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Marital Dissolution and Blood Pressure Reactivity: Evidence for the Specificity of Emotional Intrusion-Hyperarousal and Task-Rated Emotional Difficulty

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Abstract

Objective—To assess blood pressure (BP) reactivity as recently separated adults completed a laboratory task asking to mentally reflect on their relationship experiences. Marital separations and the experience of divorce are associated with increased risk for early mortality and poor health outcomes. Few studies, however, have investigated the potential psychophysiological mechanisms that may account for these broad-based associations.

Method—Seventy recently separated or divorced community-dwelling adults (26 men) completed self-report measures of divorce-related psychological adjustment. During a laboratory visit, quasi-continuous BP was assessed across four task periods, including a divorce-specific mental activation task (DMAT). A task-rated emotional difficulty (TRED) index was computed based on participants' immediate appraisals of the task demands.

Results—After accounting for relevant health-related covariates and depressed mood, participants who reported higher degrees of divorce-related emotional intrusion and physical hyperarousal demonstrated significantly elevated resting BP at entry into the study. When assessing change from a within-person control task to the DMAT, a three-way interaction indicated that men reporting high TRED scores evidenced significant increases in BP, whereas men reporting low TRED scores evidenced significant decreases in BP. Women evidenced no significant changes in BP across study periods.

Conclusions—Results suggest that divorce-related emotional intrusion-hyperarousal and real-time ratings of emotional difficulty (when people think about their separation experience) may play a specific role in BP reactivity, especially for men. These data shed new light on the potential mechanisms that may link marital dissolution and poor health.

Keywords

divorce; blood pressure reactivity; autonomic psychophysiology; social connectedness and health; emotion intrusion; multilevel modeling

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INTRODUCTION

Several large-scale epidemiological studies indicate that being or becoming divorced is associated with increased risk for early mortality (1–8), and it is well known that marriage confers a variety of positive health benefits (9,10). Although divorced adults are more than twice as likely as their married counterparts to commit suicide (3), self-inflicted death cannot fully explain the net increase in mortality, and there is ample evidence for early death post divorce for both sexes from cardiovascular disease as well as all causes (5,8,11). The mechanisms explaining the divorce-health risk remain to be illuminated, and doing so will require a combination of research methodologies ranging from social epidemiology to social psychophysiology. This paper describes findings from a laboratory analogue study designed to assess blood pressure (BP) reactivity when recently separated adults think about their relationship history and the end of their marriage.

Several candidate explanations exist for understanding divorce-health associations. First, the putative health consequences of divorce may in fact represent selection effects whereby third variables that increase risk for divorce also increase risk for later illness (12). Hostility, neuroticism, and depression, all of which predict divorce (13,14), also are associated with a range of poor health outcomes (15). Unfortunately, these dimensions of behavior, personality, and mental health have not received systematic attention as predictors of postdivorce health.[1] Studies that have addressed selection effects indicate that predivorce health behaviors, such as drinking, drug use, and risk-taking, explain common variance in both divorce and subsequent health outcomes (16). Thus, although selection effects operate to predict health outcomes after a divorce, it is also likely that this process cannot explain the entirety of the early mortality effect.

The second mechanism of interest is change in health behaviors. Marriage promotes positive health habits (10), and the loss of this protective benefit, coupled with the stress of divorce, can lead to changes in health behaviors that have long-term implications for disease processes (17). Divorced adults show increases in alcohol and substance use, increases in smoking behaviors and greater likelihood for smoking relapse, decreased consumption of fruits and vegetables, heightened weight loss, and disrupted sleep (18,19).

A third pathway of interest from divorce to later health outcomes is psychological stress and its associated physiological responses. Although the vast majority of adults cope well with a divorce experience, marital separation is consistently rated among the most stressful life experiences (20), and it is one of the most systematic predictors of a clinically significant major depressive episode (21–23). Numerous studies link chronic psychological stress and depression to poor health outcomes (24,25). Few studies, however, have assessed in detail adults' physiological reactions to divorce (26–28). Kiecolt-Glaser and colleagues (26)

[1] In a recent paper, Osler and colleagues (12) used a co-twin control design to assess the protective role of marriage relative to divorce/widowhood. This is an ideal way to isolate selection effects from putatively causal effects on health outcomes. Monozygotic (MZ) twins who were divorced or widowed evidenced significantly greater rates of depression and smoking relative to twins who were not discordant for these events, which suggests that the stress associated with divorce or widowhood plays a causal role—given that MZ twins share an identical genotype—in the onset of mood problems and smoking increases. Unfortunately, this study does not permit a disentangling of the effects associated with divorce and widowhood because these marital status classifications were grouped together in comparisons against married twins.

demonstrated that, relative to married adults, divorced adults had significantly higher antibody titers to Epstein-Barr Virus and lower percentage of Natural Killer cell activity—both of which indicate compromised immune functioning. Among the divorced group, shorter separation period and continued attachment to a former spouse were associated with poorer physiological outcomes, suggesting that psychological variables specific to divorce adjustment (e.g., continued attachment to a former spouse) are associated with immune functioning.

In the almost two decades from the time this research was published, no further work has attempted to determine how other psychological factors affect physiological functioning or self-regulatory ability after he end of marriage. To the extent that thinking about or discussing one's separation or divorce experience is affectively charged, adults' psychological responses to these events may maintain states of acute or chronic stress. This perspective is consistent with a large body of evidence indicating that psychological variables play a primary role of maintaining, attenuating, or consistently reactivating potentially harmful physiological stress responses (29–31). Determining precisely how these processes operate after a marital separation requires more detailed measurement of cardiovascular functioning aimed at capturing the interplay between cognitive-emotional variables and the use of physiological indices that have implications for long-term health outcomes.

In what particular ways might these processes unfold after a marital separation? From the perspective of attachment theory (32), the regulation of felt security or the perception that the world is safe and nonthreatening is a primary task for coping successfully with a separation or loss experience (33,34). People who recover well after their separation/divorce experience are able to maintain a sense of felt security when they think and talk about their ex-partner and their former relationship. This is consistent with Lazarus's and Folkman's (35) model of an environmental event that is rendered benign by virtue of one's appraisals; for the well-adjusted, thinking about a breakup has no emotional potency. People who have come to terms with a marital separation may experience passing (and perhaps even strong) feelings of sadness, anger, regret, or the like, but consistent with Bowlby's (32) ideas about psychological reorganization, they are able to regulate their emotions and provide themselves with a sense of felt security (34). In contrast, for people who cannot establish a sense of felt security in the aftermath of a separation, thinking and talking about the end of their relationships is an emotionally difficult experience. The limited evidence available is consistent with this perspective and suggests that physiological responses vary according to the degree to which people report divorce-related distress (26).

Present Study

In the present study, we created a divorce-specific mental activation task (DMAT) as a laboratory analogue for understanding adults' physiological responses when they think about their marital history and recent separation. At intake, participants spoke on a range of self-reported outcomes, including the emotional impact of the separation and overall levels of depressed mood. Consistent with the idea that adults who continue to struggle with their separation view the event as a persistent threat to their emotional well-being, we

hypothesized that, after accounting for depressed mood, participants who reported more separation-related emotional intrusion and hyperarousal would enter the study with significantly elevated BP and evidence significantly greater increases in BP reactivity from baseline to the DMAT. Furthermore, we expected that increases in BP would be due to the emotionally taxing nature of the DMAT; therefore, we also hypothesized that the association between emotional intrusion/hyperarousal and BP reactivity would be mediated by task-rated emotional difficulty (TRED) during the DMAT. Support for this hypothesis would provide the first evidence that when asked to think about one's separation and divorce experience, the degree of emotional difficulty of the task explains associated changes in physiological response patterns.

METHODS

Participants

Participants were 70 community-dwelling adults (n = 26 men) recruited through newspaper advertisements, divorce recovery support groups, and the local family and conciliation court. On average, participants were 39.50 years old (standard deviation (SD) = 9 years, 10 months; range = 19–61 years), reported having been married or in a marriage-like relationship for 10 years, 7 months before the separation (SD = 7 years, 11 months; range = 5 months–35 years), and having physically separated from their former partner 3 months and 2 weeks before the study session (SD = 3 months and 3 weeks; range = 2–36 weeks).[2] Thirty-two percent of the sample was legally divorced, 23% were legally separated, and 44% were physically separated without any legal action (the remainder of the sample did not describe their separation status).[3] Sixty-eight percent of the sample described themselves as White (non-Hispanic), 10% as Hispanic, 1% as Asian, 3% as African-American; the remainder of the sample chose not to provide race data. Sixty percent of the sample reported earning <$35,000 in gross annual income. Forty-two percent of the sample reported that they initiated the separation, and the remainder reported that their partner initiated the separation. Participants reported spending an average of 30% of each day (in the 2 weeks before study intake) thinking about their ex-partner and the demise of their marriage (SD = 26%; range = 0%–90% of each day); similarly, participants reported spending an average of 15.5 minutes per hour thinking about their ex-partner and the demise of their marriage (SD = 14.5 minutes; range = 0–60 minutes). The data for this study were collected over a period of 24 months between 2006 and 2008, and all aspects of this study were approved by the University of Arizona Human Subjects Protection Program.

Procedure

Adults who responded to the study advertisements were screened along several dimensions; all participants who reported that they were generally healthy, without a history of a psychotic disorder, and, for women, not pregnant were deemed eligible to participate.

[2]Marriage-like relationships were those in which participants considered themselves a long-term partnership without a legal marriage certificate. Two couples meeting this status were included in the current analyses; they reported their average relationship length prior to the separation as 137.5 months (222 months and 53 months, respectively).

[3]Variability in the separation status variable is a strength of the present study. Many studies of divorce adjustment only examine the functioning of legally divorced adults, but, if we assume that the adjustment process unfolds over time from the date of physical separation (if not before), then studying only legally divorced adults is actually a poor way to understanding divorce adjustment.

Participants were told that the purpose of the study was to understand "how adults adjust to marital separation and the ways in which your body responds when you think about and reflect on your separation experience." Before the participants' scheduled laboratory visit, they were mailed a questionnaire packet that included a series of demographic questions as well as the self-report questionnaires described below. Participants were asked to refrain from tobacco and caffeine for at least 4 hours before the study visit. At the laboratory visit, a research assistant reviewed the questionnaires, and participants completed a stream-of-consciousness recording about their separation experience (not reported here) before the physiological measurement portion of the study began. Participants were seated in a physiological measurement chamber that included one speaker and two video cameras for communication between the participant and experimenter, who was located in the control room next door. After equipment set-up, participants were instructed to sit quietly and relax during a 4-minute nature video. This period constituted the resting baseline assessment. After the nature video, participants completed a 4-minute mundane events recall (MER) control task. The MER task asked participants to reflect mentally on the answers to four nonemotional questions presented on the computer screen in front of them. For example, the first MER question that appeared on the screen was: "Imagine you need to mail a letter at the post-office. Please envision addressing the letter, waiting in line at the post-office, then sending the letter." After each MER question was presented on the screen, a 1-minute reflection period followed immediately before the next question appeared. (Thus, for both the MER and the DMAT described below, the 1-minute reflection period was initiated the instant the question appeared on the computer screen in front of the person and therefore included the time spent reading the question.) Participants did not respond to the questions aloud: They imagined and reflected mentally on their answers to their questions during each 1-minute period. The MER task targeted potential changes in BP associated with expending mental energy and at the same time concentrating on a question. Thus, changes in BP from the MER to the DMAT were specific to the content of the DMAT and were not due to a general physiological orienting response or to the physiological demands of sustained concentration. After the four MER questions, participants completed a task appraisal.

After the MER task, the 7-minute DMAT began. For this task, participants were asked to "spend some time thinking about yourself and your partner in a variety of different situations." Similar to the MER, after a question was presented on the computer screen in the measurement chamber, participants were asked to "concentrate on the question by letting any relevant thoughts, feelings, or images come to mind" for a 1-minute period. The DMAT items were ordered as follows: 1) Please think about how you and your former partner met. 2) Whose decision was it to end the relationship? Why? Please think about the events leading to the end of your relationship. 3) When did you first realize you and your partner were headed toward divorce? What was that time like? 4) What do you remember about the separation itself, the actual time during which the two of you decided to stop seeing each other? 5) How do you think you've coped with this separation? 6) How much have you seen your partner since the separation? What kind of contact have you had since ending your relationship? and 7) What's been the worst part about this separation for you? After the DMAT, participants completed a 4-minute DMAT recovery period. After this recovery period, the BP equipment was removed from the participants. Participants were then

debriefed about the overall nature of the study. All participants were paid $100 for the laboratory visit.

Psychological Measures

Beck Depression Inventory (BDI)—The BDI is a widely used 21-item inventory that assesses components of depressive states (36). Its single scale is the mean of the items, with higher scores indicating greater depressive symptoms. In the present sample, the mean ± SD BDI score was 16.42 ± 11.23 (range = 0–45), which is in the moderately depressed range of functioning, and the internal consistency for the BDI was strong ($\alpha = 0.89$).

Impact of Events Scale-Revised (IES)—The revised version of the IES (37,38) is a widely used 22-item questionnaire that assesses emotional reactions to stressful events and symptoms that are typically associated with posttraumatic stress disorder (PTSD) but that are not specific to diagnosis of PTSD. The combined emotional intrusion-hyper-arousal subscale was used in 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 scorers reflect greater emotional intrusion and somatic hyperarousal as a consequence of one's marital separation experience. Test-retest correlations for this measure are high for periods <2 weeks ($r > .85$). In the present study, the internal consistency for the IES was strong ($\alpha = 0.93$).

Task Appraisal Questions—Immediately after the MER and the DMAT, participants completed the same task appraisal form. All items were assessed on a 7-point Likert scale. For each task period, a four-item TRED scale was computed as the mean of the following questions: 1) “How upsetting did you find this task?” 2) “How much effort did you exert controlling your emotions?” 3) “How emotionally difficult was the task for you?” and 4) “How much anxiety or bodily tension did you experience during the task?” The summary score was internally consistent for both the MER and the DMAT ($\alpha = 0.81$ and 0.80, respectively). People scoring higher on this scale indicated that the task was emotionally difficult for them and that they exerted considerable effort trying to control their emotional experience. Consistent with the idea that the MER served as a nonemotional control task, participants reported significantly more emotional difficulty during the DMAT, t (69) = 17.85, $p < .001$. For the analyses described below, a difference score (DMAT score – MER score) was used to index the extent to which participants found the DMAT questions more emotionally difficult than the MER questions. Table 1 displays the zero-order correlations among the TRED index and the four other psychological adjustment scales. Three additional task appraisal items were used to check the degree to which participants reported 1) how well they were able to focus on the DMAT task; 2) how engaging they found the DMAT task; and 3) how realistic they found the DMAT task. The average participant reported a 5.60 of 7.00 on a question asking them how well they were able to focus on the DMAT questions (SD = 1.22). The average participant reported 5.70 of 7.00 on a question asking them how well they were able to engage in the DMAT task (form a detailed mental image; SD = 1.18). To assess the realism of the DMAT task, participants were asked how similar they found the DMAT items to be to their normal daily thoughts about their separation on a

scale from 1 (very artificial, never like this) to 7 (very similar to how I usually think about this event). The average participant reported a 4.98 in response to this question (SD = 1.59), indicating that they found the DMAT to be a fairly similar experience to what unfolds outside of the laboratory (but not necessarily identical to how they think about things on a daily basis). Thus, these items indicate that 1) on average, participants reported a high degree of engagement during the DMAT, as indicated by high levels of focus and mentally detailed images in response to the task questions; and 2) participants found the task to be representative of their thoughts about their separation experience outside of the laboratory.

BP Assessment

BP was assessed using a noninvasive tonometry device (relative to a standard oscillometric cuff) over the radial artery to provide frequent, real-time updates of systolic (SBP) and diastolic (DBP) BP (Vasotrac AMP 205, Medwave Inc., Arden Hills, Minnesota). SBP is the peak pressure in the arteries at the beginning of the cardiac cycle, whereas DBP is the lowest pressure at the resting phase of the cycle. The Vasotrac uses frequent compression and decompression of the radial artery at the wrist to detect the zero-load state around which the pressure signals are measured. This information is used to detect and then display arterial pressure and waveform every 12 to 15 beats. The Vasotrac was calibrated against radial catheter measures of BP and demonstrated excellent convergent validity (mean R^2 for SBP and DBP = .95) (39). The tonometry device was placed over the radial artery on the participants' nondominant arm, and participants placed their arm on a table in front of them for the duration of the study. After the tonometry device was securely fastened, there was a brief 3- to 4-minute adaptation period before the video baseline recording. BP data were scored using postprocessing software (BP 2.6, Mindware Technology, Westerville, Ohio). Minute-by-minute means were computed for SBP and DBP across each of the five main study periods (baseline, MER, DMAT, DMAT recovery), resulting in 19 total possible observations per person. For the MER and DMAT periods, each minute of BP data includes the amount of time the participant spent reading each task question as well as the time spent reflecting on each answer.

Covariates

To account for possible differences in demographic and health status variables on BP at study entry and for reactivity across tasks, several covariates were included in the analyses. Demographic covariates were participants' age and sex. Body mass index was calculated as weight in kg/(height in m)^2, and participants provided self-report information on their 1) weekly exercise habits (number of days per week of exercise); 2) history of doctor-diagnosed high BP (yes/no); and 3) current tobacco use (yes/no). In addition, two relationship-specific variables were included in the analyses: the length of the relationship before physical separation (described above in the participants section) and participants' report (on a dichotomous item) of who initiated the separation. Fifty-two percent of the sample indicated that they initiated the separation, whereas 48% indicated that their partner initiated the separation. Accounting for the association between these variables and BP responses allows us to determine if adults' psychological responses to their marital separations are uniquely associated with BP responses over-and-above more objective aspects of the relationship history and separation.

Data Analysis

To test the hypotheses outlined above, data were analyzed using multilevel modeling in the SAS Proc Mixed routine (40). When task periods are nested under each participant, multilevel modeling accounts for the nonindependence of the study data and permits for the modeling of trends in the data. This approach enables us to account for the participants' initial BP levels when exploring changes across tasks. Thus, data were analyzed to ascertain whether people scoring higher on the IES and BDI scales began the study with significantly higher BP. Change in BP over time was parameterized three ways within a single multilevel model. First, we assessed change from baseline to the MER task by dummy coding baseline as 0 and every other period of the study as 1 (coded 0,1,1,1, this variable is denoted as Time-1 throughout the report). Second, we assessed BP change from the MER to the DMAT by dummy coding the baseline and MER periods as 0, and every other period of the study as 1 (coded 0,0,1,1, this variable is denoted as Time-2 throughout the report). Finally, we assessed change from the DMAT to the DMAT recovery by dummy coding every period before the recovery as 0, then coding the recovery as 1 (coded 0,0,0,1, this variable is denoted at Time-3 throughout the report and reflects a third change from the DMAT to the DMAT recovery after accounting for the first change processes; as specified, a negative parameter estimate for Time-3 would indicate that BP decreases during the recovery). When coded this way, the three time variables can be entered into a single model to represent the functional form of the BP responses displayed in Figure 1. Time-1 accounts for a linear increase from the baseline period to the MER. Time-2 accounts for increases from the MER to the DMAT (over-and-above change that has already occurred). Time-3 accounts for any final change from the DMAT to DMAT recovery. After accounting for the covariates, the two psychological adjustment variables were entered into the model. A series of interactions among each of these variables and each of the three time variables were then tested in a forward stepwise procedure. If an interaction was significant, indicating that change in BP from baseline to the MER task (or change from the MER task to DMAT) was dependent on participants' psychological adjustment, it was retained in the model. The interactions among the TRED index and the time variables were then entered into the model as a potential mediator of the observed effects. Models used a maximum likelihood estimation procedure and an autoregressive error structure to account for the unexplained within-person variance. All continuous level-2 predictor variables were grand-mean centered before the analyses to facilitate interpretation.

RESULTS

Figure 1 illustrates the patterns of SBP and DBP across all 19 minutes of the study. The first series of models examined change in BP from baseline to the MER task and from the MER task to the DMAT after accounting for the covariates of interest. Results are displayed in Table 2 (Model 1). After accounting for the other variables in the model, men entered the study with significantly higher SBP than women (male mean SBP at intake was 130.86 mm Hg; female mean SBP at intake was 120.37 mm Hg). Participants' report of the length of their marriage before the separation also was a significant predictor of baseline SBP. Because the length of marriage variable was grand-mean centered, each additional month of marriage above the sample mean of 150 months was associated with a 0.06-U increase in

SBP. Thus, participants who were 1 SD above the mean in their reported length of marriage (95 months) entered the study with a higher resting SBP than those closer to the mean (5.60 mm Hg higher). From the baseline assessment to the MER task, there was a trend toward a significant increase in SBP ($p = .08$), with the average participant increasing just over 2.00 mm Hg from baseline to the MER). Across all participants, there was no significant change in SBP from the MER task to the DMAT. The lower panel of Table 1 displays the results for DBP.

The next series of analyses examined the role of the psychological adjustment variables on baseline BP. Results are presented under Model 2 (Table 1). After accounting for the health-related covariates, relationship history, and BDI scores, the IES emotional intrusion-hyperarousal scale was significantly associated with SBP and DBP. Specifically, participants who reported experiencing more emotional intrusion from their separation experience (e.g., having thoughts about the separation pop into one's mind, having dreams about an ex-partner and the breakup, and having waves of strong emotion) and also greater feelings of somatic hyperarousal evidenced significantly higher BP scores at study intake. Participants who scored 1 SD above the mean on the IES entered the study with an elevation of roughly 6.00 mm Hg in SBP (Figure 2), whereas participants scoring 1 SD below the mean on the IES evidenced a decrease in SBP (from the sample mean at baseline) of the same amount. To ensure that the association between IES scores and baseline BP was not due to a suppression effect in the regression analyses, the BDI scale was removed from the model and the analyses were rerun: IES scores remained a significant predictor of baseline BP in this reduced model.

To examine the hypothesis that participants reporting greater divorce-related emotional intrusion-hyperarousal would evidence greater increases in BP from the MER task to the DMAT after accounting for the effects of more generalized mood disturbance, two interaction terms were added to Model 2 (each psychological adjustment variable multiplied by the dummy coded Time-2 variable). Neither of the two interactions was significant for SBP or DBP. Because the emotional intrusion-hyperarousal variable did not moderate changes from the MER task to the DMAT, this rendered untenable the hypothesis that such changes would be mediated by TRED scores.

To explore the role of TRED scores, we examined whether this variable was associated with changes in BP from the MER task to the DMAT. Results of this analysis are presented under Model 3 (Table 2). The interaction between TRED scores and change from the MER task to the DMAT (Time-2) was significant. Participants who reported that thinking about their relationship history and separation experience was more emotionally difficult than thinking about everyday activities demonstrated significant increases in SBP and DBP from one task to the next. Specifically, participants who were 1 SD above the mean in task-rated emotional difficulty demonstrated an average increase of 2.28 mm Hg and 1.41 mm Hg in SBP and DBP, respectively. Finally, to explore the possibility that these changes in BP operate differently for men and women, the three-way interaction of the Time-2 by TRED score by participant sex was entered into the multilevel model after accounting for each main effect and each two-way interaction. The three-way interaction was significant: $b = -5.25$, $t = -2.81$, $p = .007$; and $b = -2.90$, $t = -2.28$, $p = .026$, for SBP and DBP, respectively.

Decomposition of the simple slopes using a recently developed computational tool for multilevel models (41) indicated that the significant changes were observed only in men. Men who reported 1 SD above the mean on the TRED demonstrated an 8.19 mm Hg increase in SBP, $z = 3.05$, $p = .002$, whereas men who reported 1 SD below the mean on the TRED demonstrated a 6.17 mm Hg decrease in SBP, $z = -2.144$, $p = .03$. In contrast, the simple slopes for women scoring above and below the mean were not different from zero ($z = 0.12$, $p = .90$ and $z = 0.40$, $p = .68$ for the high and low emotional difficulty groups, respectively). The same pattern of significant/nonsignificant simple slope differences emerged for DBP. Changes in SBP from the MER task to the DMAT are illustrated in Figure 3 by participant sex and TRED scores (4).

Change from the DMAT to the DMAT recovery period was examined in a final series of models using the Time-3 variable. After accounting for the covariates of interest and the significant fixed effects, the Time-3 variable was not a significant contributor to the model for SBP or DBP. Consistent with the pattern of BP responses illustrated in Figure 1, this finding indicates that the average person in the study did not exhibit significant BP change from the DMAT to the DMAT recovery period. Furthermore, in the absence of a main effect for Time-3, there was no evidence that either IES or BDI scores moderated BP change from the DMAT to the DMAT recovery period.

DISCUSSION

Despite well-documented associations between divorce and all-cause mortality (1–6), and despite the fact that divorce is rated consistently among life's most stressful experiences (20), few studies have examined how adults' psychological responses to their separation experience are associated with biological responses that affect long-term health. The present study examined BP reactivity during a laboratory analogue task prompting recently separated/divorced adults to think about their relationship experiences. There was no support for the main hypothesis that participants reporting greater divorce-related emotional intrusion-hyperarousal would evidence greater BP reactivity from the MER task to the DMAT (and, consequently, that TRED scores would explain this effect). However, two main findings emerged that have implications for better understanding the divorce-health association. First, participants who reported that they experienced high levels of intrusive thoughts about the separation/divorce and greater physical hyperarousal entered the study with higher SBP and DBP than did participants who reported less emotional intrusion-hyperarousal. The association between IES scores and baseline BP levels was evident after accounting for participants' general mood disturbance, length of marriage, who initiated the separation, and a host of health-related covariates. Second, TRED scores moderated BP reactivity from the MER task to the DMAT, but this effect depended on the participants' sex. Men reporting high levels of TRED evidenced an increase in BP across the tasks; men reporting low levels of TRED evidenced a decrease in BP across the tasks. In contrast, women evidenced no change in BP regardless of their TRED scores.

Why do emotionally intrusive thoughts about one's divorce and somatic hyperarousal predict baseline BP above-and-beyond general mood disturbance and other relationship history variables? Emotional intrusion and hyperarousal are two of the defining criteria for PTSD

and tend to be highly correlated (42). (In the present study, the intrusion and hyperarousal subscales of the IES were highly correlated (r = .82); we therefore created a single intrusion-hyperarousal scale, which is consistent with the factor analytic literature on this topic.) Resting BP is significantly associated with PTSD (43), and to the extent that participants experience the separation as an experience that is characterized by hyperarousal and emotional intrusions, elevations in resting BP are predictable. This is not to say that marital separation or divorce are traumatic stressors per se, but the extent to which adults perceive the event as traumatic, and thereby experience emotional intrusion and hyperarousal, we can expect corresponding biological responses as well. One way of viewing this finding is consistent with Lang's (44) bioinformational theory of emotional imagery, which holds that affective events are represented in memory via an associative network that codes for sensory perceptions and action information. People who report experiencing persistent, emotionally intrusive experiences about their separation experience may activate an associative network and prime their bodies for action even if no immediate environmental demands necessitate physical exertion. A critical question for the study of divorce adjustment is whether the experience of emotional intrusion-hyperarousal is state-like (grief response) or more trait-like (general propensity to experience arousing negative affect). If longitudinal studies reveal little change in IES scores over time, this may suggest one route through which divorce-specific thoughts are associated with chronically elevated BP; this association, in turn, may have direct relevance for understanding the long-term health correlates of marital disruption.

As participants transitioned from the MER task to the DMAT, there was a dissociation among the psychological adjustment variables and the TRED index. The TRED index predicted reactivity for men (not women) whereas the two psychological adjustment variables were unassociated with BP change in response to the DMAT. Although the TRED index was positively correlated with each of the two self-report measures (for both men and women), this proximal index of emotional difficulty and regulatory effort proved a better predictor of BP reactivity than mood disturbance or emotional intrusion-hyperarousal. In terms of the observed sex difference, women are more adroit at discussing emotional topics than men (45), and even when women report higher degrees of perceived negative emotion, the DMAT may not constitute an emotional challenge that requires a corresponding BP response. Although women are more likely than men to engage in ruminative thought patterns that are associated with depressive symptoms (46,47), thinking about and reflecting on emotionally difficult tasks may not be a uniquely challenging experience for women. In contrast, the DMAT may have been a more difficult and threatening experience than anticipated for men who reported higher TRED scores and showed BP elevations from the MER task. For men scoring lower on the TRED index, the DMAT may have been less threatening than anticipated, which may have permitted decreases in BP across tasks. Men evidence worse health outcomes than women post divorce (10,48–50), and to the extent that the BP changes observed here can predict later outcomes (see below), these findings suggest one route through which men may be at unique health risk after a marital separation. Men who experience a great deal of emotional difficulty when they think about their divorce experience evidenced between a 8 mm Hg (1 SD above the TRED mean) to 16 mm Hg (2 SD above the TRED mean) increase in SBP from the MER task to the DMAT. Men found

the DMAT emotionally upsetting with a total SBP between 144 mm Hg and 152 mm Hg when they reflected on their separation experience; these increases in SBP are independent of those associated with emotional intrusion and hyperarousal.

The most pressing question to emerge from this study may be whether the observed effects have long-term implications for broad-based health outcomes. Although there is ample evidence that cardiovascular reactivity in the laboratory can predict the subsequent development of hypertension (in normotensive adults) and preclinical disease states (51–53), it remains to be determined if the DMAT captures a meaningful psychological experience that unfolds over the course of one's daily life. The average participant reported thinking about their partner 30% of the time each day for the 2 weeks before study entry. If we assume, for instance, that people sleep approximately 8 hours per night (adults adjusting to an acute stressor probably sleep less), this percentage translates into >4.5 hours each day spent thinking about one's ex-partner and the end of the marriage. Three critical characteristics for understanding the impact of psychological stress on biological end points are the magnitude, duration, and frequency of the responses (54). If thinking about one's ex-partner consistently activates a BP response that approximates the response observed from the MER to the DMAT, we may consider men at risk for consequent health problems by virtue of large, sustained, and frequent BP reactivity. It is noteworthy that highly distressed men's responses to the DMAT push them into a range of hypertensive functioning (SBP >150 mm Hg and DBP >100 mm Hg), and this effect is entirely separate from their baseline levels of BP, which also may be elevated due to high scores on the IES. To understand the implications of these findings, it will be informative for future research to examine whether the DMAT adequately represents how adults typically reflect on their separation experiences outside of the laboratory. The DMAT appraisal items suggest that the average participant found the task to be realistic and similar to everyday life, but additional research is needed to confirm that this realism translates into BP reactivity in everyday life.

Although this study is the first to examine BP reactivity to a divorce-specific laboratory task, several limitations should be recognized. First, the assessment of autonomic functioning was limited only to BP, which precludes a more detailed assessment of the potential hemodynamic or vascular origins of the observed BP changes. Future research including impedance cardiography will allow for the assessment of total peripheral resistance, which can provide a summary index of resistance along the peripheral vasculature. This addition will provide a more fine-grained understanding of the observed effects. Second, because the DMAT is a mental reflection task, there was no way to determine if participants were actually thinking about their separation experience. Although the majority of participants reported (on the DMAT appraisal form) that they achieved vivid images and were able to devote a high degree of focused attention to the task, we cannot determine the specific thoughts that triggered increases in BP during the DMAT (for men who reported a high TRED score). Third, without a comparison group of nondivorced adults, it is difficult to conclude that the observed effects are specific to thinking about one's separation and divorce experience. Although the MER task provides an important within-person control condition, the lack of a between-persons comparison task is a significant limitation. Finally, although the sample size of this study was relatively large for a community-dwelling study of divorce

adjustment, the absolute number of participants (especially men) remains relatively small. A replication of this study in a larger sample should include more men.

CONCLUSION

This paper is among the first investigations of the potential psychophysiological mechanisms that may link a divorce experience to subsequent health outcomes. After accounting for relevant demographic and health indicators, participants reporting higher levels of divorce-related emotional intrusion-hyperarousal entered the study with significantly higher SBP and DBP. Participants' emotional intrusion scores predicted baseline BP above-and-beyond depressive symptoms, length of marriage before separation, and initiator status. Men who reported a higher TRED scores evidenced a significant increase in BP, whereas men who reported lower TRED scores evidenced significant decreases in BP. No changes in BP were observed for women from the MER task to the DMAT. Overall, the findings suggest that the psychological constructs of emotional intrusion-hyperarousal and task-rated emotional difficulty are uniquely and differentially associated with BP responses after a marital separation.

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Glossary

BP	blood pressure
DBP	diastolic blood pressure
DMAT	divorce-related mental activation task
MER	mundane events recall task
SBP	systolic blood pressure
TRED	task-rated emotional difficulty

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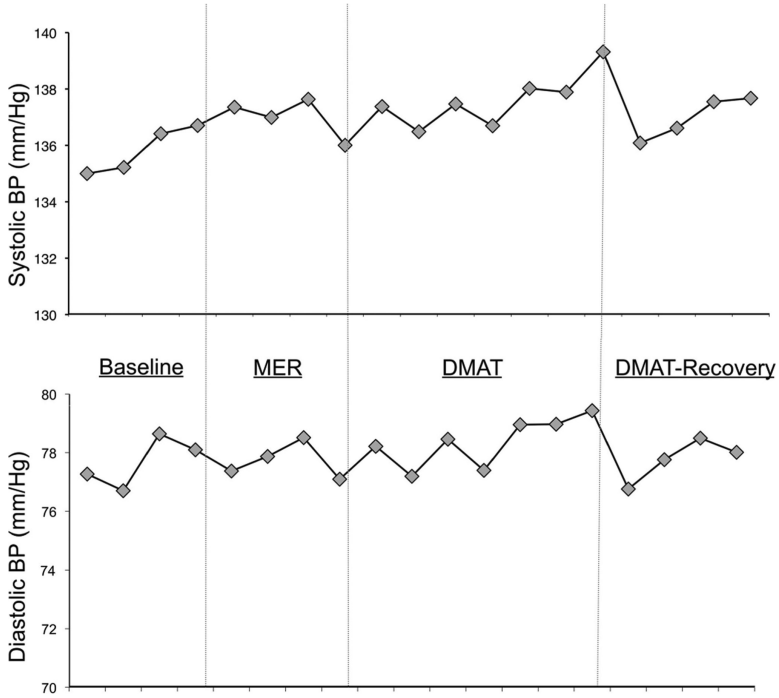

Figure 1.

Systolic and diastolic blood pressure (BP) scores across the four study periods. MER = mundane events recall task (4 minutes); DMAT = divorce-specific mental activation task (7 minutes); DMAT-Recovery = DMAT recovery period (4 minutes). Changes in minute-by-minute BP scores modeled as a function of divorce-related psychological adjustment in the subsequent analyses.

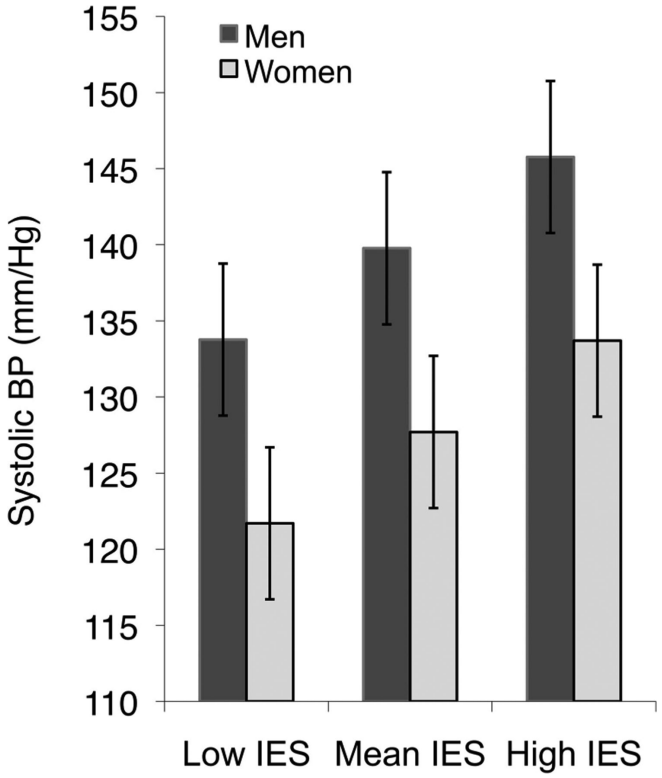

Figure 2.

The association between Impact of Event Scale (IES) intrusion-hyperarousal scores and baseline levels of systolic blood pressure (SBP) by participant sex. High scorers on the IES (1 standard deviation (SD) above the IES mean) showed an increase of roughly 8.75 mm Hg of SBP at baseline, whereas low scorers on the IES (1 SD below the IES mean) showed a decrease in SBP of the same amount.

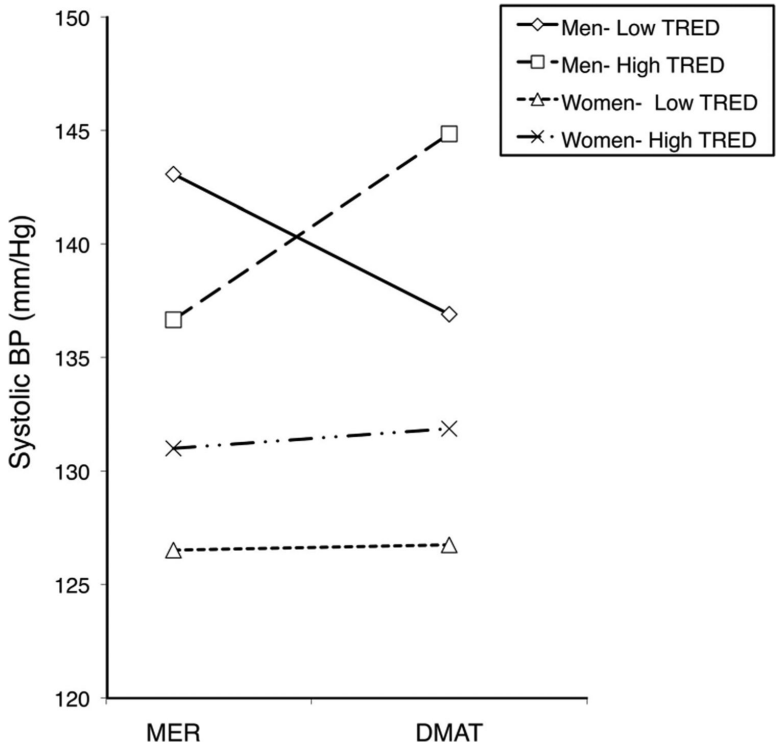

Figure 3.

Simple slopes depicting the three-way interaction between participant sex, time (from the MER task to the DMAT), and task-rated emotional difficulty (TRED) predicting changes in SBP across task periods. Only men evidenced significant simple slopes. Men with high TRED (1 SD above the TRED mean) scores evidenced a significant increase in systolic blood pressure (SBP) from the MER task to the DMAT, whereas men with men with low TRED scores (1 SD below the TRED mean) evidenced a significant decrease in SBP.

TABLE 1

Zero-Order Correlations Among the Task-Rated Emotional Difficulty Index, Psychological Adjustment Variables, and Relationship-Specific Covariates

Scale	Men					Women				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
1. TRED	1					1				
2. BDI	0.31	1				0.44**	1			
3. IES	0.3	0.89**	1			0.53**	0.67**	1		
4. Length	–0.31	–0.04	–0.16	1		–0.03	0.05	0.06	1	
5. Initiator status[a]	0.25	0.57*	0.55*	0.17	1	0.07	0.1	0.04	0.03	1
Mean	2.42	14.46	22.26	151.08	1.46	2.73	16.78	22.89	112.16	1.48
SD	1.49	11.12	13.8	94.24	0.5	1.21	11.31	12.57	95.36	0.5

TRED = task-rated emotional difficulty score; BDI = Beck Depression Inventory; IES = Impact of Events Scale; Length = length of time in months the participants were married before the separation; Initiator status = participants' reports of who initiated the separation (1 = you initiated the separation; 2 = your partner initiated the separation).

[a]Because initiator status is a dichotomous variable, point biserial correlations are reported between this measure and the four other continuous measures. None of the variables presented in the table were significantly different between male and female participants.

*$p < .01$

**$p < .001$.

TABLE 2

Unstandardized Parameter Estimates From Three Multilevel Models Assessing Change in Systolic (S) and Diastolic (D) Blood Pressure (BP) Across the Study Periods

Variable	Model 1			Model 2			Model 3		
	b	SE	*p*	b	SE	*p*	b	SE	*p*
SBP									
Intercept	141.33	12.83	.001	151.84	12.96	.001	148.78	13.09	.001
Sex	–10.47	4.44	.02	–12.07	4.3	.007	–11.73	4.27	.008
Age	0.07	0.29	.79	0.08	0.28	.3	0.02	0.27	.92
Exercise	0.78	0.99	.43	0.63	0.95	.51	0.86	0.95	.37
Tobacco	5.66	1.18	.24	3.15	4.86	.52	4.13	4.69	.38
BP Hx	6.68	6.54	.31	5.11	6.28	.42	5.74	6.28	.36
BMI	0.344	0.41	.83	0.05	0.41	.91	–0.01	0.41	.98
Length	0.06	0.03	.04	0.06	0.03	.05	0.06	0.03	.03
Initiator status	1.12	4.01	.78	–0.55	3.9	.88	–0.32	3.88	.93
Time-1	2.09	1.13	.08	2.02	1.13	.08	2	1.13	.08
Time-2	0.87	1.3	.66	0.9	1.31	.49	0.91	1.23	.46
BDI	—	—	—	–0.79	2.96	.79	—	—	—
IES	—	—	—	6.01	2.88	.04	4.46	2.12	.05
TRED	—	—	—	—	—	—	–0.16	1.88	.94
TRED × Time-2	—	—	—	—	—	—	2.28	0.97	.02
DBP									
Intercept	84.22	10.29	.001	93.44	10.31	.001	90.66	10.39	.001
Sex	–9.44	3.56	.01	–10.89	3.42	.002	–10.66	3.39	.003
Age	0.03	0.23	.88	0.05	0.22	.84	–0.01	0.22	.979
Exercise	0.79	0.8	.32	0.68	0.76	.37	0.87	0.75	.25
Tobacco	4.42	3.84	.25	2.32	3.88	.55	3.21	3.72	.39
BP Hx	7.11	5.24	.18	5.76	5	.25	6.36	4.98	.2
BMI	0.01	0.33	.97	–0.24	0.33	.48	–0.28	0.32	.39
Length	0.03	0.02	.13	0.03	0.02	.17	0.04	0.02	.09
Initiator status	0.23	0.32	.94	–1.28	3.15	.69	–1.01	3.08	.74
Time-1	0.47	1.05	.65	0.49	1.05	.64	0.46	1.05	.66
Time-2	0.35	0.97	.77	0.37	0.97	.7	0.38	0.93	.68
BDI	—	—	—	–0.40	2.37	.87	—	—	—
IES	—	—	—	4.91	2.3	.04	3.66	1.79	.05
TRED	—	—	—	—	—	—	.45	1.47	.76
TRED × Time-2	—	—	—	—	—	—	1.41	0.65	.05

Sex (1 = men; 2 = women); Time-1 = dummy-coded variable distinguishing between study baseline and all other periods, which accounts for a linear change in BP from the baseline to the mundane events recall (MER) task period; Time-2 = dummy coded variable distinguishing between the MER and the divorce-specific mental activation task (DMAT) period; BPHx = history of physician-diagnosed high blood pressure. BMI = body mass index; BDI = Beck Depression Inventory; IES = Impact of Events Scale; BP = blood pressure; TRED = task-rated emotional difficulty score; Length = length of time in months the participants were married before the separation; Initiator status = participants' reports of who initiated the separation (1 = you initiated the separation; 2 = your partner initiated the separation).