	[-0.13, 0.24]	.578
Overall model R^2		**.302**			**.333**			**.179**	

Note: All model estimates are from main effect models with the exception of the Trauma × Divorce-related distress estimates (denoted by †), which are from the moderation models. Time since divorce was measured in months. Baseline cardiovascular activity was the resting baseline level of the appropriate cardiovascular outcome. Bolded estimates indicate the effects that are significant at the $p < .05$ level.

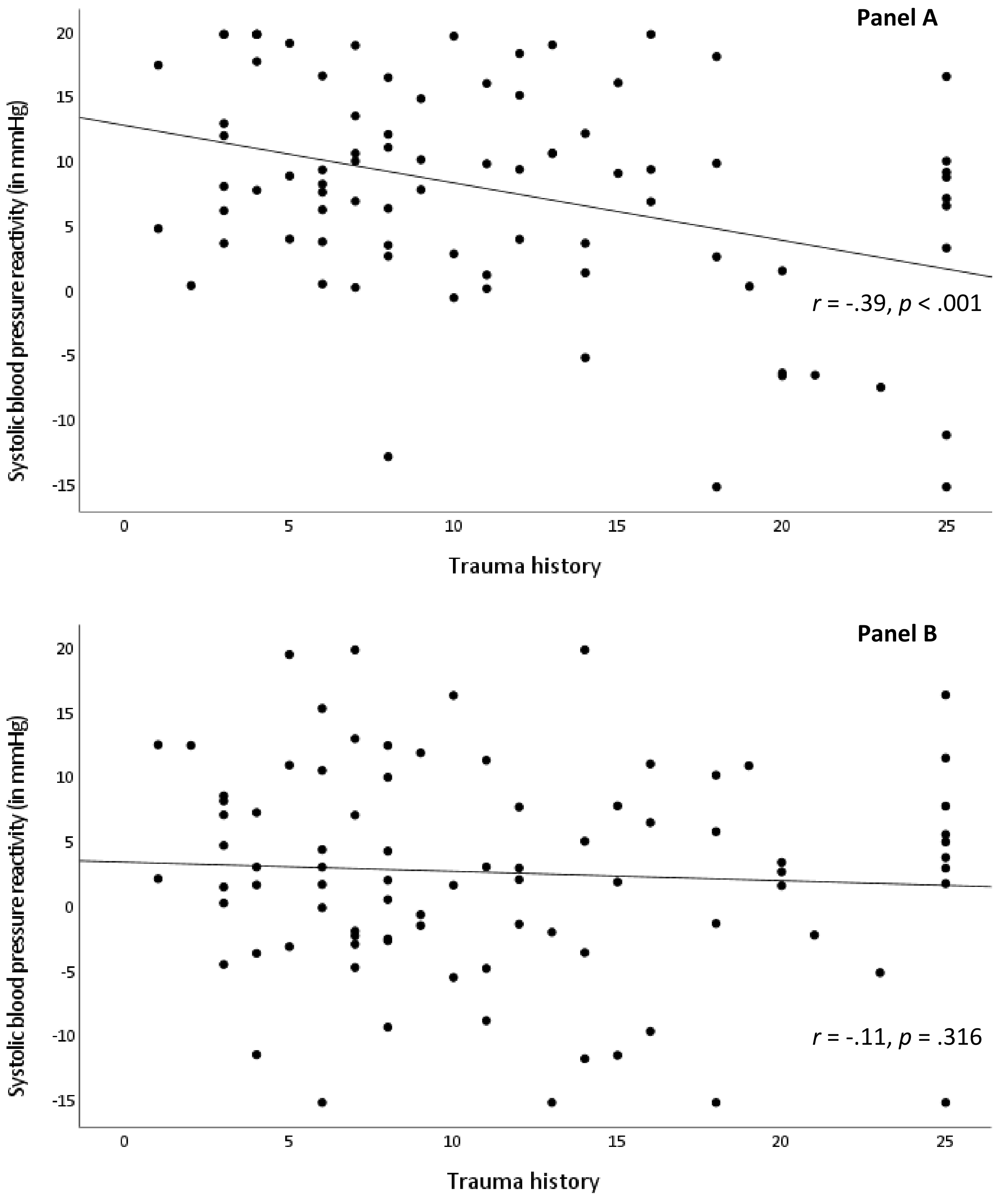

Figure 1. Scatterplot of participants' trauma history and systolic blood pressure reactivity (measured in Δ mmHg) to the cognitive stressor (Panel A) and divorce-recall task (Panel B). Reactivity levels more than 20 mmHg and less than -15 mmHg were windsorized for illustrative purposes.

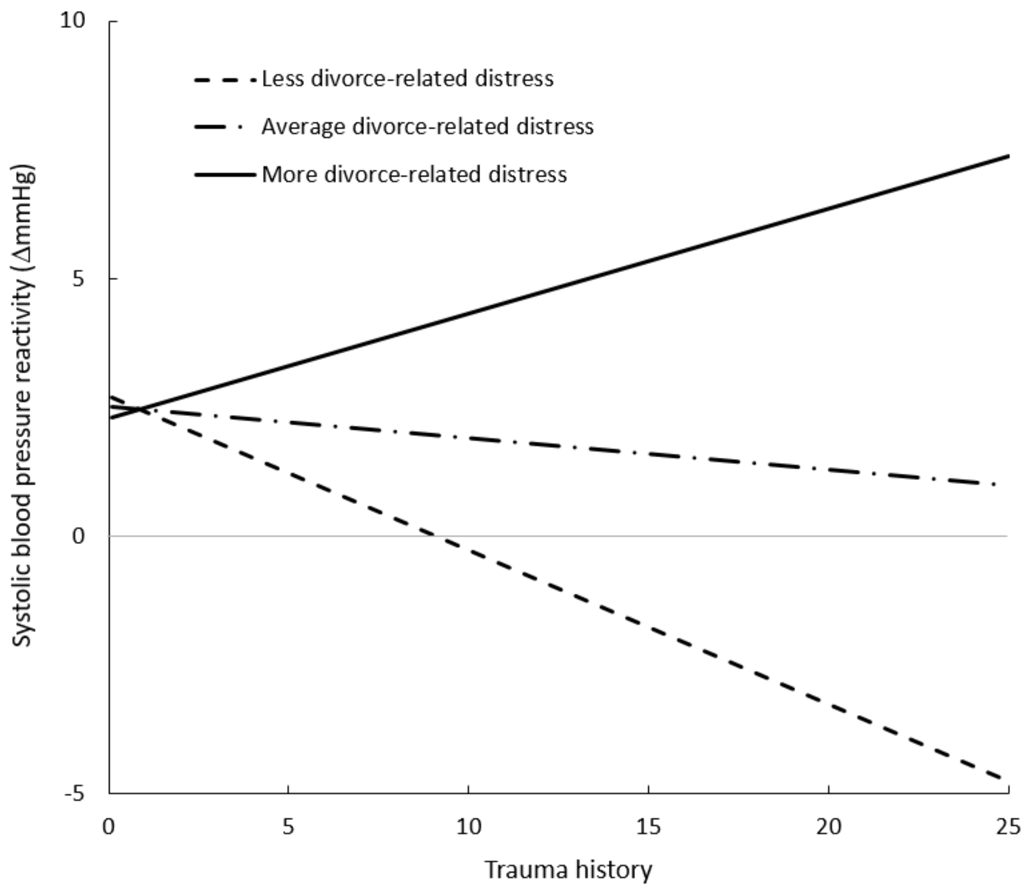

Figure 2. Blood pressure reactivity (measured in Δ mmHg) to the divorce-recall task paneled by systolic blood pressure. Lines illustrate associations at the mean level of divorce-related distress and ±1 *SD* from the mean.

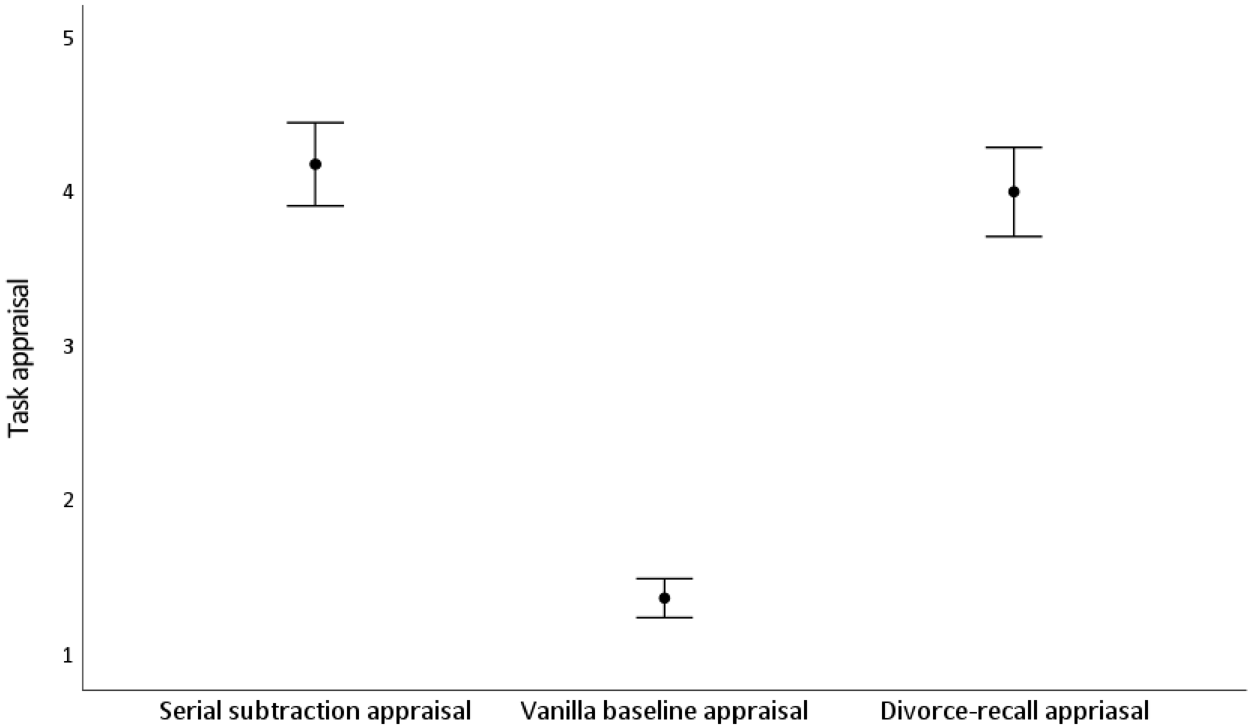

Figure 3. Task appraisals across the serial subtraction and divorce-recall tasks, as well as a vanilla baseline (a mundane event recall). Higher scores represent greater appraisals of stressfulness.

Cardiovascular Reactivity, Stress, and the Emotional Salience of Laboratory Stressors:

Choose Your Tasks Carefully

Kyle J. Bourassa & David A. Sbarra

Supplemental Materials

Supplemental Table 1. *Association Between Trauma History and Windsorized Cardiovascular Reactivity Scores*

	Systolic blood pressure			Diastolic blood pressure			Heart rate		
(N = 96)	β	95% CI	p	β	95% CI	p	β	95% CI	p
Cognitive task reactivity									
Trauma history	-0.41	[-0.75, -0.15]	<.001	-0.36	[-0.55, -0.17]	<.001	-0.09	[-0.30, 0.12]	.391
Divorce-related distress	-0.07	[-0.27, 0.13]	.501	-0.16	[-0.36, 0.04]	.122	-0.01	[-0.22, 0.21]	.878
Age	-0.08	[-0.29, 0.12]	.438	-0.07	[-0.27, 0.13]	.492	-0.15	[-0.29, 0.12]	.149
Sex	0.02	[-0.17, 0.22]	.829	-0.06	[-0.25, 0.14]	.575	0.11	[-0.09, 0.31]	.271
Time since divorce	0.23	[0.03, 0.43]	.022	0.21	[0.01, 0.41]	.038	0.02	[-0.19, 0.22]	.878
Baseline cardiovascular activity	0.09	[-0.11, 0.30]	.374	0.02	[-0.18, 0.22]	.868	-0.07	[-0.27, 0.13]	.391
Trauma × Divorce-related distress†	-0.06	[-0.25, 0.13]	.525	-0.02	[-0.22, 0.17]	.826	-0.01	[-0.22, 0.19]	.890
Divorce-recall task reactivity									
Trauma history	-0.02	[-0.23, 0.18]	.819	-0.11	[-0.23, 0.18]	.262	-0.07	[-0.27, 0.13]	.471
Divorce-related distress	0.21	[0.01, 0.40]	.040	0.24	[0.05, 0.44]	.013	0.19	[-0.01, 0.39]	.057
Age	0.14	[-0.06, 0.35]	.166	0.09	[-0.10, 0.29]	.347	-0.10	[-0.29, 0.09]	.296
Sex	-0.18	[-0.37, 0.01]	.062	-0.21	[-0.39, -0.02]	.031	-0.23	[-0.42, -0.05]	.015
Time since divorce	-0.05	[-0.25, 0.15]	.643	0.01	[-0.18 0.21]	.892	-0.04	[-0.23, 0.16]	.712
Baseline cardiovascular activity	-0.32	[-0.53, -0.12]	.002	-0.31	[-0.50, -0.10]	.003	-0.24	[-0.43, -0.06]	.011
Trauma × Divorce-related Distress†	0.21	[0.03, 0.40]	.025	0.21	[0.03, 0.39]	.026	0.03	[-0.17, 0.22]	.789

Note: All model estimates are from main effect models with the exception of the Trauma × Divorce-related distress estimates (denoted by †), which are from the moderation models. Time since divorce was measured in months. Baseline cardiovascular activity was the resting baseline level of the appropriate cardiovascular outcome. Systolic blood pressure scores were windsorized to -15.0 mmHg and 20.0 mmHg when higher and lower than these values, respectively, whereas diastolic blood pressure scores were windsorized to -10.0 mmHg and 15.0 mmHg when higher and lower than these values, respectively (n = 32 scores, 8.3% of the 384 total reactivity scores).

Supplemental Analysis 2. *Depression and Reactivity Scores*

Self-reported depressive symptoms were assessed in this study using the Beck Depression Inventory (BDI). Mean BDI scores in the sample were 16.7 points (*SD* = 11.6). BDI scores were correlated with trauma history ($r = .32$, 95% CI [.13, .52], $p < .001$). BDI scores were not associated with cardiovascular reactivity to either the serial subtraction or divorce recall task, as assessed by heart rate, systolic BP, and diastolic BP (all $|rs| < .15$, $ps > .15$).